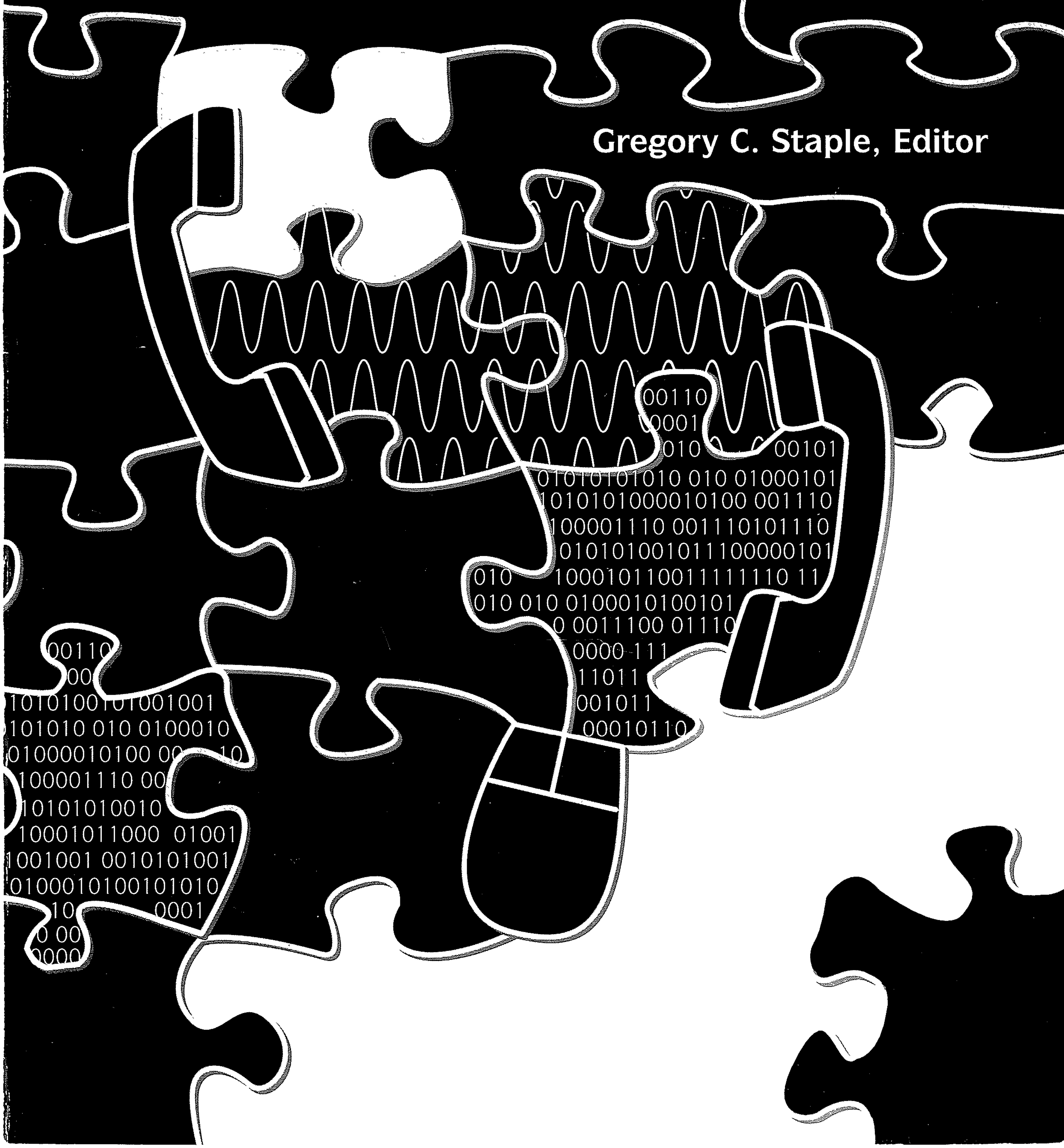
TeleGeography 1999

Global Telecommunications Traffic Statistics & Commentary

Gregory C. Staple, Editor



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Global Telecommunications Traffic Statistics and Commentary

First Printing—October 1998

Second Printing—November 1998

Third Printing—January 1999

ISBN 1-886142-15-7

Printed in the United States of America

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This report was prepared by TeleGeography, Inc., an independent research and publishing company based in Washington, D.C.

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Preface

Beyond the Beginning

Today, there is no doubt that telecommunication carriers and customers have reached the shores of a new world. Like Columbus in 1492, after his ships landed in the West Indies, we too have survived the uncertainty of the open seas. We have now reached the terra firma of a new age. And we have some idea, based on experience, of the contours and characteristics of the new terrain. We also know the vast opportunity provided by the interior into which we enthusiastically move.

Deregulation, privatization and liberalization not only have been predicted and anticipated, but also experienced. The WTO agreement has evolved from an exciting news story. It now serves as the underpinnings of business plans for new competing telecom companies all over Europe. The Internet is not just a trendy novelty with great potential, but an increasingly routine part of everyday life and commerce. The migration from switched networks to IP/data packets has moved from arresting futurology to conventional wisdom substantiated by fact.

So, with a bow to Winston Churchill, we may be able to look back to the close of the twentieth century, not as anything approaching the end, or even the beginning of the end, but as the end of the beginning—of the Communications Age.

As we solidify our beachhead and prepare a forward march into the new telecommunication world and the opportunities that surely await, a reliable guide is essential. That's why MCI WorldCom and Stentor are proud to sponsor *TeleGeography 1999*. For customers and providers, for regulators and investors, even for wandering citizens who want to understand the new world, this industry standard supplies trustworthy data and guideposts that are essential for the trip.

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Acknowledgements

We wish to thank the numerous carriers, government departments, regulators and international organizations from around the world who responded to our requests for information. This report would not exist without the help of the dedicated people at these organizations who took the time to ensure that the data reported here are as current and accurate as possible.

We would also like to thank the people who helped review the final draft of this book, including: Stephan Beckert, Nancy Dysart, Cindy Obenstine, Jonathan Starzyk, and Ian Watson.

TeleGeography 1999 was supported, in part, by a publication grant from MCI WorldCom, Inc. and Stentor Resource Centre Inc. As in the past, however, this grant was made without any pre-condition; TeleGeography, Inc. is solely responsible for the report's editorial contents.

The Editors

Introduction

by Gregory Staple, TeleGeography, Inc.

These are the days of miracles and wonder
This is the long distance call...
The way the camera follows us in slow-mo
The way we look to us all.

- Paul Simon, *Graceland*

Last year, we tracked the telephone industry's shift from carrier club to open market. The 1997 World Trade Organization (WTO) agreement liberalizing market entry by foreign telephone companies capped the old regime.

This year we consider how this new market-oriented regime is changing the industry's economic geography and vice versa. Telecom networks affect the global economy which, in turn, impacts the telecom industry's future prospects. In Part II we review some of the trans-national economic strategies—branding, service portals, and backbone networks—being pursued by major telecom companies. The Internet's cross-cutting power is given special attention. We close in Part III with a short note on the challenge of making tomorrow's network services not only fully international but interplanetary too. Let us start, though, with some down-to-earth economics.

I. The Networked Economy

Many readers of *TeleGeography* will have experienced that rush of emotion—panic, fear, depression—which accompanies the sharp drop in the price of one's listed shares. It can happen overnight (see Figure 1). The world's round-the-clock currency and securities markets have left few nations untouched and have dramatized the economic spillover from the last decade's investments in cross-border telecom facilities.

International telecom networks relay the successes and failures of once distant countries worldwide, and often in unpredictable and unprecedented ways. That has made the world smaller but, at the same time, less manageable, as policymakers struggle to account for the networked effect of hundreds of new places and actors. Telegeography may thus lead even the most powerful countries to lose control over social and economic matters which were thought to be purely local.

So large are today's currency markets, so great are the cross-border flows of capital, and so powerful are the networks which oil these transactions that no one country can intervene effectively. "It's just like the Internet," as one foreign affairs writer put it, "nobody is in charge" of the global economy (see Figure 2).

Whether or not governments are able to change that, as some propose (e.g., by creating a new global reserve bank and more flexible financial safety nets), it is now clear that the telecom sector itself will not escape unscathed from the present economic crises. Incumbent carriers and those newcomers fortunate enough to have issued shares before mid-1998 are now in a much stronger position. Other market entrants have been crippled. The cutback in Indonesia's foreign-led network expansion program and the uncertain future of network competition in Brazil are but two examples. The roll-out of mobile satellite services may be particularly hard hit if the purchasing power of the world's least wired markets (Asia, Africa) remains low just as new systems, such as Iridium and Globalstar, begin service.

Most telecom operators see themselves as innocent bystanders in this unfolding economic drama. In some ways, they are: international carriers did not cause the "melt-down" in Asian currencies or South American share prices. Nor can they single-handedly reflate the worlds' economies.

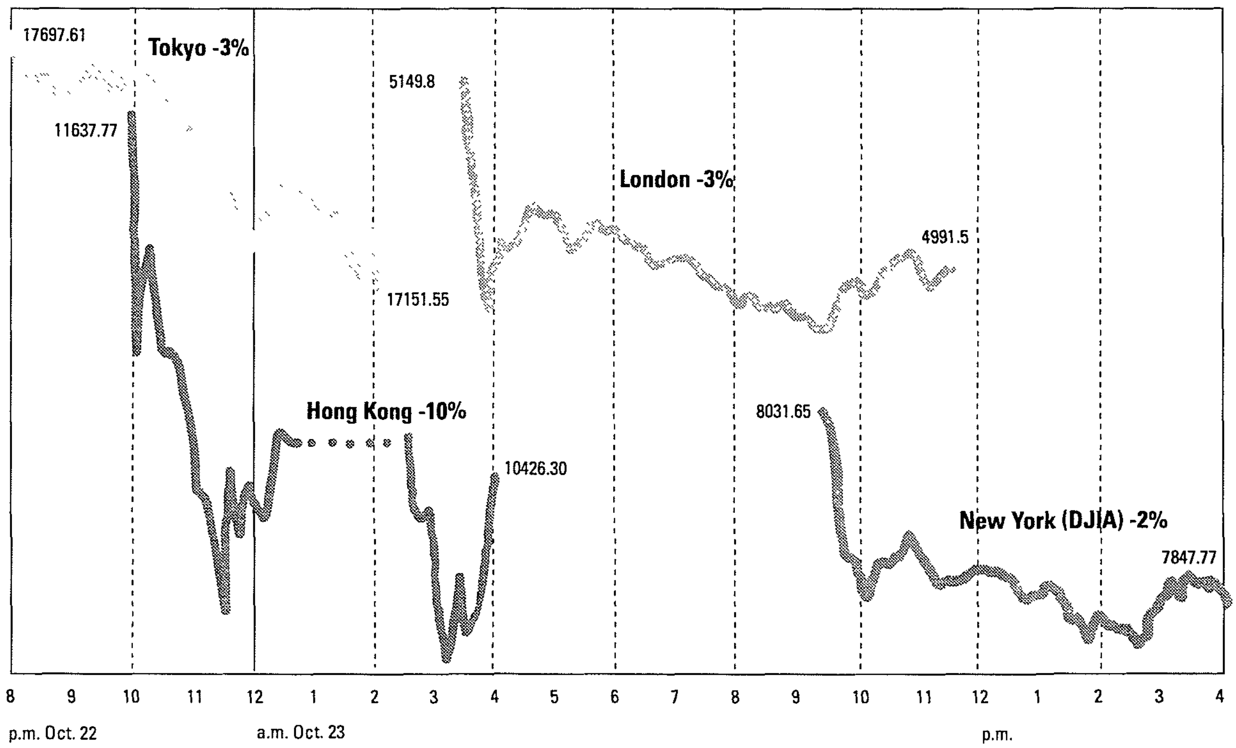
On the other hand, without global networks, the breadth of the recent market shocks, and the speed of their transmission to other economies—the so-called financial contagion—almost certainly would have been more limited. Likewise, without the global currency and securities markets which telecom networks make possible, any economic recovery will be far more protracted and uneven. It would thus be a mistake to discount the role which telecom networks have played in bringing us to the current economic juncture or in surmounting it. To see why, a brief historical reprise may be useful.

Since the late 1970s, first in the U.S. and Western Europe, and later more generally, telecom policy makers have advanced a new model for the industry, one based on private ownership and competition rather than state-owned monopolies. The initial stimulus for reform came largely from corporate users, especially in the financial community, and the computer industry. They feared that the enormous potential of computer-to-computer connections (data networks, electronic trading systems) would be frustrated if telecom sector rules (licensing, tariffs) applied. Businesses also wanted the right to self-provision networks, to buy their own terminal equipment, and to obtain private or leased lines on flexible terms.

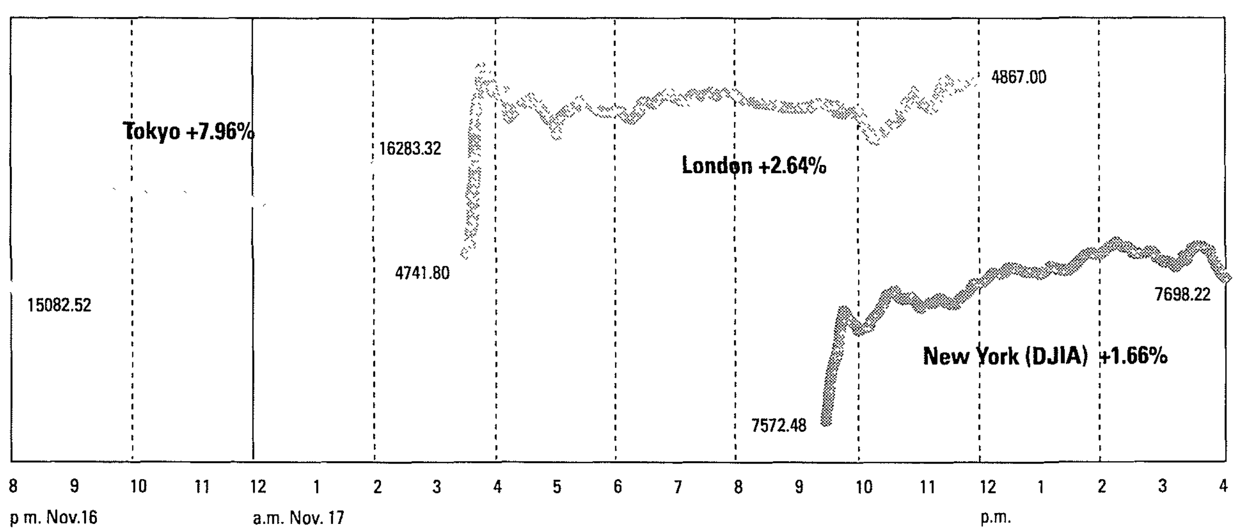
By the early 1980s, the reformers' agenda began to win wider political support. Governments admitted the poor performance

Figure 1. The Global Market: Someone Is Always Trading When You're Not

October 22-23, 1997: Hong Kong Market Drop Pulls New York Down



November 16-17, 1997: Japanese Surge Sparks Worldwide Rally



Note: Figures show Hong Kong, Tokyo, London, and New York (Dow Jones Industrial Average) stock exchange indexes. The Tokyo and Hong Kong exchanges close for lunch.
Source: *The Wall Street Journal*, © Dow Jones, Inc. 1998

Figure 2. Living in a Two Super-Power World

Few mainstream journalists have paid much attention to the ways in which electronic networks are shaping the world economy. One who has is Thomas L. Friedman, a foreign affairs columnist for *The New York Times*, now on sabbatical to finish a book about globalization. Some of Friedman's thoughts are excerpted below. The first except is taken from an April 6, 1998 speech in Washington, D.C. to the Anti-Defamation League (ADL); The second is from a August 15, 1998 column in *The Times*.

"The global economy is an entirely anonymous force. It's just like the Internet. Nobody is in charge ... Last year, I spoke at a conference on globalism in Morocco ... A former Algerian Prime Minister was there and he got up when I was done and said: 'Mr. Friedman, I have to tell you, this global economy you talk about, this globalization, is just another conspiracy to keep us down. It's like Zionism and Colonialism and Westernism ....' Mr. Prime Minister, I said, I have to tell you something. It's much worse than you think ... I wish I could tell you that we were back there turning the dials and pulling the levers ... But we're not. We're not thinking about you at all. That's what's really scary ... We're too caught up under the same pressures to downsize, to streamline, to get our economy in order, worrying about the bond market and the stock market and the man from Moody's. We live in a two super-power world. There is the United States and Moody's bond rating service. The United States can destroy you by dropping bombs and Moody's can destroy you by down-grading your bonds. It doesn't matter whether you are the United States ... or Canada or Algeria ..."

* * *

"I had an unusual interview the other day. It was with Dejair Birschner, the 48 year old Mayor of Una, a town of 32,000 inhabitants on the edge of Brazil's Atlantic rain forest. [I toured] the rain forest ecopark near Una that is supposed to provide jobs so .... people won't strip the forest bare and destroy one of the world's great ecosystems. Mayor Birschner said he understands that logging is not sustainable anymore but he also knows that his town really isn't prepared for life without logging... Mayor Birschner represents a whole generation of people ... who are trapped in a no man's land, between the computer generation that their kids, if they're lucky, might get up to speed for and their parents' generation that enjoy the stable existence from logging and farming. I knew what [the Mayor] was trying to ask me: 'My villagers can't live off the forest anymore, and we're not equipped to live off computers. What are we supposed to do?' ... There are a lot of [people] out there trying to avoid becoming road kill on the information highway. They are the villagers in Una, the pensioners in Russia, the unemployed in China, Indonesia, South Korea and Thailand. Analysts have been wondering for a while now whether those left behind by globalization will develop an alternative ideology to liberal, free market capitalism ... I don't think there will be an alternative ... [Those] who can't keep up will just eat the rain forest—each in his own way, without trying to explain it or justify it ... if governments don't develop safety nets for the left-behinds, to protect them from hitting bottom and to help lift them into the game ..."

of many state-owned operators and the very large amounts of capital needed to expand and to modernize their networks. The growing telecom demands of the service sector, already the largest employer in some countries, provided a further constituency for reform. Encouraged by such information-intensive businesses, most governments came to view telecom sector reform as a precondition for success in the information economy.

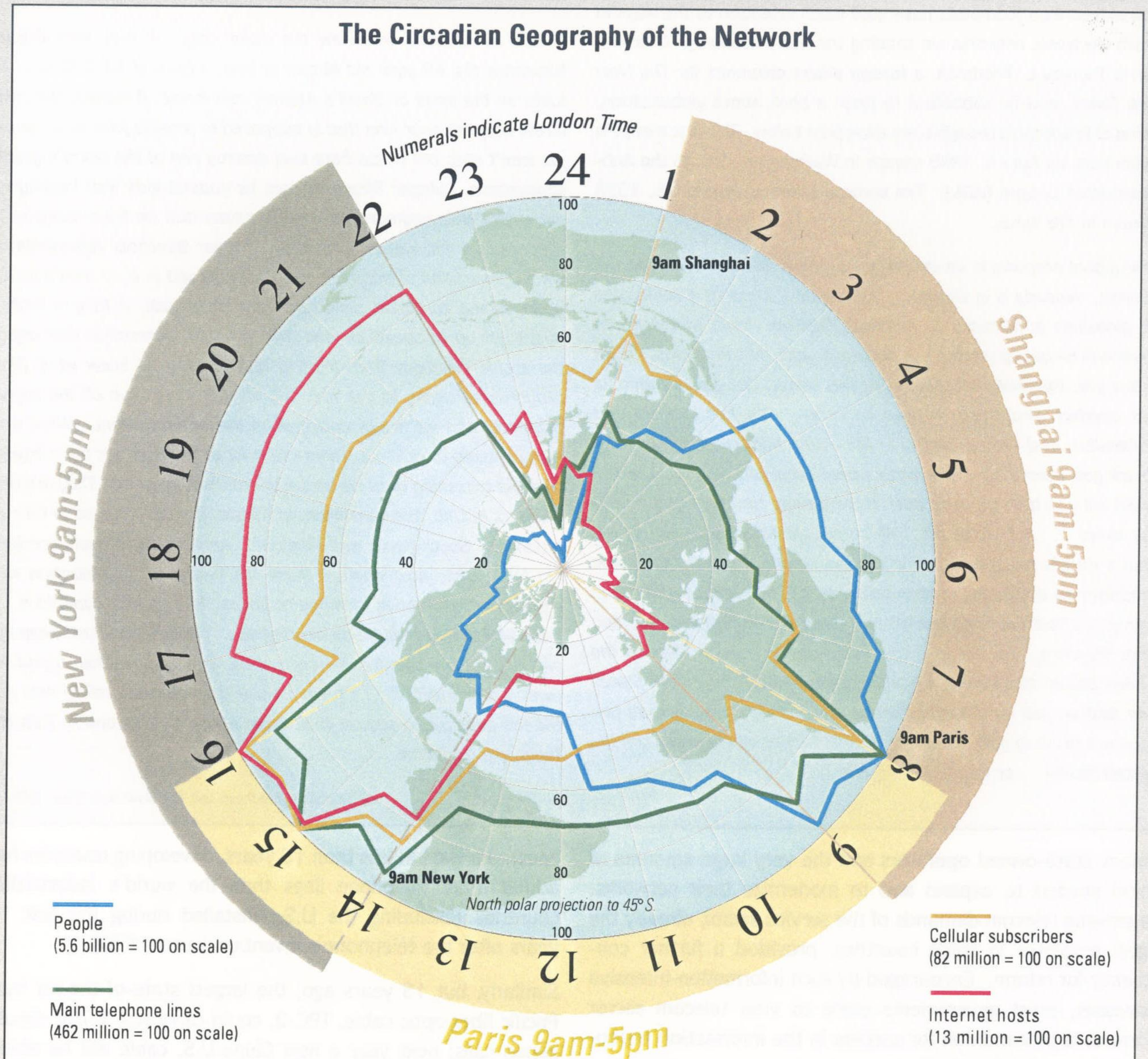
The victory of this reform agenda is well documented. Starting with British Telecommunications and Nippon Telegraph & Telephone in the mid-1980s, dozens of carriers have been privatized, numerous markets have been opened to competition, and sectoral investment has soared. The change in network access—in global connectivity—is truly astonishing, and the financial services industry has been among the greatest beneficiaries. Some of the statistics are worth reviewing because they show just how novel and, thus, how unprecedented is today's networked economy.

Since 1985, carriers have installed over one half of the world's fixed telephone network (over 400 million lines) and almost all of the world's mobile telephone facilities (another 175 million lines). Further, in less than 15 years, developing countries have added more telephone lines than the world's industrialized countries (excluding the U.S.) installed during the first 100 years after the telephone's invention (circa 1876).

Similarly, but 15 years ago, the largest state-of-the-art trans-Pacific fiber optic cable, TPC-2, could carry just 1,700 simultaneous calls; next year a new China-U.S. cable will be able to carry almost 5 million calls at once, and will increase trans-Pacific capacity more than sixfold. Call volumes already reflect the rapid change in connectivity. Within the next week, Americans will spend more time on the phone to Russia and China than they did during all of 1985. And, this year, international telephone traffic from South Korea to Japan will more than triple Korea's calls to the entire world in 1985; the same will be true for Korean traffic to China and the United States.

And then, of course, there is the Internet. In 1988 it connected a few hundred thousand people, mostly in the U.S. Today the Internet links over 100 million users in more than 150 countries, and as e-commerce gains wider consumer support, the Internet is rapidly becoming a marketplace of choice for trading shares and numerous other products.

Figure 3. Clocks are Maps—Time is an Atlas



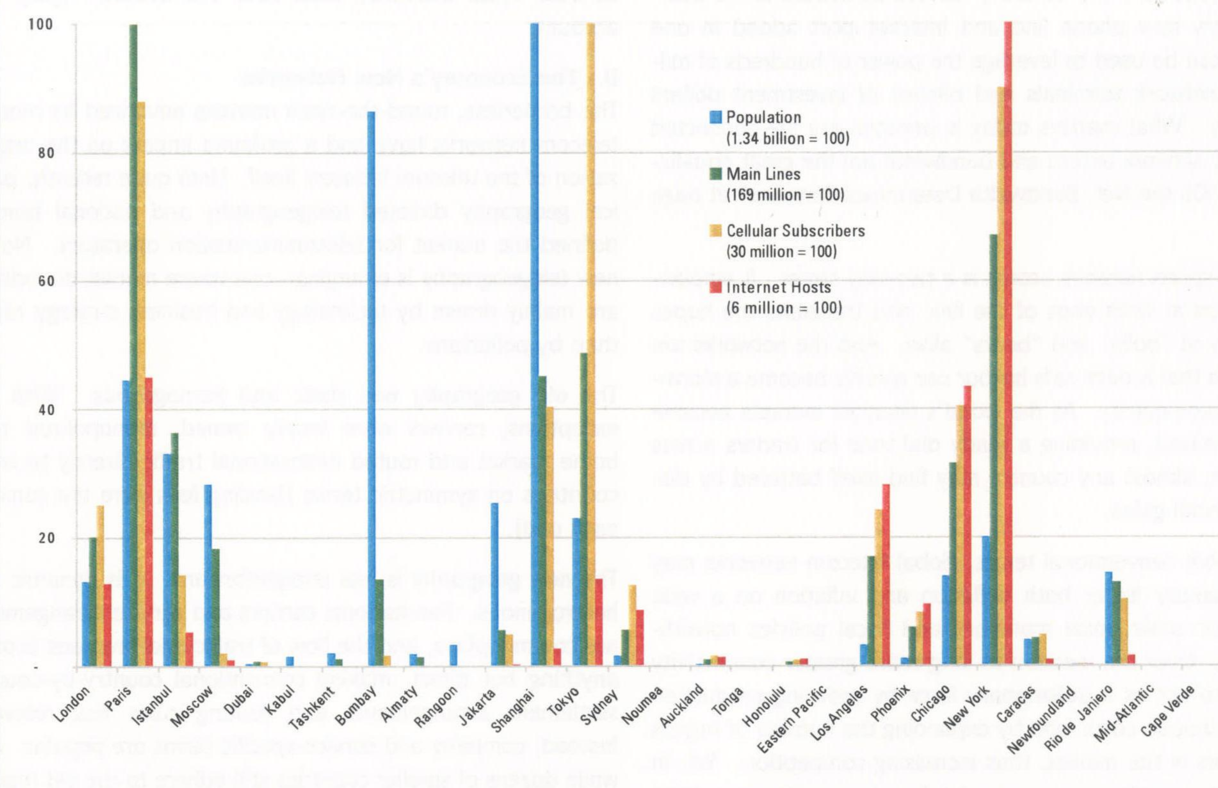
Global networks make time rather than distance the main barrier to communication. Time zones, networked together during office hours, have become continents. But because network terminals are not evenly distributed around the world, the size and position of these new continents varies. This map shows the proportion of the world's people, telephones, cell phones, and Internet hosts which may be connected during the working day (9 a.m. to 5 p.m.) in three cities: Shanghai, Paris and New York.

At 8 a.m. London time, the beginning of Paris's workday, the largest number of people and phone lines are accessible as Europe and Africa join their Asia colleagues at the office. But, as China goes home (after 9 a.m. in London) network connections drop until the Americans begin to arrive at work at 2 p.m. (14:00) London time. During the next few hours, available Internet hosts and cell phones peak only to taper off as New York goes home (22:00 London time).

Each day, while the demand for connections moves clockwise from east to west with the sun, available network capacity appears to move counterclockwise as network resources are idled during the night.

Figure 3. Clocks are Maps—Time is an Atlas (continued)

Indexed Population and Network Terminals By Time Zone, 1996



Key

The map on the facing page was created by summing data for each indicator (population, telephones, etc.) up to nine whole time zones (the period from 9 a.m. to 5 p.m.). The data were also scaled. Raw data for individual time zones are shown on this page. Data are for 1996. Data for the United States and Canada have been scaled according to the population of each state and province; other countries that span multiple time zones have been treated as if the total population and all terminals were found in the capital city. Data source: International Telecommunication Union.

"Clocks are Maps" was designed and produced by Gregory Staple and Zachary Schrag.

Population and Network Terminals By Time Zone, 1996 (millions)

	Time	Population	Main Lines	Cell Phones	Internet Hosts
London	12:00	181	34	8	1
Paris	13:00	609	169	26	3
Istanbul	14:00	452	62	4	0
Moscow	15:00	387	31	1	0
Dubai	16:00	6	1	0	0
Kabul	16:30	21	0	—	—
Tashkent	17:00	28	2	0	0
Bombay	17:30	1,180	23	1	0
Almaty	18:00	27	3	0	0
Rangoon	18:30	46	0	0	—
Jakarta	19:00	347	10	2	0
Shanghai	20:00	1,366	77	12	0
Tokyo	21:00	314	83	30	1
Sydney	22:00	23	10	4	1
Noumea	23:00	1	0	0	0
Auckland	24:00	5	2	0	0
Tonga	1:00	0	0	0	0
Honolulu	2:00	2	1	0	0
Eastern Pacific	3:00	—	—	—	—
Los Angeles	4:00	45	29	7	2
Phoenix	5:00	16	10	3	1
Chicago	6:00	191	53	12	3
New York	7:00	274	114	27	6
Caracas	8:00	55	7	1	0
Newfoundland	8:30	1	0	0	0
Rio de Janiero	9:00	197	22	3	0
Mid-Atlantic	10:00	—	—	—	—
Cape Verde	11:00	0	0	—	—

These new global networks have not only helped the world's market makers. By plugging into a network, small countries which are far from the world's major markets need no longer come second to more centrally located competitors. In addition, every new phone line and Internet port added in one country can be used to leverage the power of hundreds of millions of network terminals and billions of investment dollars elsewhere. What matters today is whether you are connected and how; network access and bandwidth are the great equalizers (see "On the Net, Bandwidth Determines Distance" at page 126).

But high speed network access is a two-way street. It empowers traders at both ends of the link, and transmits the hopes and fears of "bulls" and "bears" alike. And the networks are global, so that a once safe harbor can quickly become a storm-washed promontory. As the world's financial markets became network-based, providing a ready dial tone for traders across the globe, almost any country may find itself battered by distant financial gales.

Put in more conventional terms, global telecom networks may simultaneously foster both deflation and inflation on a wide geographic scale, local monetary and fiscal policies notwithstanding. Over the medium to long term, greater connectivity is likely to act as a deflationary force by reducing production and distribution costs, and by expanding the number of buyers and sellers in the market, thus increasing competition. Yet, in the short run, the expansion of telecom capacity may have exactly the opposite effect. By sharply cutting transaction costs, especially for financial services, electronic networks may inject (and later extract) huge amounts of liquidity into the economy. They may likewise radically decentralize the creation (and destruction) of credit by private actors (banks, hedge funds, corporations) in ways we do not understand. Hence the common belief that no one is in charge of the global economy.

Global networks also can make economic sentiment (i.e., market confidence) as contagious as wildfire, leading to worldwide bouts of optimism and gloom. Against this background, traditional economic policy tools (interest rates, government spending) may be of limited value in creating economic stability let alone renewed growth. The right approach probably will not be found until we know far more about how the tools we already have are affected by the networked economy described here.

Finally we must keep in mind that the global network ties all of its users to a distinct daily rhythm. Though networks make distance to market less important, they can make time more so. As a result, the ability to leverage one of the Net's three main time zones or telecontinents may become as important to economic success as network access (see Figure 3).

To sum up then, our thesis is straightforward: the triumph of telecom reform—including deregulated telephone services, unregulated markets for data communications, and the resulting network investments—is partly responsible for today's economic policy dilemmas. It follows that any serious attempt to address these dilemmas must take this telecom legacy into account.

II. The Economy's New Networks

The borderless, round-the-clock markets advanced by modern telecom networks have had a profound impact on the organization of the telecom industry itself. Until quite recently, political geography dictated telegeography and national borders defined the market for telecommunication operators. Now a new telegeography is emerging—one where market boundaries are mainly drawn by technology and business strategy rather than by politicians.

The old geography was static and homogenous. With few exceptions, carriers were locally owned, monopolized their home market and routed international traffic directly to other countries on symmetric terms (landing fees were the same at each end).

The new geography is less straightforward. It is dynamic and heterogenous. Pan-national carriers and service arrangements are commonplace, and the flow of traffic and revenues is often anything but direct, making conventional country-by-country settlement arrangements and routing rules less relevant. Instead, company and service-specific terms are popular. And while dozens of smaller countries still adhere to the old regime, tomorrow's telegeography will be distinguished by more and more local variation.

A. Agents of Change

The industry's post-national geography is being shaped by several factors. Three stand out. Of prime importance is the Internet. Its packet-switched architecture and protocols have become the medium of choice for new international networks. Internet traffic patterns differ markedly from those on the public-switched telephone network (PSTN). There are no fixed routes between service providers. International traffic typically is sent indirectly over several networks to take advantage of cheaper or less congested bandwidth. The flow of much Internet traffic also is asymmetric—reflecting the Internet's hybrid communications model, which is like telephony (one to one) and broadcasting (one to many) at the same time. The few key strokes needed to enter the name of a far-off Web site may then generate a torrent of bits in the opposite direction. The financial terms on which Internet service providers hand off traffic amongst themselves are different as well.

Politics has also played a role in changing the industry's geography. As with other economic sectors, governments have opened most of the largest telecom markets for competition, and the WTO agreement generally prevents politicians from later closing the door. This has prompted foreign carriers to enter new markets in droves. (See our *New International Carriers* directory for the details.) International joint ventures and end-to-end service arrangements are growing. Prices are falling. And investment capital has been plentiful. (That may not last, of course, given the recent downturn in equity markets.) All of this has affected cross-border traffic patterns.

The rapid buildout of mobile telephone networks is a third factor underlining the breakup of the old world. Mobiles still generate only a small portion of all international traffic. But the spread of wireless terminals, like the Internet, has changed many people's perception of place. Once fixed and site-specific, offices and homes are becoming transient—a function of personal mobility and available telecom networks, a social rather than a physical construct. Every additional mobile adds to this new sense of place and to the overall demand for borderless communications, anytime and anywhere.

It is much too soon to be sure about the various ways the Internet, competition, and mobile service networks will change the geography of international communications. The process is uneven and changes in some countries are well along while the status quo continues elsewhere.

B. Post-National Strategies

As national boundaries cease to define the traffic base, facilities and routing options for international operators, how will the industry adapt? What will distinguish the winners among tomorrow's stateless operators?

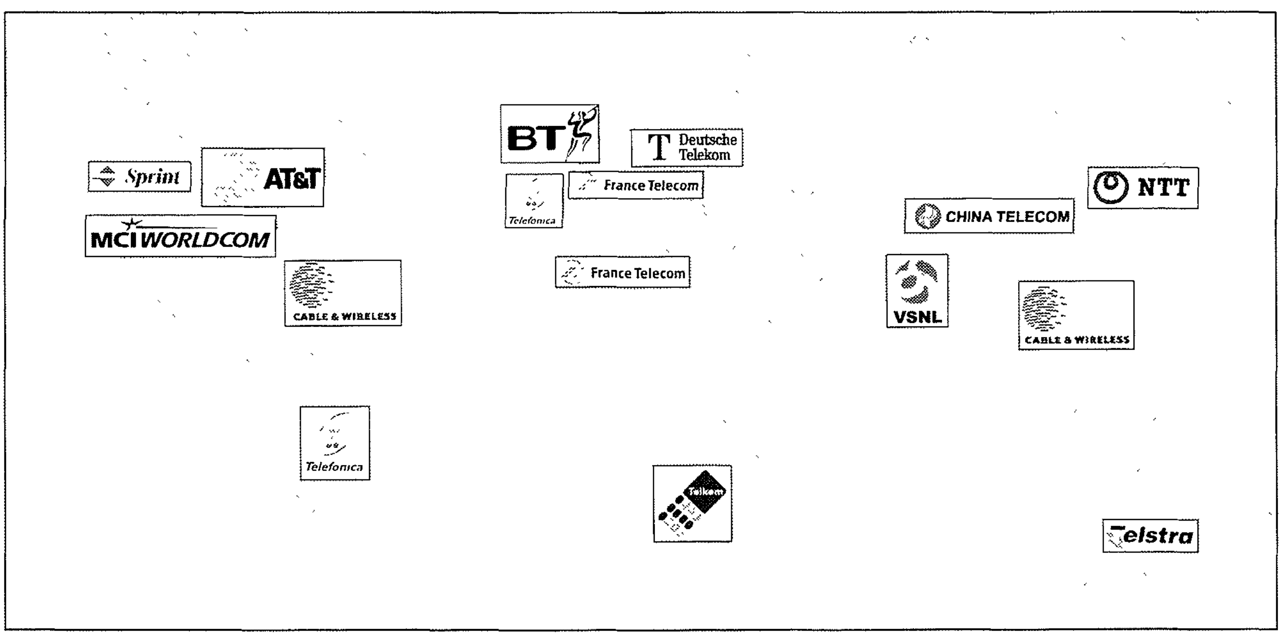
1. Brands

One response to the declining power of physical geography is the promotion of a strong virtual substitute: a brand.

For the largest telephone companies with global ambition, branded services may be paramount, especially as falling prices make discounting schemes less viable. Global brands already define the market for many products which, unlike telecommunications, have not been regulated closely. Brand names for the top-selling sport shoes, cars, drinks, and cosmetics—Nike, Ford, Coca-Cola, Revlon—are better known than most countries. *Indeed, for many consumers, brands are countries.* They provide identity, security, status, and a passport to success, regardless of nationality.

Only a handful of telecom operators have global brands today. AT&T is reportedly the best known (see Figure 4). As monopolies, most telecom operators paid little attention to their brand name. Many incumbent carriers still have weak brands. It is the new entrants, often mobile carriers, that have made branding a priority, although success has often eluded them too. A recent survey of European consumers by Andersen Consulting and the French company, Ipsos Opinion, found that less than ten percent of users could name a telephone company outside their home market (e.g., only three percent of Germans named

Figure 4. Branding the World: The Best Known Telecom Brands



Note: In the latest edition of *The World's Greatest Brands* (New York University Press, 1997), a quadrennial survey by Interbrand, an international leader in branding services, only one telephone company, AT&T, was ranked among the world's 100 most popular brands. And even AT&T ranked 55th, well below such would-be competitors as Microsoft (9th) and IBM (10th).

Source: Interbrand (www.interbrand.com), TeleGeography, Inc.

Figure 5. Global Numbers for Global Markets

However you label it—toll-free, free-call, or 800 service—universal freephone service is off to a slow start. In its first year (before services were launched) only around 16,000 numbers were registered with the ITU. Following the pattern of national freephone services, the system is more popular in some areas than others. Currently, around 90 percent of all national freephone numbers are registered in North America, and a large majority of universal international freephone numbers (UIFNs) are registered there as well.

To receive a UIFN, a customer applies through a Recognized Operating Agency (ROA), which includes all companies recognized by a telecom regulatory authority. Once approved, the customer must implement the number in at least two countries within 90 days of registration, or the number will immediately return to the pool of available numbers. Unlike registering an Internet domain name, a customer pays a one-time fee (currently around 200 Swiss Francs/US$140) to register and to maintain the number rather than paying annual or bi-annual fees.

UIFNs are registered on a first-come first-served basis, with no extra charge involved for "vanity" numbers. If a duplicate application is received, priority will be given if one of the applicants has the same number registered for national freephone service.

Once registered, the number is completely portable, allowing the customer to retain the same global number when changing service providers or adding new routes. The cost of the incoming calls, varying by carrier, range from about $1 to $2 a minute in the U.S.

Currently, universal freephone service is available in the following countries: Australia, Belgium, Denmark, France, Germany, Hong Kong, Japan, Netherlands, New Zealand, Norway, Switzerland, the United Kingdom and the United States. Other countries have agreed to participate in the program, but have not yet implemented the system on their networks.

BT and only one percent of British consumers named Deutsche Telekom).

By comparison, the competition in waiting—the Internet—has a growing roster of global brands. Netscape, Microsoft, AOL, Yahoo, IBM and even Sun (Java) probably have wider name recognition than do Deutsche Telekom or Teleglobe. Then there is the television industry, increasingly Internet savvy (visit www.msnbc.com), and with a large stable of global marks: ABC (Disney), NBC (GE), MTV (Viacom), CNN (Time Warner).

Telecom operators probably have two choices. They can purchase, or ally, with the strongest brands available in the broader communications industry. Or they can spend heavily to create their own brands. The financial value of such an exercise should not be underestimated. Based on a survey by Interbrand, Telecom New Zealand (TNZ) restated the value of its intangible assets in 1998 to include NZ$3 billion for brands —almost 40 percent of its total assets. Though some accountants might find such a valuation suspect, TNZ's approach reflects the post-national world of telecom competition. When brands trump nations, branded services will be the price of sovereignty.

Various cross-market branding strategies are also becoming common. Excel (now owned by Teleglobe) and other telcos have already announced flat rate long distance telephone services on the home pages of various Internet companies. Some observers suspect that the recent wave of big mergers in the U.S. (AT&T-TCI, GTE-Bell Atlantic, SBC-Ameritech) is driven in part by the desire to develop national consumer brands for bundles of different telecom services. In Europe, efforts are afoot to create multinational marketing identities. For example, BT, Telenor, and Tele Danmark recently named their consortium Telenordia as part of their strategy to tackle the Scandinavian market.

Advertising expenses are likely to rise as more companies launch branding (or rebranding) campaigns. But carriers may be helped by two proven pan-geographic marketing tools: access numbers and calling cards. Each let carriers stake out a virtual territory far beyond their own physical networks.

Single or double digit access codes are particularly easy to brand. Hence, the spirited legal battle in France over the rules for allotting the 7 remaining single digit access codes for new carriers. Even where access codes are longer and less scarce, however, as in the U.S., a memorable number (e.g., call "10-10-321" to save 50 percent) can even provide a well-known company with a leading brand (in this case, MCI). Put the number on a calling card and its reach is even greater.

Most telephone access codes currently are, at best, national brands. Contrast the Internet, where a memorable address offers an instant global brand; you can click on it anywhere in the world and get to the same local site. One day soon more and more phone calls may start that way, with telephone numbers and Internet addresses automatically translated by the service providers' software. Branding global access codes will then be much easier (among other things). In the meantime, operators seeking a global access number must make do with the new "free phone" codes launched last year by the International Telecommunication Union (ITU) (see Figure 5).

2. Portals

While strong brands will help some companies tap a wider market, others may go global by promoting new service gateways or portals. And while brands are all about creating one's own identity, success in the portal business is likely to depend on partnerships.

As Randall Rothenberg related in *Wired* magazine, "The theory that profits lie in serving a gateway through which consumers pass ... took off about last March—around the time Yahoo affiliated with MCI." Disney then bought the rest of Starwave to become a portal and Lycos did a deal with AT&T to become one, too. In May, a little known enterprise called Zap Corporation, formerly in the seafood-processing market, made an unsuccessful $1.7 billion offer for Excite, one of the last independent, high-profile search engines.

Portal pandemonium continued in June with NBC and Disney buying into, respectively, CNET's Snap and Infoseek. AT&T and AOL could not agree on a merger, however, and AT&T turned around and bought one of yesterday's choicest portals, the cable TV giant TCI.

Watching these deals unfold led Rothenberg to conclude that "becoming a portal involved no special skill set." And, he's right, of course. In cyberspace, if you don't have an attractive front door or a good location, build it. If your business doesn't generate a lot of consumer traffic, find a partner or two or three who does. This is information architecture, after all. We're not talking about national parks. Like other virtual artifacts, portals have no natural beauty; their landmark status and crowd drawing ability are all artificial (see Figure 7).

For telecom operators, therefore, portals might be thought of as a generic term—a virtual construct rather than a finished product. Markets are becoming global and customers are demanding easy access to both voice and data services. New network gateways—let's keep calling them portals for now—are likely to play a key role in helping carriers meet this twin challenge.

Portals also are a magic word for investors. Even though the stock market has cooled dramatically, a typical portal company such as AOL or amazon.com is still trading at a much higher earnings multiple than is common for major international carriers (see Figure 7).

So how do telephone companies become portals? For the most part, they already are, but without the cachet. Think: access codes, directory assistance, free phone numbers and calling cards. Branding services like these can make any telephone keypad into an effective portal for many voice services.

But to be a portal, carriers will need to find ways to leverage their current traffic streams. They must also duplicate their brands on-line so as to draw a wider audience and to offer more services (e-commerce). That is where partners come in. Telephone companies are just learning to manage web-based information and entertainment services. By joining forces with widely known Internet sites they are likely to leverage the reach of all concerned.

3. Backbones

To some readers the preceding discussion of brands and portals may seem beside the point. Brands don't deliver services—networks do. Without networks, portals are a dead end. Network facilities have always set the bounds for telecom markets, and now that governments have stopped artificially partitioning networks along national or even sub-national lines, networks will define whether a carrier is sovereign or not. Anyone who doesn't realize that has got their OSI protocol stack upside down (see Figure 6). Services run on top of networks, not vice versa.

This engineering perspective is compelling in many ways. And it enjoys as much favor, perhaps more, in the investment world as the sales (brands) and marketing (portals) visions discussed above (see Figure 8).

The rise of Internet Protocol (IP) based networks presents telephone carriers with the biggest economic and technical challenge since national voice networks were first knit together in the early 20th century. Packet-based communications networks using IP technology are angling to take over the services offered by established telephone companies as never before. The new IP-centric or "next-gen" telcos are likely to have radically lower cost structures than the incumbents (see Figure 9). And they can efficiently transport video and data services as well as voice traffic. Thus, as Randall Hancock and Charles Gerlach of the Gemini consultancy, Cambridge, Massachusetts, wrote in a recent White Paper: "This IP revolution is real. It is happening now, and it will fundamentally restructure the $500 billion global telecommunications industry over the next decade." The big question, of course, is where and how fast?

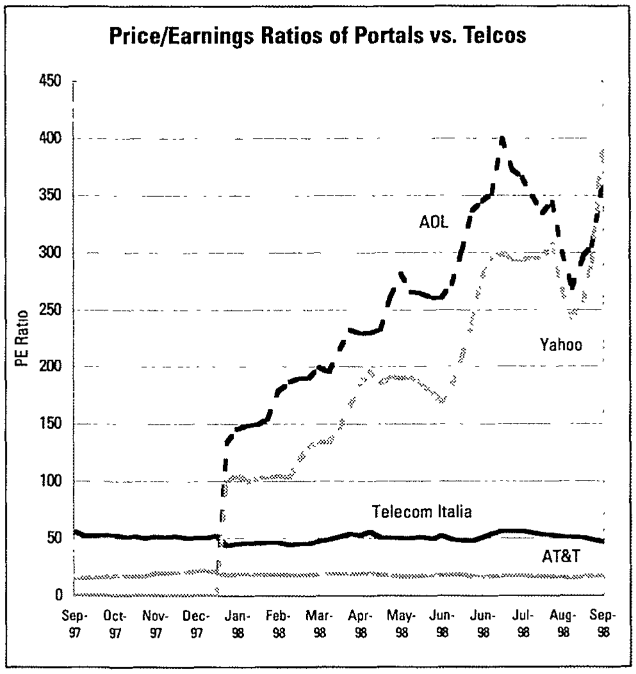
Figure 6. The OSI Protocol Stack

The Open Systems Interconnection (OSI) standards provide a seven level design framework for communication networks so that equipment from different vendors can interoperate. The first three levels of the OSI stack are the Physical, Data Link and Network layers, which roughly correspond to the network infrastructure and routing protocols. The last three layers are Session, Presentation and Applications which affect specific user services. The fourth level—Transmission—typically provides a software interface between the top three and bottom three layers. However, bright line boundaries between different OSI levels do not always exist (e.g., some Level 3 functions may be performed by a network at Level 2 or 4).

Figure 7. Virtual Places, Real Money

The astonishing market value which portals now command may have taught the telecom industry a valuable lesson (see chart at right). Virtual places can have every bit the economic clout of physical places and sometimes more. This may seem illogical. We are accustomed to describing the places we know in terms of their physical attributes—the street where we live, the countryside we saw on holiday. Yet, places are always a mix of hard (physical) and soft (social) factors. The character of a neighborhood or a resort is determined not simply by its physical characteristics, but by our interaction with others and with the place itself. Likewise, the Internet runs over thousands of kilometers of cable circuits and myriad computers in tens of countries, but it is nothing if not a social network.

A new generation of geographers is trying to make sense of the power held by both virtual and physical places. Paul Adams, a professor at the State University of New York, Albany, argues that place is best understood as a function of communications and human action—that is, as a historical process. Adams (with Barney Wharf) recently co-edited a special issue on cybergeography for the *American Geographical Review*. He contends that the pattern of communications defines the existence and particularity of place just as do walls, furniture or sight lines. Adams writes: "a communication system is to communicators as a place is to inhabitants." That may also help to explain why the spread of new communication systems, particularly the Internet, has been accompanied by so many geographical metaphors from "chat room" to "information highway" to "home page."



The international phone network and the Internet already connect. But IP network gateways to the PSTN are still relatively scarce. By and large, today's Internet is a network within other networks, built from various carrier-owned transmission circuits and largely non-carrier switches and terminals. It primarily transmits non-voice traffic. In contrast, although the PSTN provides local dial-up gateways for Internet users, in most of the world the PSTN is still used primarily for voice traffic.

The functional differences between the telephone network and the Internet are breaking down, however. The main reason is data traffic. Demand for data communications is rising much faster than for voice, and new technologies make it ever cheaper to convert any traffic stream into a digital (i.e., data) format. Thus, as data traffic becomes predominant—that probably happened this year for some U.S. long distance carriers (see Figure 10)—the core transmission function of the Internet and the PSTN will converge and so will protocols, say network engineers. Both networks will be primarily data networks with IP or IP-compatible traffic and, consequently, they will also be direct competitors.

International telephone services face the most immediate challenge from IP services. Fax traffic accounts for at least 20 percent of international minutes on the switched network and on many trans-Pacific routes the share exceeds 50 percent. IP fax programs already are integrated into word processing and e-mail applications; they can also be downloaded from IP fax carriers, such as FaxSav or FaxWeb. While Internet fax remains a niche business for now, international IP services are quickly moving into the mainstream.

The head-on challenge which IP fax and later IP telephony pose for existing operators has led many of them to buy or build similar low cost, IP-friendly networks. Most incumbents already control the all important "last mile" of the network. Long haul IP backbone facilities have thus become the real geographic imperative. As the IP revolution gathers force, it is the reach and capacity of these networks that will define one carrier's sphere of influence *vis-a-vis* its competitors.

For example, Sprint has announced an ambitious plan for a new broadband integrated data network (see Figure 10). That plan was apparently triggered, in part, by WorldCom's pending acquisition of MCI, a deal which WorldCom said would provide it with an unrivaled network for "corporate" (read: data) customers plus an enhanced Internet backbone. Competition authorities later ruled that MCI had to divest its Internet business as a precondition to the merger given the large Internet backbone business WorldCom already had (i.e., UUNet). But the buyer of MCI's Internet business, Cable & Wireless (C&W), was permitted to lease transmission capacity from the new MCI WorldCom; both MCI and WorldCom kept their existing networks, which are considerable. WorldCom's European fiber

Figure 8. Next Generation Networks: Betting on the Future

Performance of Next-Gen Network Stocks Since IPO

Company	Market:Ticker	IPO Date	Offering	Offer Price	Sept. 17, 1998
Global Crossing, Ltd.	NASDAQ:GBLX	Aug. 13, 1998	$399M	$22.00	$19.75
Equant	NYSE:ENT	July 20, 1998	$541M	$27.00	$47.75
IXC Comunications, Inc.	NASDAQ:IIXC	July 2, 1998	$89M	$16.00	$30.06
Level 3 Communications, Inc.	NYSE:LLL	May 19, 1998	$132M	$22.00	$35.25
Global TeleSystems Group, Inc.	NASDAQ:GTSG	Sept. 26, 1997	$222M	$20.00	$29.50
RSL Communications, Ltd.	NASDAQ:RSLCE	Aug. 25, 1997	$158M	$22.00	$22.13
Qwest Communications, Inc	NASDAQ:QWST	June 24, 1997	$297M	$22.00	$32.50
COLT Telecom Group	NASDAQ:COLTY	Dec. 10, 1996	$300M	$18.10	$44.38

optic net (Ulysses) is now linked to the U.S. via the new 30 Gbps Gemini cable, and a WorldCom backed trans-Pacific cable (Southern Cross) is scheduled for service in 2000.

A high speed (200 Gbps) IP backbone network is also at the center of the AT&T-BT joint venture for international services announced this July. The new venture will combine both companies' existing facilities. Additionally, it will spend $1 billion over five years—in part to buy technology from others—to develop a "carrier strength" IP network linking 100 major cities. Corporate executives shepherding this new venture have also hinted that within a few years this new IP network could largely replace the two companies' international switched networks, and all the conventional interconnection and settlement fees that go with them.

What AT&T and BT are now whispering has already been shouted by today's upstart IP telephone operators. Yet few have cared to listen, perhaps because the implications are so unsettling and also so uncertain. The international telephone business is just coming to grips with the revenue and pricing consequences of changing from a century-old regime of standard, country-specific call termination charges or settlement fees to a system of network access fees which not only vary by country, but often by city and carrier too (see page 62). International IP networks now threaten to orphan this infant regime by adopting a new family of interconnection arrangements based on Internet traffic flows. What that will ultimately mean for the balance of payments between carriers or the bottom line is still anybody's guess.

Peering (sender keep all) arrangements have been popular among most Internet networks in the past. But larger networks now seem keen on promoting pay-as-you-go terms for all but a handful of other large networks with which they will peer privately. And whereas international carriers have long shared the cost of transnational circuits, each paying their way to a midpoint, there is no such rule for the Internet and no agreed midpoints. More alarming still, unlike international telephony, retail customers are typically billed for Internet services at a flat monthly rate regardless of the duration or distance of the connection (though outside North America per minute local call charges often apply). In these circumstances, those international operators willing to contemplate an IP network future seem brave indeed.

Nevertheless, the AT&T-BT vision is a multi-billion dollar endorsement—some might say, gamble—on the direction being taken by the world's IP-centric telephone companies. Two U.S. companies, Qwest Communications and Level 3 Communications, have attracted the most attention, although non-U.S. telcos such as Bell Canada, which has announced its own North American IP backbone, have similar plans. Qwest has almost completed a 16,000 mile long distance fiber network in North America with more bandwidth—48 fiber pairs, each operating at 9.6 Gbps (OC-192)—than AT&T, MCI WorldCom, and Sprint now use combined. Over a fraction of this capacity, Qwest has begun selling flat rate, 7.5 cents a minute, long distance calls in the U.S. It has also sold or swapped capacity on its network to GTE, Frontier, and Teleglobe, among others.

Qwest's willingness to sell "dark fiber" to its competitors has been a ray of light for many smaller telcos which understand the IP network imperative but lack the resources to act independently. Most telecom regulators have recognized that resale opportunities, like interconnection rights, are crucial to the development of fully competitive telephone service markets. But data networks historically have been able to pick and choose their network partners and resellers, and the network access which Qwest has offered its competitors thus far could well be denied downstream. Furthermore, other IP networks may set different policies.

Like the new AT&T-BT venture, the eponymous Level 3 (recall the OSI stack) hopes to build its own high capacity IP-based network which can interoperate easily with the PSTN. Level 3 wants to deliver end-to-end services, not merely trunking capacity, as Qwest does today, and thereby capture the full cost advantages of its network. To do so, Level 3 has allied with major equipment vendors such as Cisco (which will also help switch Sprint's ION traffic), Nortel and Lucent.

Level 3 and its allies are pushing Internet engineers and the ITU's standards body to adopt IP Device Control (IPDC) software for gateway switches to control access to both IP and switched networks, thus creating a standard interface for voice and IP traffic exchange. In simplified terms, with IPDC, a network's Internet and PSTN gateway would be under the unified control of a media gateway controller (MGC). It would use the telephone industry's existing Signaling System 7 (SS7) to analyze an incoming "call" and then apply IPDC software to instruct an Internet or voice switched gateway, as appropriate, to carry the traffic.

Every major telco supplier is anxious to gain an edge in installing such next-gen switching technologies even if that means buying up data networking suppliers to get there. Nortel bought Bay Networks and is now known as Nortel Networks, while Alcatel, one of Europe's champions, merged

Figure 9. Next Generation Networks Will Cost Less

The data-centric long distance networks now being built by Sprint, MCI WorldCom, Level 3 and others are likely to have far lower delivery costs (70 percent lower, says Sprint) for most voice and data services. The reasons are: (1) a better performance/cost ratio for data switches and routers vs. conventional central office switches and (2) a 1,000 fold capacity increase for fiber optic networks since the late 1980s.

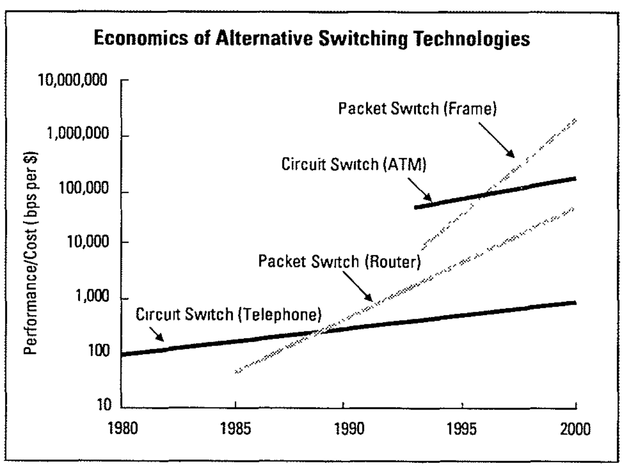
Switching Costs

For example, Level 3 CEO James Q. Crowe contends that IP packet switching has a better performance/cost ratio than Asynchronous Transfer Mode (ATM) or conventional class 4/5 PSTN switches, and the difference is growing. (ATM is a protocol for the high speed transmission of data packets.)

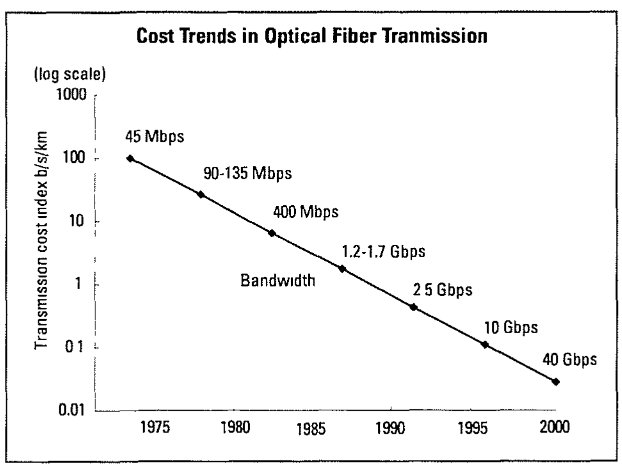
To support this claim, Crowe cites research by Peter Sevcik, a senior associate at Northeast Consulting Resources Inc. (Boston). Sevcik has found that each successive new generation of switching technology cuts the performance/cost doubling time in half. That is, conventional central office switches double their performance/cost ratio every 80 months, according to Sevcik, while ATM switches do it in 40 months. Even better, packet switches and routers double their performance/cost ratio every 20 months. For example, Cisco Systems 7000 Series, introduced in 1993, can switch 45 megabits per second at a cost of around \$320/Mb/s. Cisco's 12000 Series, introducd last year, can switch 2.4 gigabits per second at a cost of around \$30/Mb/s.

Transport Costs

New optical transmission technologies permit very large volumes of digitized voice or data traffic to be carried on a single strand of fiber optic cable by dividing the available bandwidth into multiple, frequency-specific channels of light. This technique, known as Dense Wave Division Multiplexing (DWDM), already permits carriers simultaneously to route over 1.5 million phone calls on a single fiber pair. The cost of routing calls is diminishing exponentially. In a few years, the capacity of a fiber pair is likely to be 15 times that or over 300 Gbps. DWDM will also permit similar very high bit rates on the next generation of trans-oceanic submarine cables, such as TAT-14, which will go into service in 2000 and beyond (see page 93). The per minute cost of carrying a voice call on such cables is minuscule.



Source: Peter J. Sevcik, Senior Associate, Northeast Consulting Resources, Inc., Boston, sevcik@ncri.com. Originally in "Why Circuit Switching is Doomed," Business Communications Review, Sept. 1997.



Source: AT&T data reproduced by the World Bank with Texas-based DSC Communications Corp. In addtition, Lucent (formerly an arm of AT&T) has bought several smaller datacom vendors too, and is actively promoting its own "voice-grade" switches for IP networking. The fear of Nortel et al is, if anything, more pronounced than their core customers: as IP networks handle ever more of the world's telecom traffic, the revenue stream from manufacturing and installing today's central office switches may fall off abruptly.

The strategic implications of the IP network revolution are hard to understate. Ever rising volumes of data traffic, and the new economics of fiber optic cables and high-capacity data switches, make data-centric networks compelling even for smaller carriers. The next-gen facilities of a Qwest or a Level 3 may seem geographically limited today. But a clutch of new undersea mega-cables will let them, and their offshore cousins, reach around the globe tomorrow.

In the short run, end-to-end IP backbones can be used by voice services for self-correspondence (to bypass accounting rates). Later, the same backbone capacity will be crucial to competing for new IP services, whatever they might be.

The economic logic of next-gen networks also looks compelling for any carrier that must compete on price or service quality. Data traffic is a bandwidth "hog" and those carriers with the largest backbone networks are most likely to be able to make the transition from the Internet's current "best efforts" packet delivery service to a 99.9 percent reliable carrier-grade model. Moreover, only IP networks which can deliver similar grades of service are likely to be offered "private" sender-keep-all peering arrangements. Networks which cannot meet the grade may end up paying by the packet for interconnection which, in turn, is likely to mean higher prices for customers or lower margins for the operator.

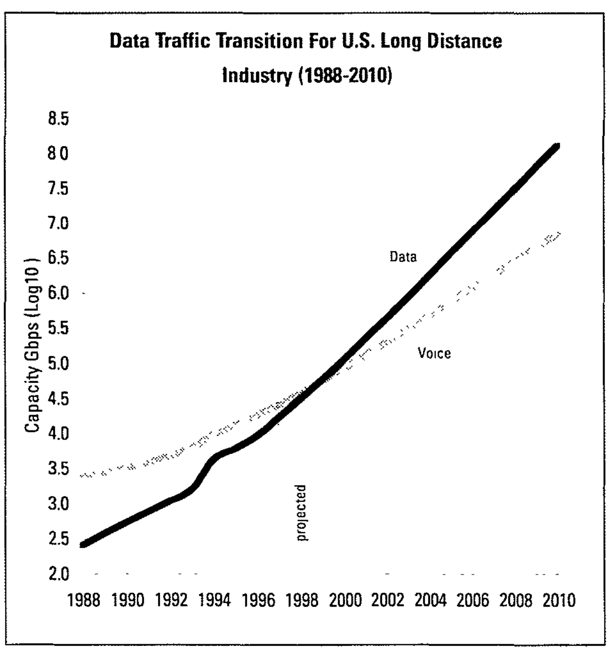
III. From Cyberspace To Outerspace

This essay began by considering the legacy of telecom policy reform and network investments on the economy—the so-called "network effect." Viewed from a distance though, say the mid 21st century, the most lasting legacy of today's global telecom networks may not be the worldwide diffusion of a market culture but the germination of an interplanetary one. How so?

Satellites and other space vehicles operate at such a speed and at such a remove from the earth that radio communication is always an essential part of the enterprise. Space to Earth links are one part of the infrastructure. So are the communication packages onboard every space probe. Global networks also are needed to link the wide array of ground stations used for command and control functions, as well as for downloading data and images. That is actually where the real telecom story begins.

Since the 1960s, successive advances in space communication networks have brought us face-to-face with the cosmos. Remember the Earth rise filmed by the Apollo astronauts on the Moon; the eerie familiarity of a rock-strewn desert relayed by the Viking lander on Mars; the wondrous haze of distant galax-

Figure 10. Data Eclipses Voice—Will Revenue Follow?



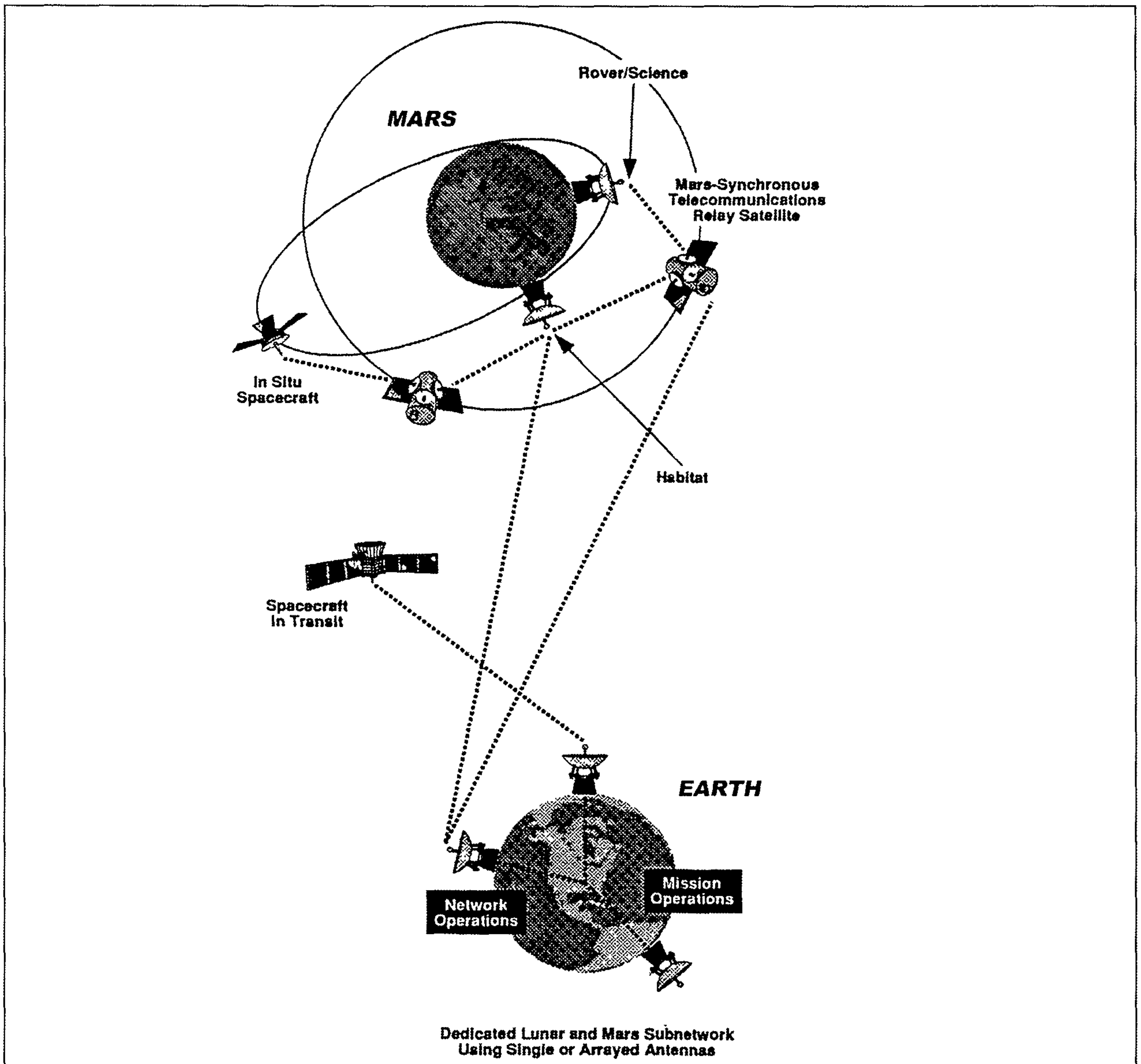
1998 appears to be the year when the volume of data traffic eclipsed voice traffic for some U.S. long distance carriers. Although conclusive statistics are not yet available, this crossover was anticipated by an influential 1997 analysis of U.S. long distance traffic by two MIT researchers, Philip Mutooni (now with I.P. Phusion Technologies, Inc.), and Dr. David Tennenhouse (see chart). In June 1998, Sprint seemed to confirm the MIT study in announcing that it would replace its current U.S. long distance network with a new broadband Integrated On-demand data Network (ION) for the simultaneous delivery of voice, video and data services. Overall, however, voice traffic on U.S. local exchange and long distance networks is still estimated to be several times the volume of data traffic. See A. Odlyzko, "The Internet and Other Networks: Utilization Rates and Their Implications." (www.research.att.com/~amo/doc/networks.html)

Source: *Modeling the Communication Network's Transition to a Data-Centric Model* by Philip Mutooni and David Tennenhouse. Capacity figures derived from data on mix of trunk lines at selected AT&T and MCI points of presence (POPs). For details, see: http://ksgwww.harvard edu/iip/iicompol/Papers/Mutooni.htm.

ies lensed by the Hubble telescope; and, just last summer, Pathfinder's stunning new panoramas from Mars. As image after image from Pathfinder was posted on the web site of the National Aeronautical and Space Administration (NASA), it became one of the most popular Internet destinations on Earth (see http://mars.ivv.nasa.gov). Millions of people looked to cyberspace for the best view of outer space.

All this publicity may not be lost on future mission planners. Most space communication systems have been narrowly tailored to a mission's scientific payloads. New space nets may be engineered with a broader purpose, especially as the number of interplanetary missions rises. For instance, the Jet Propulsion Laboratory (JPL) near Pasadena, California, a prime NASA contractor, already has an ambitious plan to bring the Internet to outer space by developing a more delay tolerant IP protocol to support high bandwidth communications. It also hopes to engineer a number of IP gateways in space that would relay communications from the earth to both planetary and deep space vehicles. The JPL scored something of a coup earlier this year when it appointed Vint Cerf, one of the Internet's founders, as a distinguished visiting scientist. As Cerf told the annual Internet Society Conference (ISOC) in Geneva last July, the time

Figure 11. Mars Calling: How NASA May Keep in Touch with the Red Planet



Source: A. Cohen, *Report of the 90-day Study on Human Exploration of the Moon and Mars,* NASA, Washington, DC, November 1989.

is right for developing an interplanetary Internet because planning for Pathfinder's follow-on missions is already well advanced.

Although Cerf's speech may have seemed far-fetched to many participants, the Internet's ability to deliver Martian vistas to people's desktop PCs seems to have sparked a broad new interest in space exploration. A month later, over 700 Mars enthusiasts from a dozen countries gathered in Colorado to found the Mars Society (www.marssociety.org). The founding convention was largely organized by Robert Zubrin, an independent astronautical engineer. His 1996 book, *The Case For Mars*, offers a blueprint for a comparatively low cost human mission to Mars by 2010. As the images relayed by future landers reach us, Zubrin argues that "we will see Mars as truly another world, no longer a notion, but a destination." Or as other space activists put it, "Space is a place, not a program."

The Mars Society is intent on raising private funds to get to the red planet, if governments decline to underwrite the mission. Some supporters have even hinted at selling media rights, Olympics-style. And, yes, ever so quietly, a few big name telecom brands have started to compete for the right to connect the first telephone call on Mars (see Figure 11).

Our review of interplanetary communications continues at the back of this volume. For those interested in more local networks, a new edition of our best selling wall map on world telecommunications will be published in January 1999. As always, we welcome your comments and suggestions.

Gregory Staple is President of TeleGeography, Inc. and a partner in the Washington, DC communications law firm Koteen & Naftalin. He can be reached by email at gstaple@telegeography.com.

For Further Reading

The Networked Economy

The economic impact of global networks was mooted a decade ago in *The Borderless World: Power and Strategy in the Interlinked Economy* by Kenichi Ohmae (Harper Business, 1990). For more recent accounts, see *The Death of Distance* by Frances Cairncross (Harvard Business Press, 1997); *Market Unbound, Unleashing Global Capitalism* by Lowell L. Bryan (John Wiley & Sons, 1996), and *Money/Space: Geographies of Monetary Transformation,* edited by Andrew Leyshon and Nigel Thrift (Routledge, 1996).

For background, see Gregory Staple, "TeleGeography and the Explosion of Place, Why the Network That is Bringing the World Together Is Pulling It Apart," in E.M. Noam and A. J. Wolfson (Editors), *Globalism and Localism in Telecommunications* (Elsivier Science, B.V. 1997).

Recent U.S. proposals to stabilize the global economy were outlined by President Clinton in a September 14, 1998 speech to the Council on Foreign Relations, New York (www2.whitehouse.gov/MH/New/html/19980914-520.html). See also the October 6, 1998 address by Michael Camdessus, Chairman, International Monetary Fund, to the Fund's Governors, www.imf.org/external/np/speeches/1998/100698.htm. For an instructive review of the debate on delinking weak economies from the global market by, for example, restricting capital inflows, see Martin Wolf, "Wisdom of Free Flows Questioned," *The Financial Times*, October 2, 1998; and the record of the October 2, 1998 IMF Economic Forum at www.imf.org/external/np/tr/1998/tr981002a.htm.

Next Generation Networks

The impact which IP-centric networks will have on circuit-switched telephone companies is profiled in a June 1998 White Paper by Randall S. Hancock and Charles L. Gerlach, "The IP Revolution," Gemini Strategic Research Group, Cambridge, Massachusetts. For an engineering view, "The Cook Report On Internet" (www.cookreport.com), published monthly by Gordon Cook, is invaluable. Also of interest are the April 1998 issue of *tele.com* on the convergence of television and the Internet (www.tele.com.com/0498/Features/tdc0498covers.html), and Andrew Odlyzko's papers on the data/voice network crossover (www.research.att.com/tildeamo/doc/networks.html)

Interplanetary Communications

The wireless modems which relayed Pathfinder's Martian vistas over 120 million miles are profiled in "Mars: 2400 Baud Away," by Todd Wallock, *Network World*, July 14, 1997 (www.nwfusion.com). For background on future mission requirements, see Michael A. Jordan, Eric O. Basgues, and Patricia E. Gould, "Communications Needs For Mars Exploration: Operational Implications," in Thomas R. Meyer, *The Case For Mars IV: The International Exploration of Mars*, (American Astronautical Society, 1997). A profile of NASA's current Deep Space Network for interplanetary communications can be found at http://deepspace.jpl.nasa.gov.

Carriers

International Carrier Evolution

Overview: Boom Times For New Carriers

As of July 1998, over 1,000 facilities-based international carriers were operational worldwide. Two years before, there were less than 500 (see Figures 1 and 2). These carriers, old and new, are all authorized to own and to operate international transmission facilities. How did they all arise?

Some owe their existence to politics—the abolition of monopolies. Others were helped more by new technologies (e.g., call-back switches) that made it easier for new entrants to gain a foothold in the market. Together, these changes have made it possible for carriers to service niche markets and later to begin building their own networks.

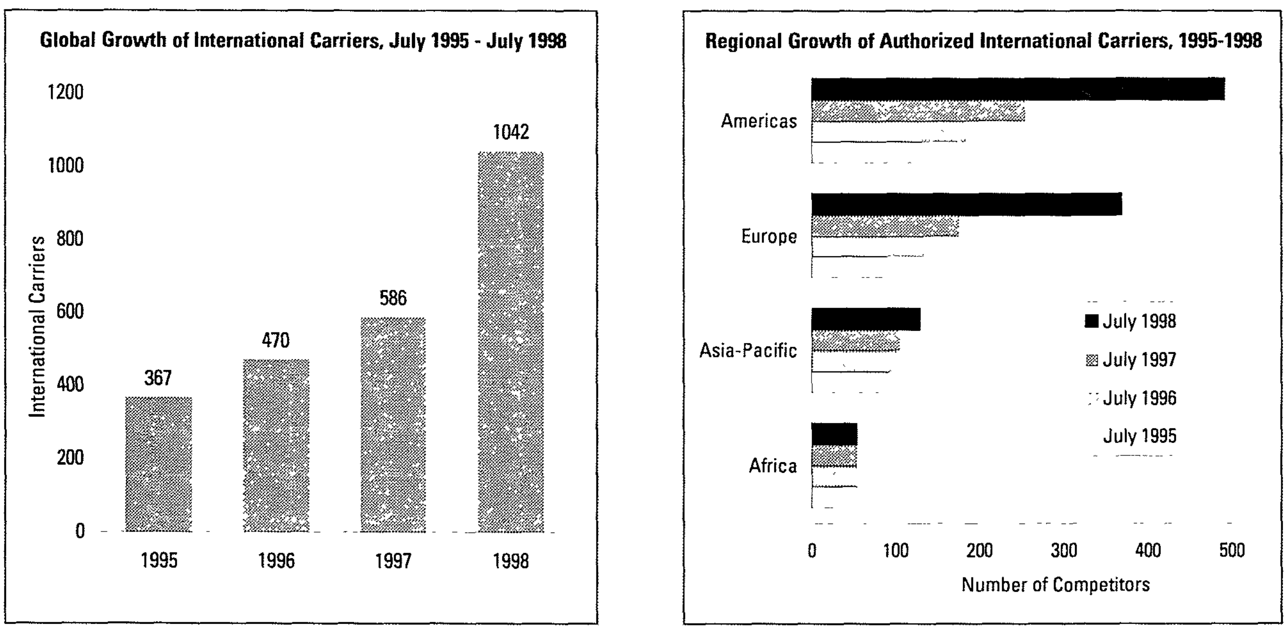
When examined country-by-country, competition has occurred on different schedules. On a regional basis though, change seems to come in waves:

North America - With over 200 new international carriers entering the U.S. market between July 1997 and July 1998, the U.S. leads the world in new carriers. This is due both to the streamlined authorization process in the U.S. and America's status as the world's premier traffic hub (not to mention a strong domestic economy). Soon the Canadian market will expand as well, as Teleglobe's monopoly on overseas calls will end later this year. For more analysis, see "Emerging North American Carriers" on page 47.

Europe - Spurred by the 1998 market-opening agenda of the European Union (EU), more than 400 facilities-based carriers now compete to provide international service. Competition is also taking hold in non-EU states: Switzerland will soon have at least 20 carriers; Iceland and Norway offer fully open telecom markets; and many Eastern European markets are preparing for liberalization. But the greatest growth has occurred in the U.K., where full competition was introduced in 1996. As of July 1998, there were more than 140 authorized international operators in the U.K., including both full facilities-based carriers and international simple resale (ISR) carriers (see below for more on ISR).

Asia/Pacific - Due to regulatory constraints and ongoing financial crises, competition has lagged in Asia. The notable exceptions are Australia and Japan, which

Figure 1. The International Carrier Boom



Note: Figures include all carriers authorized to provide international facilities-based service or international simple resale.

Source: Adapted from TeleGeography's 3-volume directory of international carriers, *New International Carriers.*

Figure 2. Countries with Multiple International Carriers

		Number of Authorized International Carriers				
Rank	Country	July 1998	July 1997	July 1996	July 1995	CAGR 95-98 (%)
1.	United States	393	175	115	65	82.2
2.	United Kingdom	144	100	65	35	60.2
3.	Germany	32	1	1	1	217.5
4.	France	29	1	1	1	207.2
5.	Russia*	29	25	21	18	17.2
6.	Netherlands	23	3	1	1	184.4
7.	Canada	21	21	19	18	5.3
8.	Switzerland	21	1	1	1	175.9
9.	Mexico	15	9	1	1	146.6
10.	Australia	14	10	8	8	20.5
11.	Austria	13	1	1	1	135.1
12.	Japan	13	3	3	3	63.0
13.	Sweden	13	11	9	7	22.9
14.	El Salvador	12	1	1	1	128.9
15.	Philippines	12	9	9	9	10.1
16.	Belgium	11	1	1	1	122.4
17.	Denmark	11	9	7	1	122.4
18.	New Zealand	11	9	9	2	76.5
19.	Chile	9	9	9	9	0.0
20.	Italy	9	1	1	1	108.0
21.	Spain	9	1	1	1	108.0
22.	Finland	8	8	8	5	17.0
23.	Norway	7	1	1	1	91.3
24.	Ireland	5	3	3	1	71.0
25.	Malaysia	5	5	5	4	7.7
26.	Hong Kong	4	1	1	1	58.7
27.	Colombia	3	1	1	1	44.2
28.	Dominican Republic	3	3	3	3	0.0
29.	Israel	3	3	1	1	44.2
30.	Kazakhstan	3	1	1	1	44.2
31.	Korea	3	2	2	2	14.5
32.	Luxembourg	3	1	1	1	41
33.	Bermuda	2	2	2	1	26.0
34.	Brunei	2	2	2	2	0.0
35.	China	2	2	2	2	0.0
36.	Ecuador	2	1	1	1	26.0
37.	Ghana	2	1	1	1	26.0
38.	Indonesia	2	2	2	2	0.0
39.	Monaco**	2	2	1	1	26.0
40.	Portugal	2	2	2	2	0.0
41.	Uganda	2	1	1	1	26.0
42.	Ukraine	2	2	2	2	0.0

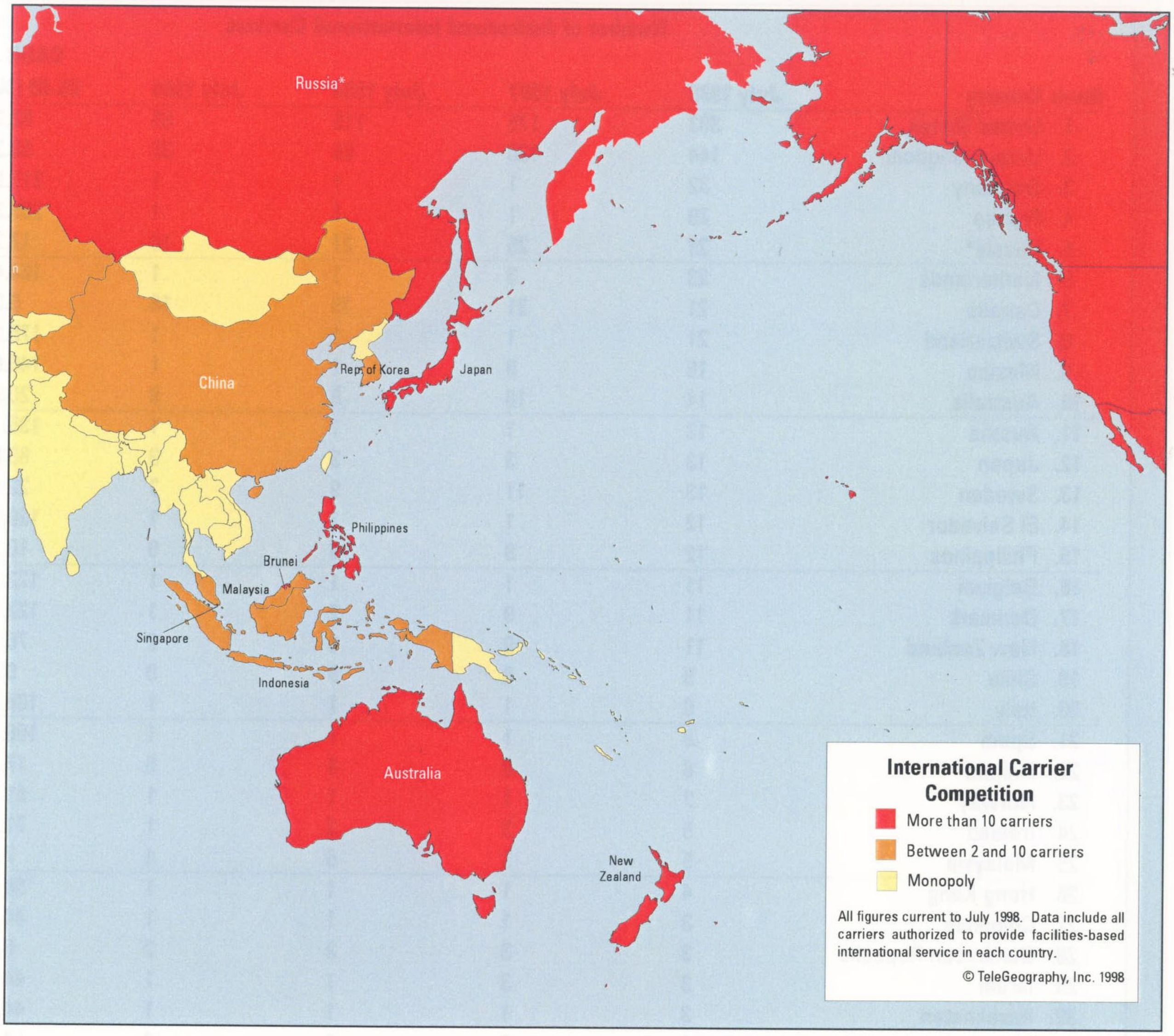
Note: Figures include all carriers authorized to provide facilities-based international service or international simple resale as of July 1 for each year.

* Estimates include carriers authorized to provide service in only certain municipalities.

** Although more than one carrier operates in the country, carriers do not directly compete.

Source: Adapted from TeleGeography's 3-volume directory of international carriers, *New International Carriers.*

Map of International Carrier Competition



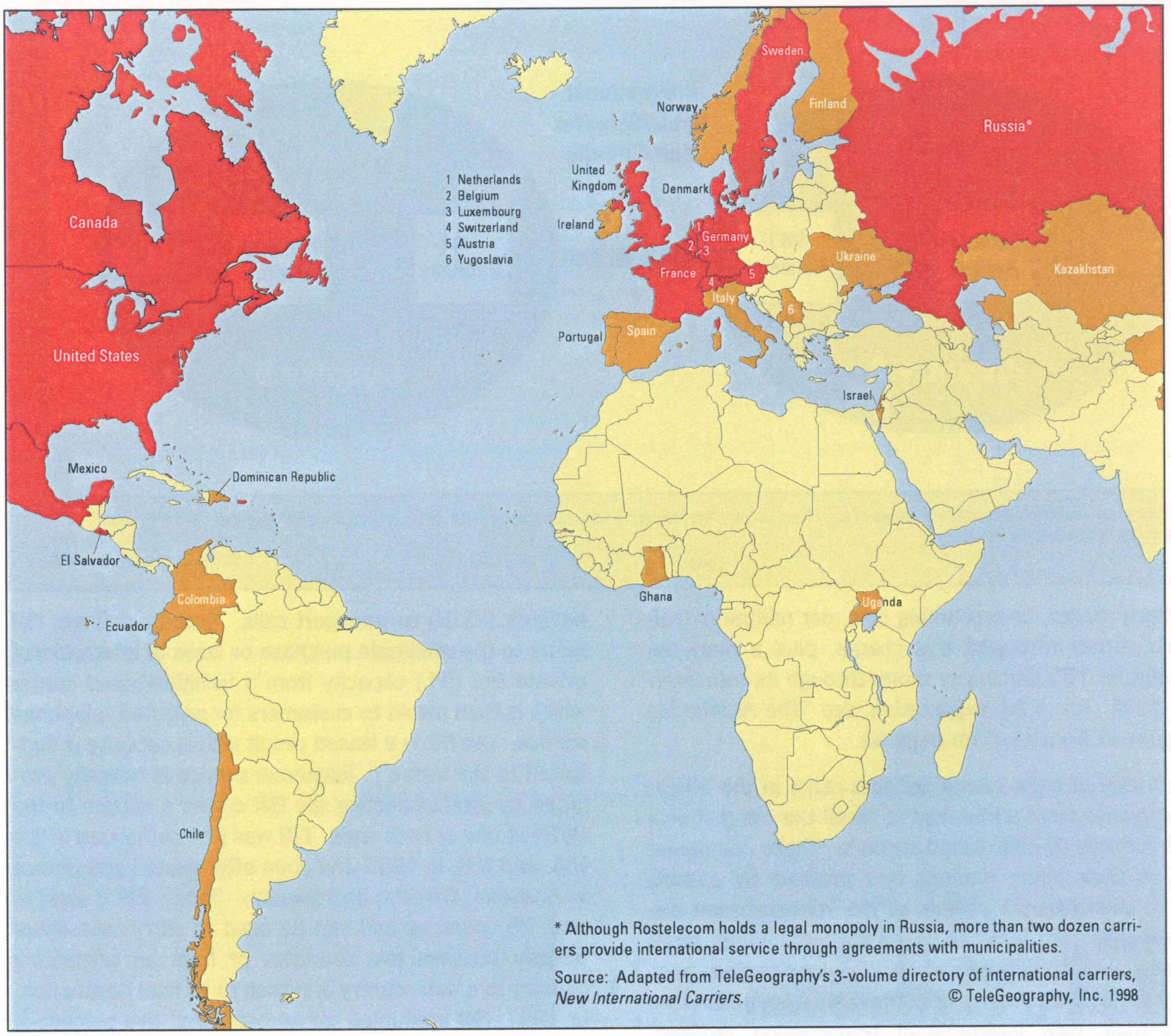
opened their markets to full competition in 1997 and 1998, respectively. Both countries now have more than a dozen carriers competing to provide international services. To read more about recent developments in the Asian market, see "International Telephony & Network Expansion" on page 41.

Latin America - Chile and the Dominican Republic, once the only two competitive markets in this region, have been joined by Mexico, Ecuador, Colombia, and El Salvador, which together have hatched almost 30 new carriers over the last year and a half. Soon the biggest Latin market, Brazil, will have competition, with a new long distance concession for sale in late 1998. To read more about Latin America, see "International Long Distance in Latin America" on page 44.

The proliferation of carriers is far from over. The February 1997 World Trade Organization (WTO) agreement on basic telecom services set market opening schedules for over 50 countries, many of which have yet to go into effect (for a summary of commitments, see "Map of WTO Commitments" on page 38). If competition continues apace, despite inevitable consolidation, we expect more than 2,000 facilities-based carriers will compete to carry international calls by 2002.

Heavy and Light Carrier Models

Without question, the rapid growth of international carriers is impressive. But to lump all carriers together is a bit misleading. The truth is there are very few newcomers that can be directly compared with the incumbent former monopolies. While new companies and old both have similar regu-



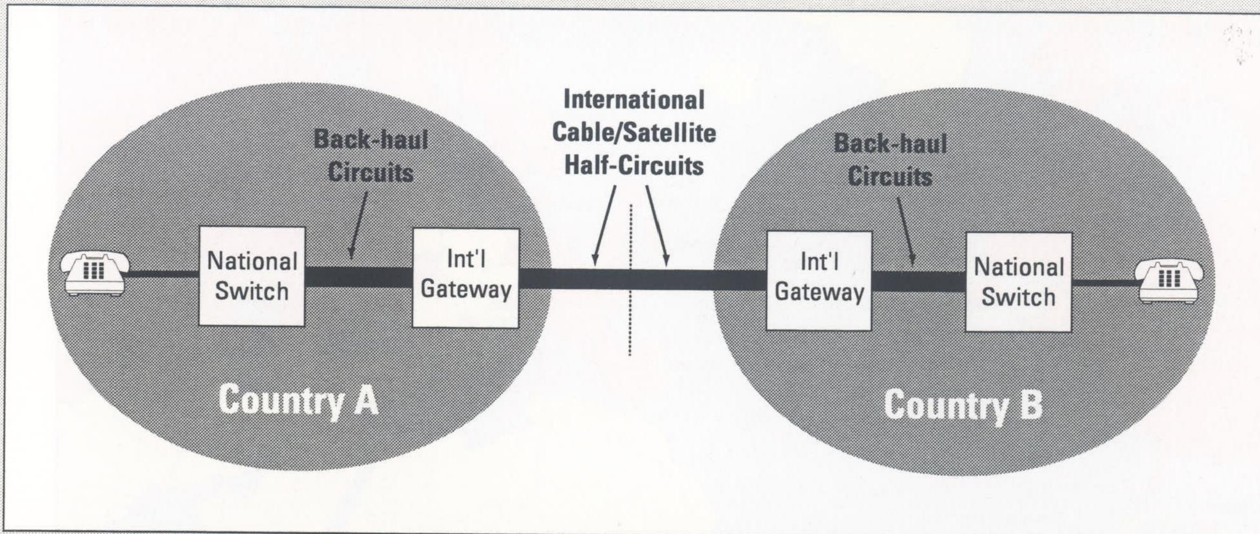
latory authorizations, many of the challengers exist (and thrive) by reselling, repackaging, and reprogramming the offerings of established carriers. In past editions of *TeleGeography*, we termed this the "Light" carrier model. The "Heavy" carrier model, by comparison, typically involves the construction or purchase of substantial network facilities. That can be a costly enterprise, of course, and thus the Heavy carrier model is more typical of established telephone companies. New market entrants, on the other hand, tend to rely on Light carrier strategies either as a first step toward creating a network or as an end in itself.

Although the distinction between Heavy and Light carriers is helpful, it can also be deceptive. The line between Light and Heavy is most noticeable in markets which lack facilities-based competition. In competitive markets, even former monopolies engage in Light carrier practices such as resale, call-back, refile, and other forms of untraditional call routing.

The Old Regime

To better understand the current international service market, it is useful to look at the origin of the Light carrier model. The old regime governing international telecommunications was characterized by state-owned national monopolies, typically Post Telegraph & Telephone (PTT) operators. Historically, these Heavy carriers did not operate directly in other countries but provided international service by connecting their cable and satellite "half-circuits" with the matching facilities of a foreign carrier (see Figure 3, "Typical Infrastructure of an International Call"). The PTTs compensated one another by a 50/50 division of a whole-

Figure 3. Typical Infrastructure of an International Call



Note: Figure assumes that calls are routed directly from Country A to Country B (i.e., no transit or refile arrangements are used) and that calls are routed over the public switched network.

sale facilities charge, or accounting rate, per minute of traffic. Each carrier recouped this charge, plus a mark-up, which might be 150 percent or more, through its own international tariff. For a full explanation, see "The Accounting Rate Regime in Transition" on page 62.

The first trickle of Light carrier services came in the 1980s when companies were authorized to resell the international switched services of established carriers. These companies focused on their home markets and profited by passing through to subscribers a portion of the volume-based discount available from facilities-based carriers. Later, facilities-based competition began when a few new carriers, such as MCI in the U.S. and Mercury in the U.K., were authorized to build their own international transmission facilities. Throughout the 1980s, however, competition was limited and the options for customers sparse. The old regime remained intact, albeit with threats looming on the horizon.

Alternative Call Routing

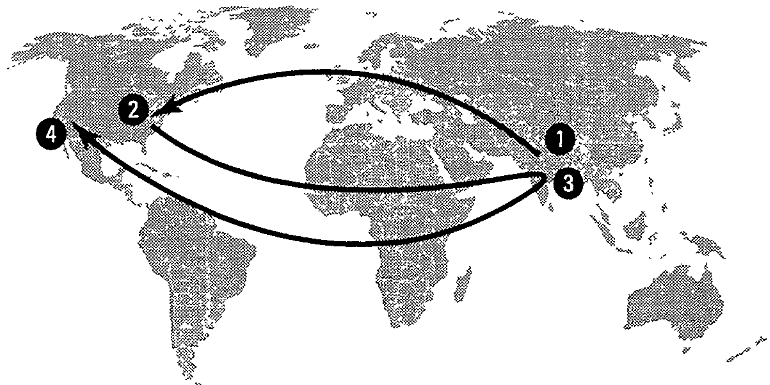
At the beginning of the 1990s, new technology, rapidly falling transmission costs, and the rising demands of multinational users brought a challenge to the old regime. In addition to using basic service resale, carriers began to explore a number of new call delivery methods, all of which departed from the old regime's method of exchanging international traffic (see Figure 4, "Alternative Call Delivery Methods"). In each case described below, the new methods exploit, or bypass altogether, the accounting rate system:

International Simple Resale (ISR) - ISR bypasses per-minute charges of the accounting rate system by using private lines rather than the public switched telephone network (PSTN) to transport calls. Broadly defined, ISR refers to the wholesale purchase or lease of international private line (IPL) capacity from a facilities-based carrier which is then resold to customers for switched telephone service. (An IPL is a leased circuit whose capacity is dedicated to the lessee.) Telephone service is typically provided by interconnecting the ISR carrier's circuits to the PSTN at one or both ends. ISR was first authorized in the U.S. and U.K. in 1992 and soon after gained acceptance in Australia, Canada, and Sweden. Today, ISR is legal in over 25 countries and can be used to carry calls either directly between two countries or from an originating country to a hub country and then to its final destination. In 1997, ISR accounted for an estimated two percent of global traffic (around 1.5 billion minutes), most of which was carried on the U.S-Canada and U.S.-U.K. routes.

Call-back - With a small investment in hardware and software, call-back carriers can change the direction and thus the cost of an international call. A basic call-back arrangement works like this: A pre-subscribed customer in country A dials a call-back operator in country B and, after a certain number of rings, hangs up. (The customer does not pay for this initial uncompleted call.) The call-back company then uses its switching software to initiate a call to the subscriber, and when the caller in country A answers, she receives a dial tone from the call-back company's switch. The customer can then place a call in country B (e.g., the U.S.) or to a third country (for details on the economics of call-back, see Figure 5, "The Call-Turnaround Effect"). Call-back companies, such as USA Globalink and Telegroup in the U.S., originated approxi-

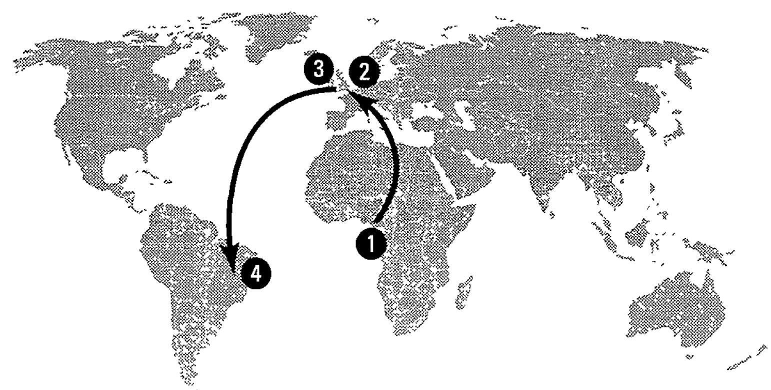
Figure 4. Alternative Call Delivery Methods

Call-back



1. Customer dials international access number, waits for ring, then hangs up.
2. Carrier calls customer from call-back hub country.
3. Customer answers phone and has dial-tone from call-back country.
4. Customer then calls a final destination inside or outside the call-back country.

Refile



1. Customer dials international number.
2. Originating carrier sends call to refile carrier.
3. Refile carrier terminates call in refile hub country (U.K.).
4. Call is re-originated and sent to final destination via refile carrier.

Internet Telephony (phone to phone)

1. Customer dials international number.
2. Call is routed to carrier's server via PSTN; server converts analog voice call to IP format and sends to Internet gateway.
3. Call travels over the Internet to a gateway in terminating country; call is re-converted to analog format.
4. Call is delivered to its destination via PSTN in terminating country.

Note: The diagrams above are not drawn to scale and call paths are drawn for illustrative purposes only. Call-back, refile, and IP telephony can all take different forms depending on origin, destination, technology, and company. IP telephony, for example, is also possible between two personal computers (PCs) or between a PC and a telephone-based destination.

Source: TeleGeography, Inc.

Figure 5. The Call-Turnaround Effect

International telephone traffic is a bit like water; it always tends to follow the path of least resistance. Other things being equal, the direction of traffic will follow price differentials in the same way that flows of water reflect underlying gradients.

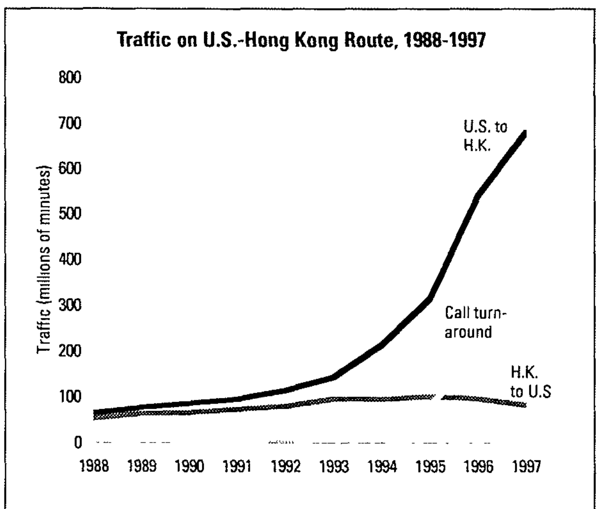
For international telephone calls, there are really two prices: a retail price paid by consumers and a wholesale price agreed by the operators providing the service. Historically, thanks to the accounting rate system, there was effectively no gradient in the wholesale price because the same rate (the accounting rate) was applied in both directions. Thus, insofar as there was a price differential, it was in the prices charged to end-users (the collection charge) and the mark-up that this represented over the accounting rate. In competitive markets with significant economies of scale, such as the U.S., the margin between the retail price and the wholesale price tended to be lower than in other countries, so that marginally more traffic originated from the U.S. than from other countries.

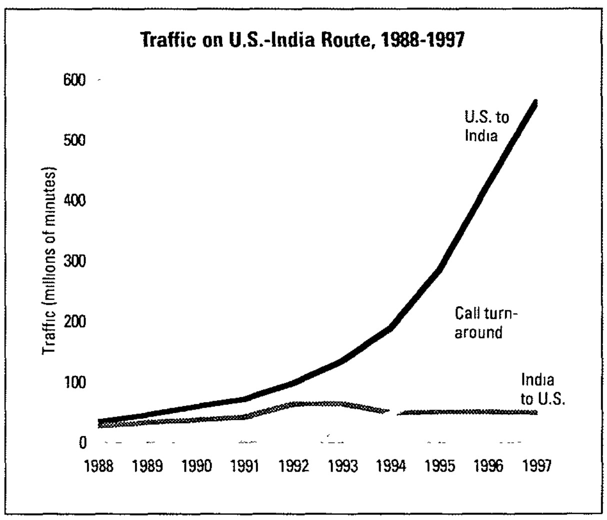
In the early 1990s, two things happened to change that picture. First, computer technology became available which made it easier to reverse the direction of a call, through call-back, calling cards or country-direct services. Second, wholesale carriers in the U.S. began selling outbound capacity at rates either at, or just below, the settlement rate. They were able to do this because a bizarre U.S. regulation—proportionate return of traffic—meant that they could afford to lose money on outbound traffic in order to gain proportionately more return traffic and the associated per minute settlement payments. Thus proportionate return created an artificial gradient in the settlement rate on the U.S. route which made it relatively more profitable to terminate traffic in foreign countries. As a result of these developments, call-turnaround is now a multi-billion dollar industry (see charts below).

Developing countries have made angry-sounding noises about call-back and many of them have tried to ban it. But the reality is that by reversing the direction of traffic from poor countries, call-back sends developing countries more settlement payments. For a country such as India, call-turnaround probably generated around 200 million minutes of traffic in 1997 and it contributed to India's net settlement in-payment of US$517 million from the U.S. that year.

But what would happen if a real gradient were created in the settlement rate? What would happen if India charged $0.23 per minute to land traffic while U.S. carriers charged only $0.07 to terminate traffic? This proposition is not as far fetched as it may seem, because even though India is a member of the WTO, and therefore eligible to enter the U.S. market, it has not agreed to open its market to foreign carriers. Hence, because it may soon become more profitable to terminate traffic in the U.S. than in India, the direction of call-turnaround may be reversed. Even if one ignores proportionate return for the moment, which the Federal Communications Commission will soon abolish on many routes, a switch located on Indian territory would be able to offer U.S. residents a rate only slightly above $0.07 per minute to call India whereas U.S. based carriers could only compete at rates above $0.23 per minute. Of course, the Indian operator offering the call-back service would have to make a net settlement payment towards the U.S., but this should be easily covered by its collection charges to the U.S. Perhaps those developing countries which are currently eager to ban call-back ought to think a little more seriously about this market opportunity before foreclosing their options.

This box was contributed by Dr. Tim Kelly, Head of Operations Analysis at the ITU. The views expressed are his own and do not necssarily reflect the opinions of the ITU or its membership.





Note: Call turn-around figures are estimates based on change in traffic balance on each route.
Source: TeleGeography, Inc. and International Telecommunication Union.

mately 2 billion minutes of call-back traffic in 1997, accounting for 2.5 percent of global traffic.

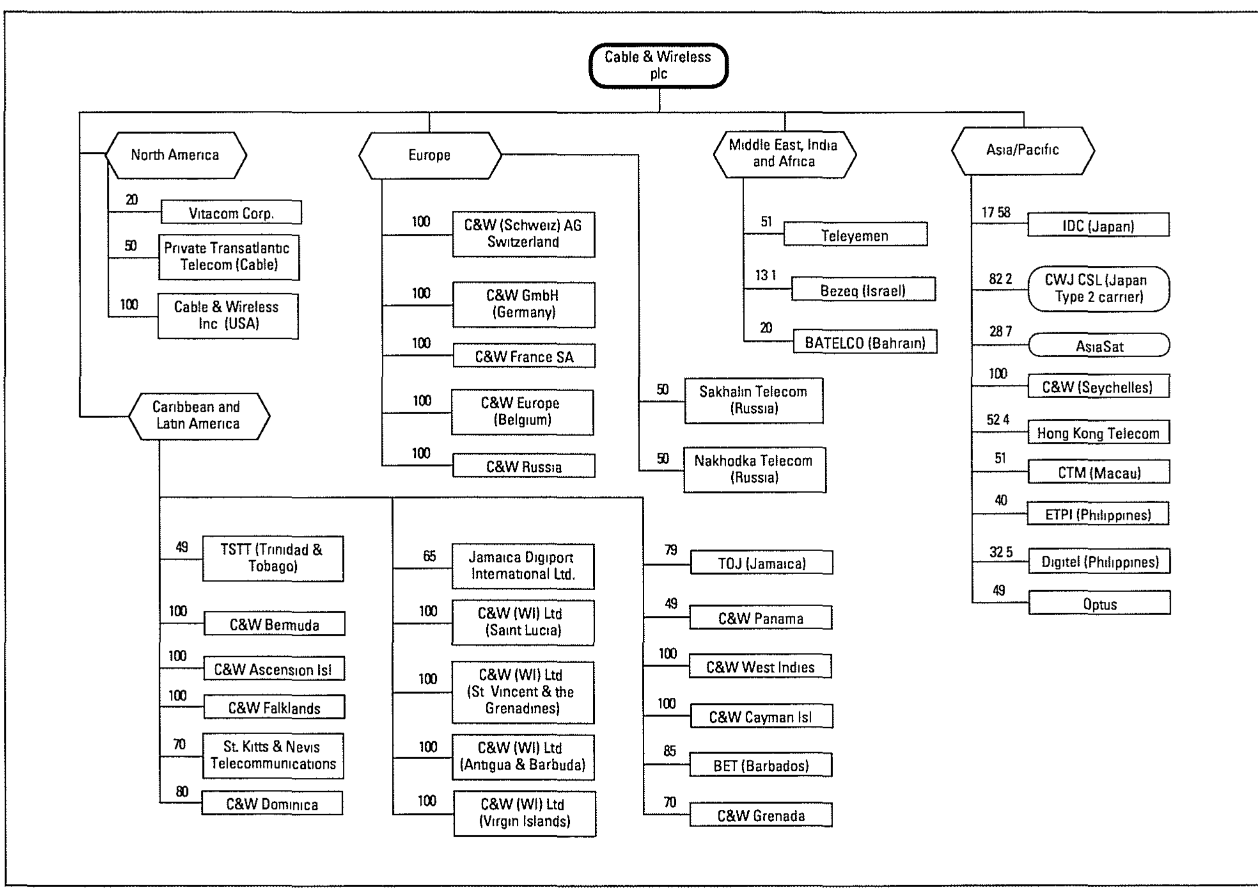
Refile - Refile is a form of indirect call routing which, like call-back, seeks to arbitrage non-cost-based differences in wholesale call prices to turn a profit. Refile generally is profitable for a carrier if it is cheaper to send a call from country A to country C via country B because the cost of paying the wholesale landing fee from A to B plus the fee for B to C is cheaper than paying to send the traffic from A to C directly. Refile thus involves two calls; one to the refile country and another, re-originated call, to the final destination. Unlike traditional transit traffic (A to C via B), however, the terminating carrier is unaware of the call's true point of origin and has not given its consent. Thus the term "traffic smuggling" has been used to describe refile. Although refile is difficult to measure due to its routing, we estimate that five percent of the world's traffic (4 billion minutes) was refiled through third countries in 1997.

Internet - Although the routing methods described here may decline as accounting rates become more cost-based, one new method should flourish: the global Internet. In combination with privately-owned international lines and gateways, some new carriers are avoiding accounting rates by pushing traffic onto the Internet, the same network that carries web pages and email messages. For a more detailed discussion of Internet telephony issues, see "The Global Internet: A Primer" on page 112.

Multinational Carriers

The element which most clearly marks the difference between the old regime and the new is the disintegration of national boundaries which once dictated the direction of traffic flows and facilities ownership. Due in part to commitments made in the WTO agreement, operators may now hold stakes in foreign international carriers in over 70 countries. In addition, over 20 countries now allow foreign carriers to open wholly-owned operations on turf once reserved for national carriers only. In many countries, today's carri-

Figure 6. International Carrier Affiliates of Cable & Wireless



Note: Figures include all international carriers owned in whole or in part by Cable & Wireless plc.

Source: Adapted from TeleGeography's 3-volume directory of international carriers, *New International Carriers*.

Figure 7. Selected Multinational Carrier Authorizations

Parent Carrier	Headquarters	Wholly-Owned Affiliate	Affiliate Market
FaciliCom International, LLC	United States	FCI Austria	Austria
		FCI Belgium	Belgium
		FCI Finland	Finland
		FCI France	France
		FCI Italy	Italy
		FCI Benelux BV	Netherlands
		FCI Norway	Norway
		FCI Switzerland	Switzerland
		FaciliCom International Ltd.	United Kingdom
Hermes Europe Railtel BV	Belgium	Hermes Europe Railtel (France) SARL	France
		Hermes Europe Railtel (Germany) GmbH	Germany
		Hermes Europe Railtel BV	Netherlands
		Hermes Europe Railtel	Switzerland
		Hermes Europe Railtel (UK) Ltd	United Kingdom
Long Distance International, Inc.	United States	LDI Denmark A/S	Denmark
		LDI (France)	France
		LDI (Germany)	Germany
		LDI (Italy)	Italy
		LDI (Sweden)	Sweden
		Long Distance International Ltd.	Switzerland
		Long Distance International Ltd.	United Kingdom
Primus Telecommunications Group, Inc.	United States	Primus Telecommunications Pty Ltd.	Australia
		Primus Telecommunications, Inc.	Canada
		Primus France	France
		Primus Telecommunications Deutschland GmbH	Germany
		Primus Netherlands	Netherlands
		Primus Telecommunications Ltd.	United Kingdom
RSL Communications, Inc.	United States	RSL COM Australia Pty Ltd.	Australia
		RSL COM Danmark A/S	Denmark
		RSL COM Finland Oy	Finland
		RSL COM France SA	France
		RSL COM Deutschland GmbH	Germany
		RSL COM Japan KK	Japan
		RSL COM Nederland BV	Netherlands
		RSL COM Sweden AB	Sweden
		RSL COM UK Ltd.	United Kingdom
Teleglobe Inc.	Canada	Teleglobe Australia Pty Ltd.	Australia
		Teleglobe France SAS	France
		Teleglobe GmbH	Germany
		Teleglobe Italia SpA	Italy
		Teleglobe Japan Inc.	Japan
		Teleglobe BV	Netherlands
		Teleglobe Norge AS	Norway
		Teleglobe International (UK) Ltd.	United Kingdom
		Teleglobe USA Inc.	United States
Viatel, Inc.	United States	Viatel Belgium SA	Belgium
		Viatel SA	France
		Viaphone GmbH	Germany
		Viatel SRL	Italy
		Viatel Global Communications BV	Netherlands
		Viatel UK Ltd.	United Kingdom
MCI WorldCom, Inc.	United States	WorldCom Australia	Australia
		WorldCom France	France
		WorldCom Telecommunication Services GmbH	Germany
		WorldCom Ireland	Ireland
		WorldCom SpA	Italy
		WorldCom Japan Inc.	Japan
		WorldCom Netherlands	Netherlands
		WorldCom AB	Sweden
		WorldCom International, Ltd.	United Kingdom

Note: Affiliates include all wholly owned affiliates authorized to provide facilities-based international services as of July 1998. Affiliates authorized to provide international simple resale (ISR) service are also listed. All parent companies are also authorized to provide service in their home markets.

Source: Adapted from TeleGeography's 3-volume directory of international carriers, *New International Carriers.*

Figure 8. International Carrier Mergers and Acquisitions, Sept. 1997-Oct. 1998

Buyer	Country	Target	Country	Date	Value (millions)
Advanced Comm. Group	U.S.	Feist Long Distance, Inc.	U.S.	May 98	Undisclosed
	U.S.	Firstel, Inc.	U.S.	May 98	Undisclosed
Ameritech Corp.	U.S.	Tele Danmark A/S (34.4%; grown to 42.2%)	Denmark	Jan 98	$3,200
AT&T Corp.	U.S.	Tele-Communications Inc.	U.S.	Pending	$45,000
	U.S.	Teleport Communications Group	U.S.	Jul 98	$11,000
Bell Atlantic Corp.	U.S.	GTE Corp.	U.S.	Pending	$66,600
British Telecommunications plc	U.K.	Binariang Bhd (33.3%)	Malaysia	Pending	$436
Call-Net Enterprises Inc.	Canada	Fonorola Corp.	U.S.	Jul 98	$1,220
China Telecom	China	Hong Kong Telecommunications Ltd. (7.8%)	Hong Kong	Feb 98	$1,184
	China	Hong Kong Telecommunications Ltd. (9.5%)	Hong Kong	Apr 98	$2,232
Deutsche Telekom AG	Germany	France Télécom (2%)	France	Aug 98	$1,300
Esprit Telecom Group plc	U.K.	IMS Telecom	Netherlands	Nov 97	Undisclosed
Excel Communications, Inc.	U.S.	Telco Communications Group	U.S.	Oct 97	$1,200
FaciliCom International, LLC	U.S.	TeleOne Ltd.	Finland	May 98	Undisclosed
France Télécom	France	Deutsche Telekom AG (2%)	Germany	Aug 98	$1,670
Global Crossing Ltd.	Bermuda	Neptune Communications Corp.	U.S.	Jul 98	Undisclosed
Inter-Americas Comm. Corp.	U.S.	Iusatel Chile SA	Chile	Dec 97	$7
Japan Telecom Co. Ltd.	Japan	International Telecom Japan Ltd.	Japan	Oct 97	Undisclosed
Kokusai Denshin Denwa Co., Ltd.	Japan	Swiftcall UK	U.K.	May 98	Undisclosed
	Japan	Teleway Japan Corp.	Japan	Pending	$424
MCI Corp.	U.S.	Embratel SA (20% equity; 51.8% voting)	Brazil	Jul 98	$2,260
News Corp.	U.S.	PLD Telekom Inc. (38%)	Russia	May 98	$81
Primus Telecommunications, Inc.	U.S.	TresCom International, Inc.	U.S.	Feb 98	$135
	U.S.	USFI, Inc.	U.S.	Oct 97	$12
Qwest Communications Intl. Ltd.	U.S.	LCI International Telecom Corp.	U.S.	Jun 98	$4,400
RSL Communications, Ltd.	U.S.	Callcom AG (78.5%)	Switzerland	Dec 97	$2
	U.S.	European Telecom SA (90%)	Belgium	Jan 98	Undisclosed
	U.S.	Newtelco Telekom AG (90% stake)	Austria	Sep 97	Undisclosed
	U.S.	Westel Telecommunications, Inc.	Canada	Pending	$38
	U.S.	Westinghouse Communications	U.S.	Apr 98	$90
SBC Communications, Inc.	U.S.	Ameritech Corp.	U.S.	Pending	$65,400
	U.S.	SNET	U.S.	Pending	$5,700
Scottish Telecommunications Ltd.	U.K.	Demon Internet Ltd.	U.K.	Apr 98	$110
STAR Telecommunications, Inc.	U.S.	PT-1 Communications, Inc.	U.S.	Pending	$195
SwissCom	Switzerland	UTA Telekom AG	Austria	Jul 98	Undisclosed
Technology Control Services Inc.	U.S.	Interglobe Telecom. International, Inc.	U.K.	Mar 98	$17
Teleglobe Communications Corp.	Canada	Excel Communications, Inc.	U.S.	Pending	$3,100
Teleport Communications Group	U.S.	ACC Corp.	U.S.	Apr 98	$1,100
Viatel, Inc.	U.S.	Flat Rate Communications, Inc.	U.S.	Mar 98	Undisclosed
	U.S.	Jazztel (7.5%)	Spain	Jun 98	$6
WorldCom, Inc.	U.S.	MCI Corp.	U.S.	Oct 98	$41,800
	U.S.	TCL Telecommunications	Ireland	Oct 97	$29
WorldPort Communications, Inc.	U.S.	AACR	Dom. Rep.	Pending	Undisclosed
	U.S.	EnerTel NV	Netherlands	Jun 98	$110

Note: All transactions involve 100 percent of target's shares unless otherwise noted. Dates indicate time of legal completion of transaction rather than announcement of intention to merge or to acquire.

Source: Adapted from TeleGeography's 3-volume directory of international carriers, *New International Carriers.* © TeleGeography, Inc. 1998

ers may fully or partly own facilities on both ends of an international call. This type of end-to-end facilities-based service model is still the exception rather than the rule, but it is seriously affecting investment decisions and making accounting rates less and less relevant (when a carrier owns facilities at both ends, settlement rates became an internal transfer payment between two affiliates).

To take advantage of these options, many new carriers are establishing beachheads in multiple markets—either by establishing a new affiliate or by purchasing the operations of an existing carrier (see Figure 7, "Selected Multinational Carrier Authorizations" and Figure 8, "International Carrier Mergers"). Companies like Primus, RSL, Esprit, and LDI represent the first wave of new "multinational" carriers. They may have a national headquarters, but they are essentially stateless carriers. Europe's unique economic geography has made it a prime target for the multinational operations of such new carriers, including COLT, Facilicom, Hermes, and Tele2.

Figure 9. Upcoming International Carrier Privatizations

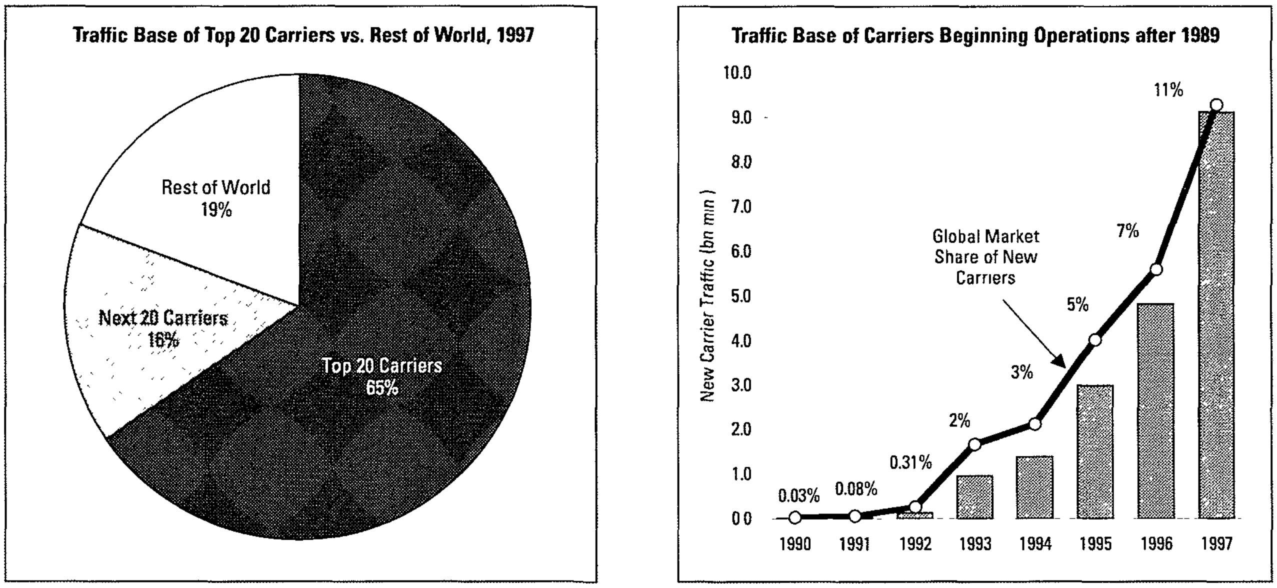
Country	Company	Gov't Share	Share to Sell	Sale Date	1996 Traffic (million min.)
Australia	Telstra	66%	66%	1999	9,452.0
Bahamas	BATELCO	100%	49%	1999	56.7
Bulgaria	BTC	100%	51%	1999	83.5
Croatia	HPT	100%	25%	1999	242.4
Czech Republic	SPT Telecom	51%	51%	1999	210.4
Denmark	Tele Danmark	9%	9%	1998	573.0
Ecuador	Emetel (Andinatel + Pacifictel)	100%	35%	1998	48.2
Egypt	Telecom Egypt	100%	20%	1998	113.0
Estonia	Estonian Telecom	100%	49%	1999	58.5
Finland	Sonera (Telecom Finland)	100%	20%	1998	219.2
France	France Télécom	75%	12%	1998	3,116.0
Greece	OTE	75%	10%	1998	516.0
Honduras	Hondutel	100%	49%	1998	41.6
Iceland	Iceland Telecom Ltd.	100%	51%	2000	32.5
India	VSNL	65%	11%	1999	384.2
Japan	NTT	65%	n.a.	1999	1,710.0
Jordan	JTC	100%	40%	1998	74.6
Kenya	KPT	100%	n.a.	1999	20.8
Korea	Korea Telecom	71%	33%	1999	520.0
Kuwait	KCC	100%	51%	2000	140.7
Macedonia, FYR	Macedonia Telecommunications	100%	33%	1998	51.0
Malta	Maltacom	100%	40%	1998	31.7
Moldova	Moldtelecom	100%	37%	1998	50.2
Mongolia	MTC	100%	100%	1998	2.4
Netherlands	PTT Telecom BV	62%	62%	2001	1,534.0
Nicaragua	Enitel	100%	40%	1999	29.4
Oman	GTO	100%	40%	n.a.	62.6
Pakistan	PTCL	88%	26%	1999	77.0
Papua New Guinea	Telikom PNG	100%	n.a.	1999	24.5
Poland (a)	TPSA	100%	25%	1998	437.2
Romania	RomTelecom SA	100%	35%	1998	91.5
Saudi Arabia	Saudi Telecom	100%	80%	2000	584.0
Singapore	Singapore Telecom	88%	12%	n.a.	942.0
Sri Lanka	Sri Lanka Telecom Limited	62%	62%	2001	29.3
Switzerland	Swisscom	100%	34.5%	1998	1,936.0
Taiwan	Chunghwa Telecom	100%	75%	1999	674.0
Tanzania	Tanzania Telecom	100%	100%	1999	5.9
Thailand	CAT	100%	n.a.	1999	247.4
Thailand	TOT	100%	n.a.	1999	9.5
Turkey (b)	Türk Telekomünikasyon	100%	20%	1998	473.0
Uganda	Uganda Telecom	100%	51%	1998	5.4
Ukraine	Utel	51%	25%	1998	340.8

Note: Table includes all international carrier privatizations announced as of September 1998. Almost 140 other carriers are at least part government-owned but have not made recent privatization plans. Traffic is volume (in minutes) of outgoing international calls.

(a) Poland plans to sell up to 25 percent of TPSA through an IPO in 1998, with an additional 30 percent stake to be made available to a strategic investor in early 1999.
(b) Turkey plans to sell 20 percent of Türk Telekomünikayson to a strategic investor in November 1998, with an additional stake to be made available through an IPO in 1999.

Source: Adapted from TeleGeography's 3-volume directory of international carriers, *New International Carriers.*

Figure 10. Traffic Base of Incumbent and New Carriers



Note: "New Carrier Traffic" only includes carriers that began facilities-based operation after 1989. Therefore, the figures exclude traffic originated by MCI, Sprint, Cable & Wireless Communications, IDC, and Japan Telecom.

Source: TeleGeography, Inc.

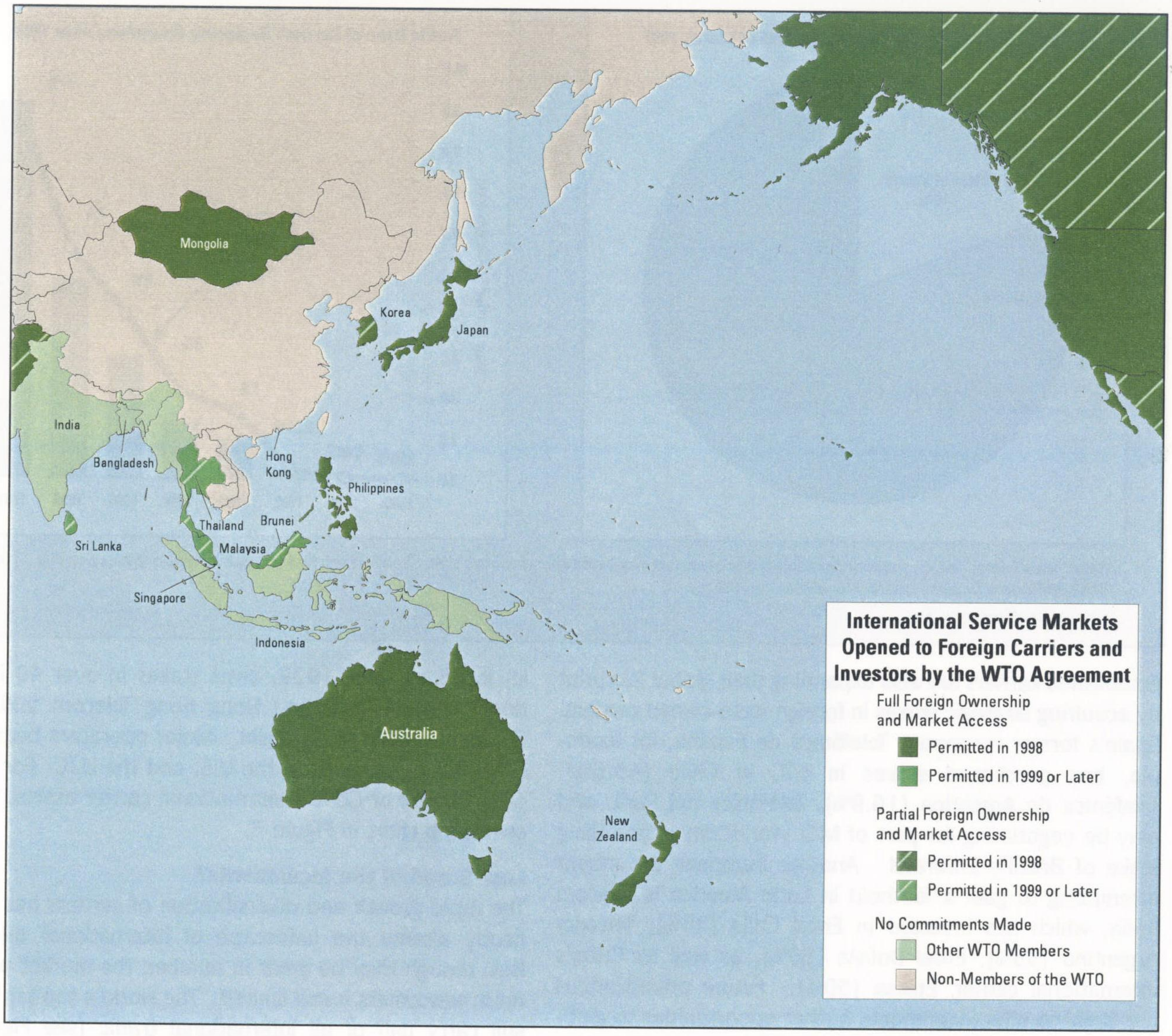
Established carriers are also expanding their global footprint by acquiring strategic stakes in foreign state-owned carriers. Spain's former monopoly, Telefónica de España, for example, has purchased stakes in CTC in Chile (43.6%), Telefónica de Argentina (16.9%), Telefónica del Perú, and may be negotiating for part of MCI WorldCom's controlling stake of Brazil's Embratel. Another European incumbent attempting to gain a foothold in Latin America is Telecom Italia, which has invested in Entel Chile (20%), Telecom Argentina (33%), Entel Bolivia (50%), as well as Cuba's international carrier, Etecsa (30%). Future privatizations are likely to offer incumbents further opportunities to globalize their business because many governments still hold a large stake in their national carriers. As of September 1998, 30 of the top 50 international carriers were still partly government-owned (see Figure 9, "Upcoming Carrier Privatizations").

Another way to become a global carrier is to inherit it. U.K.-based Cable & Wireless (C&W), the company which has been bringing telephone service to exotic (and not so exotic) locations since 1929, owns stakes in over 40 international carriers, including Hong Kong Telecom and Optus Communications in Australia. Major operators bearing the C&W name also exist in the U.S. and the U.K. For a complete picture of C&W's international carrier assets, see the ownership chart in Figure 6.

Last Stand of the Incumbents?

The rapid growth and diversification of carriers has permanently altered the landscape of international telephony. But, though they be great in number, the market power of most newcomers is still limited. The world's top ten carriers still carry half of all international traffic (see Figure 10, "Traffic Base of Incumbent and New Carriers"). The primary issue is not whether incumbent carriers will survive—they most certainly will. At issue is their way of doing business. And as new carriers continue to gather steam, their new weapons (ISR, call-back, refile, the Internet, and multi-country affiliates) are likely to forever change the rules of the game.

Map of WTO Commitments

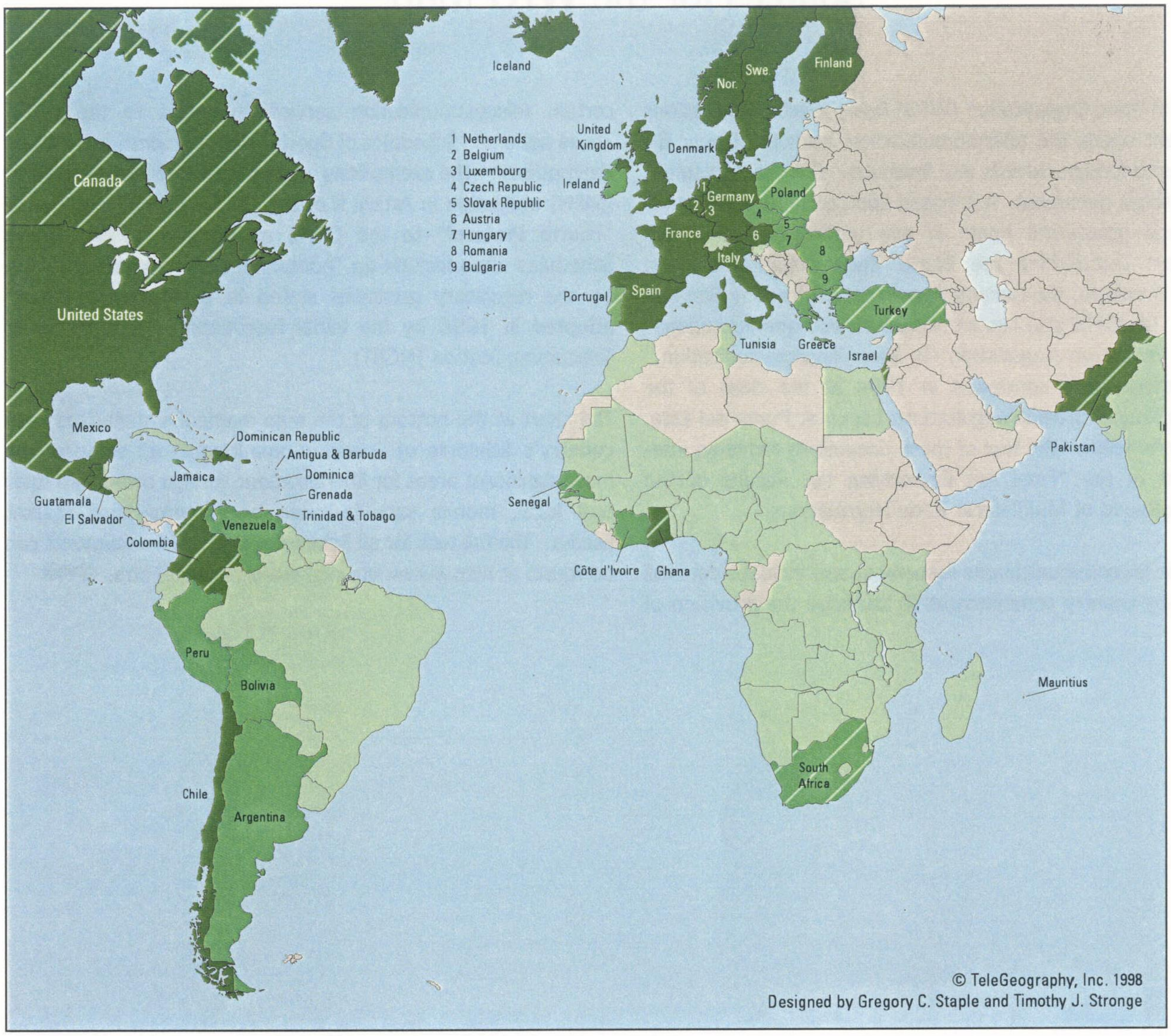


Key to Country Commitments under the WTO Agreement

- ● Full Market Access in 1998
- ○ Partial Market Access in 1998
- ● Full Market Access in 1999 or After
- ○ Partial Market Access in 1999 or After
- ○ No Commitments Offered

Note: Country commitments under the 1997 WTO Agreement on Basic Telecommunication Services include the right to offer **Local** (local telephone exchange), **International** (international telephone service), and **Satellite** (mobile satellite-based telephone service; commitments on fixed satellite services not shown). **Foreign ownership** refers to the right of a WTO member to invest in a foreign telecom carrier; some countries have exempted specific carriers.

	Local	International	Satellite	Foreign Ownership
Antigua & Barbuda	No Commitments Offered	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1999 or After
Argentina	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1998
Australia	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998
Austria	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998
Bangladesh	Partial Market Access in 1998	No Commitments Offered	No Commitments Offered	Partial Market Access in 1998
Belgium	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998
Bolivia	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1999 or After
Brunei	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1999 or After
Bulgaria	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1999 or After
Canada	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998	Partial Market Access in 1998
Chile	No Commitments Offered	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998
Colombia	Partial Market Access in 1998	Partial Market Access in 1998	Partial Market Access in 1998	Partial Market Access in 1998
Côte D'Ivoire	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1998	Full Market Access in 1999 or After
Czech Republic	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1999 or After
Denmark	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998
Dominica	No Commitments Offered	No Commitments Offered	Partial Market Access in 1998	No Commitments Offered
Dominican Republic	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998
El Salvador	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998
Finland	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998
France	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998
Germany	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998
Ghana	Partial Market Access in 1998	Partial Market Access in 1998	Partial Market Access in 1998	Partial Market Access in 1998
Greece	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Full Market Access in 1999 or After
Grenada	Full Market Access in 1999 or After	Full Market Access in 1999 or After	Partial Market Access in 1998	Full Market Access in 1999 or After
Guatemala	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998	Full Market Access in 1998
Hong Kong	No Commitments Offered	Partial Market Access in 1999 or After	Partial Market Access in 1999 or After	Full Market Access in 1998



	Local	International	Satellite	Foreign Ownership
Hungary	◍	◍	◍	◍
Iceland	●	●	●	●
India	◯	○	○	◯
Indonesia	◯	○	○	◯
Ireland	◍	◍	◍	◍
Israel	◯	◯	●	◯
Italy	●	●	●	●
Jamaica	◍	◍	◯	●
Japan	●	●	●	●
Republic of Korea	●	●	●	◯
Luxembourg	●	●	●	●
Malaysia	○	○	○	◯
Mauritius	◍	◍	◍	◍
Mexico	●	●	●	◯
Mongolia	●	●	●	●
Netherlands	●	●	●	●
New Zealand	●	●	●	●
Norway	●	●	●	●
Pakistan	○	◯	◍	◯
Peru	◍	◍	◍	◍
Philippines	●	●	○	◯
Poland	●	◍	◍	◯
Portugal	◍	◍	◍	◯
Romania	◍	◍	◍	◍
Senegal	◯	◯	○	◯
Singapore	◯	◍	◍	◯
Slovak Republic	◍	◍	◍	◍
South Africa	◯	◯	○	◯
Spain	●	●	●	●
Sri Lanka	○	◯	○	◯
Sweden	●	●	●	●
Thailand	◍	◍	◍	◯
Trinidad & Tobago	◍	◍	●	◍
Tunisia	◍	○	○	◯
Turkey	◯	◯	◯	◯
United Kingdom	●	●	●	●
United States	●	●	●	●
Venezuela	◍	◍	◍	◍

Note: Belize, Brazil, Ecuador, Morocco, Papua New Guinea and Switzerland have made separate commitments.

Sources for the WTO Map

The World Trade Organization (WTO) Basic Telecommunications Agreement opens the telecommunication markets of over 60 countries to foreign carriers and investors. But the Agreement is not a single document. It is based upon certain general principles and procedural rights in two umbrella treaties—the Agreement Establishing the World Trade Organization and Annex 1B thereto, the General Agreement on Trade in Services (GATS). The GATS also has an "Annex on Telecommunications" and an "Annex on Negotiation On Basic Telecommunication." Both treaties were concluded in 1994 at the close of the Uruguay Round of trade negotiations begun at Punta del Este, Uruguay in 1986. The text of these documents forms an integral part of the "Final Act Embodying the Results of the Uruguay Round of Multilateral Trade Negotiations."

The Basic Telecommunications Agreement also includes detailed country-by-country commitments to liberalize the provision of certain telecommunication services pursuant to the GATS. These national "Schedules of Specific Commitments and Lists of Exemptions"—the exemptions refer to the Most Favored Nation (MFN) obligation in Article II of the GATS—are annexed to the "Fourth Protocol" to the GATS, adopted in 1996. These Schedules often include an "Additional Commitment" to abide by the regulatory principles stated in a "Reference Paper" adopted in 1996 by the initial Negotiating Group on Basic Telecommunication (NGBT).

The chart at the bottom of the map overleaf summarizes each country's Schedule of Specific Commitments on some of the most significant areas for liberalization: foreign ownership rules and local, mobile satellite-based and international market access. The full text for all Schedules and GATS documents can be found at http://www.wto.org/wto/services/tel.htm.

International Telephony & Asian Network Expansion

by Craig Irvine, Merrill Lynch & Co., Inc.

Introduction

The Asian financial crisis has changed the economics of international telephony and its role in network financing. Net settlement revenues are now cherished, while a capital shortage favors incumbents and has altered the traditional economics of network expansion.

The New Financial Challenge

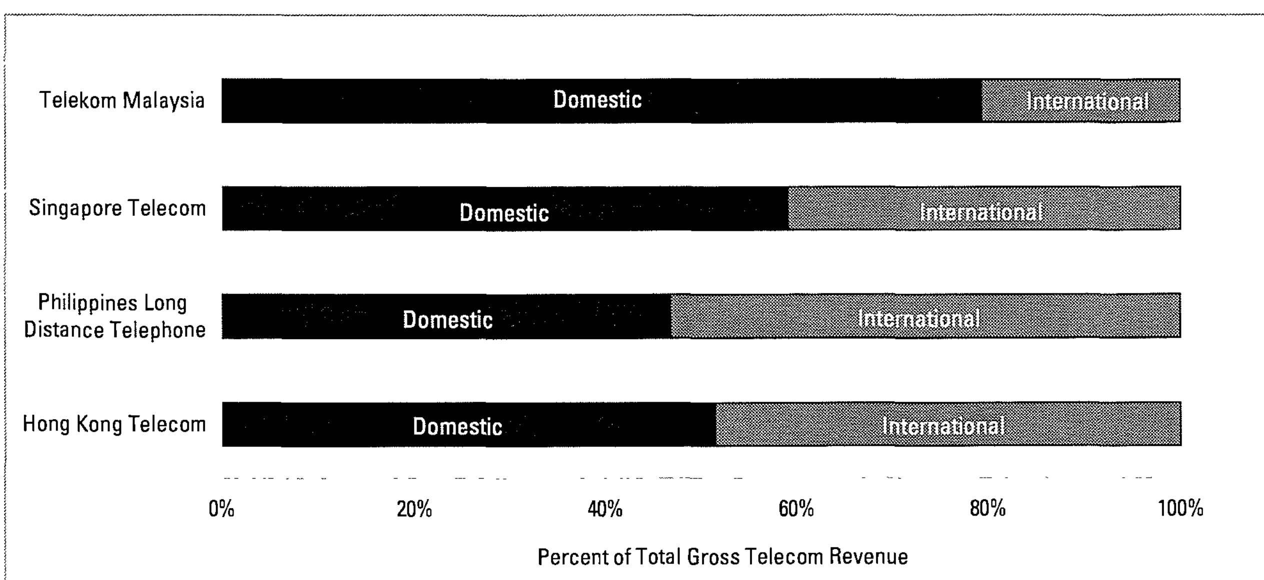
For most Asian incumbents, international telephony has historically accounted for 30 percent to 60 percent of revenue, as shown in Figure 1. A growing settlement imbalance, particularly with the United States, has increased net settlement revenues and resultant pressure for lower settlement rates. A year ago, falling settlement rates and the Federal Communications Commission's (FCC's) settlement benchmarks were the top strategic priority problems for many Asian carriers. We believe this is no longer the case.

Shrinking access to investment capital has overtaken dependence on international settlement payments as the key financial challenge for many Asian carriers. The depreciation of Asian currencies has transformed a key concern—falling net settlement revenues—into a key positive—U.S. dollar revenues. Pressure on settlement rates continues, but it has been overcome by the shortage of investment capital as debt spreads have widened and new equity funding has dried up. This is not to suggest that carriers have surrendered in the settlement rate battles. Rather, many have shifted their focus to a new area of greater concern: where to apply their scarce investment capital.

An acute shortage of capital enhances incumbents' competitive position. Established players enjoy distinct—and now more sustainable—competitive advantages over new entrants. Expensive local loop assets remain a key route to capturing international traffic. A competitive advantage based on network coverage—which is unsustainable given adequate time and resources—becomes relatively sustainable when capital is scarce. Indirect access to alternative international carriers has not overcome this obstacle: access charges in many countries remain stubbornly high, leaving insufficient margin for the new entrant to finance a meaningful toehold in the local loop.

Incumbent profitability is also based primarily on pre-crisis investment costs. A few cases of successful tariff rebalancing notwithstanding, local currency tariffs remain at or below cost, while equipment remains largely imported and thus considerably more expensive today than a year ago in most of Asia. So while an incumbent can typically slow investment and harvest cash, the new entrant is spending precious capital at ever-higher prices just to catch up, let alone pull ahead.

Figure 1. Domestic and International Telecom Revenue, 1997



Source: Merrill Lynch & Co., Inc. © TeleGeography, Inc. 1998

Foreign strategic capital can turn this dynamic on its head. A fresh injection of capital can rejuvenate the financial viability of the new entrant. Not surprisingly, virtually every new entrant in Asia (wireline and wireless) is now attempting to court one or more foreign strategic partners, though we believe transactions will be sparse in the current environment.

So does this mean incumbents are securely riding a virtuous cycle where a dominant share of end user connections feeds them international traffic and keeps net settlement revenues rolling in? Probably not. While competitive pressures may be easing, pressure on profitability clearly remains. Incumbents enjoy strong cost advantages over new entrants, but in the current environment, they must still apply this advantage wisely to support overall returns.

The currency crisis has directly affected the incentives to expand basic networks. Figure 2 shows a simple estimate of the internal rate of return (IRR) of new line investment now and eighteen months ago. For simplicity, we assume revenue per line and operating margins remain constant (ignoring cellular and other distortions), and that the incremental investment cost of a new line is a constant US$1,000 per line with a seven year life. Clearly, this cost is even higher for new entrants still installing core infrastructure.

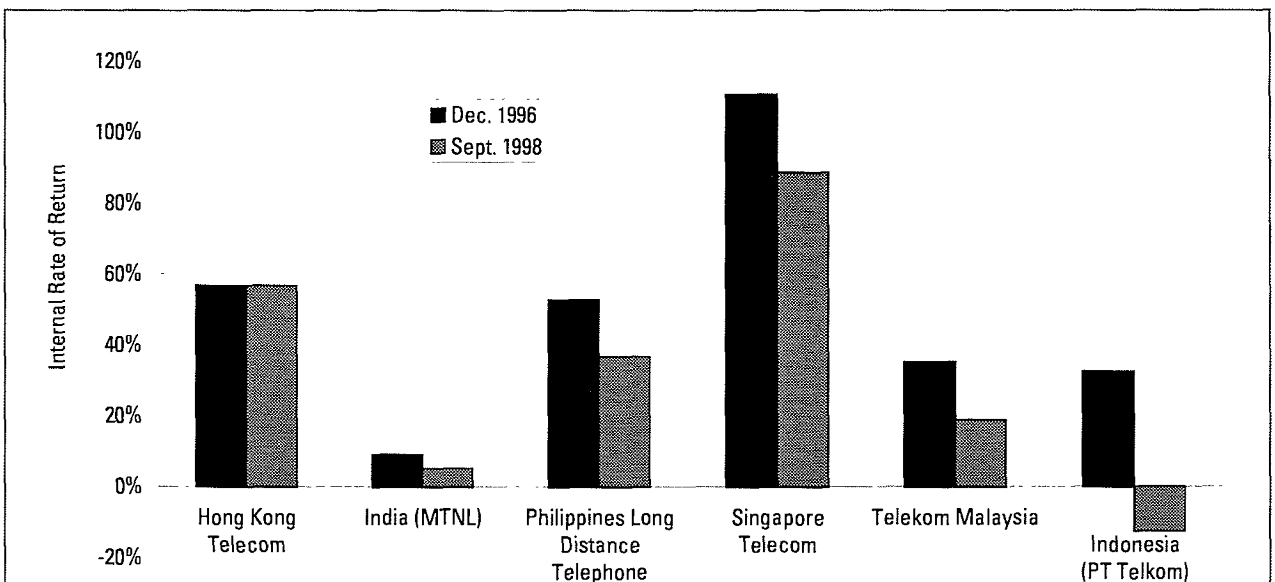
Decreasing IRRs have thus lowered the incentive to expand networks, which further implies less need to defend high settlement rates. So are we now seeing greater willingness to negotiate down settlement rates? Yes and no. Most carriers continue to resist falling rates, but Hong Kong Telecom (HKT) would like to see the pace of decline accelerate.

The cross subsidy has evolved into a different form in Hong Kong. Rather than subsidize network expansion, high international telephony margins have been used to subsidize competitive entry. For three years now, new entrants have shared their delivery fees with consumers and captured enough of HKT's core business that earlier this year HKT agreed to give up its international monopoly.

Hong Kong Telecom is now preparing for the post-monopoly world by negotiating settlement rates to below the same FCC benchmarks (US$0.15 per minute) which a year ago they were aggressively resisting. Hong Kong may be able to become the first Asian country to do away with settlement rates on some routes where international simple resale (ISR) is legal—perhaps even without a major discontinuity in profitability or ability to finance network expansion. One of HKT's goals is to reclaim this traffic for the switched network and, in effect, to offer an international direct dial (IDD) service that is price-competitive with ISR and call-back, while betting on broadband services, superior cost efficiencies, and abundant capacity to maintain profitability.

As such, reform in Hong Kong has moved closer to the competitive ideal than any other Asian market. ISR will be legal (with licenses "on demand") on reciprocally legal routes from January 1999 with facilities-based competition from January 2000. Other regulatory initiatives support development of free

Figure 2. Simplified IRR of New Line Investment



Note: Internal Rate of Return (IRR) is the theoretical discount rate at which the net present value (NPV) of new line investment equals zero. Devaluations in Asian currency have had a serious impact on these projections, most notably in Indonesia.

Source: Merrill Lynch & Co., Inc.

competition, including mandatory number portability and sharing of certain local loop facilities. Interestingly, Hong Kong is pushing ahead with these reforms when international traffic (ex-China) is falling, thereby creating an interesting case study in accelerating reform during difficult times.

If carriers are short on internally generated capital, what can they do? Unfortunately for most carriers, the regional crisis has slowed external capital raisings to a virtual halt. Exceptions include a few debt refinancings, but new equity issuance has slowed dramatically. Many carriers thus seek to obtain new capital from each other—through mergers and/or strategic investments.

Market observers have predicted consolidation in the Asian telecom industry for several years now. However, virtually all regional mergers and acquisitions have been confined to in-country deals, partly because foreigners are generally not interested.

Foreign telcos are less than interested in strategic investment in Asia for several reasons. In most Asian countries, foreign ownership limits have prevented foreign investors from obtaining direct control. And past difficulties in obtaining meaningful operating influence on a minority basis have made injecting fresh capital into struggling new entrants difficult to justify on current terms. While global players would likely pay a strategic premium to be able to guarantee quality connectivity to global multinational carriers, they have generally been unable to obtain this degree of direct operating control. Moreover, strategic investors can rarely justify acquisitions on a replacement cost or inexpensive capacity argument. Returns on telecom assets have historically been closely tied to their physical location and hence, to the economic activity of the area. Foreign carriers must thus be cautious about viewing distressed Asian networks merely as cheap capacity.

Privatizations have similarly stalled. Deep vested interests in heretofore unusual market structures have persisted, and in some cases, actually deepened. Several countries still lack an independent regulator, even where the governing ministry has an economic stake in unusual market structures or revenue sharing arrangements.

When will this improve? Most likely when governments and/or dominant private shareholders lower their valuation and control expectations. This is likely to happen only when the pain gets intense enough, which in turn is integrally related to issues like the degree of creditor forbearance (for privately-owned carriers) and depletion of government fiscal reserves (for state-owned carriers).

Strategic Responses

In this environment, over the next 12-18 months, carriers have several strategic alternatives, including:

Develop a "hub" strategy - For carriers less reliant on international service to finance buildout, we expect "hub" strategies. For example, having effectively lost the high margin of switched international traffic, HKT is attempting a transition to a high volume, low margin hub business. In one sense, this strategy attempts to turn telecom services into a "tradable" good. Rather than be dependent on traffic originating from or terminating in the host country, an efficient carrier with no IDD margin to protect can compete for the entire global market—but only if their internal efficiencies, correspondent relationships and transmission capacity are strong enough.

Acquire struggling competitors - We expect incumbents to be on the lookout for regional acquisitions. In this respect, the Asian crisis has created some attractive value for international carriers seeking to diversify their revenue bases away from the pricing risks of the settlement rate system. We believe acquisitions of local loop assets—at the right price—will develop into a key strategy, particularly for Asian international carriers with abundant cash.

Grow or acquire cellular customer bases - A corollary to this approach is to focus on cellular, which represents a rapidly growing proportion of total "lines." As a key source of international traffic, cellular is thus growing in strategic importance to diversifying international carriers.

Conclusion

Financing Asian network expansion remains a complicated game. International tariffs continue to fall while local currency investment costs rise. Most Asian carriers still face a difficult transition to fully rebalanced tariffs, which despite the growing financial pressure to liberalize more fully, is still probably several years away.

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International Long Distance in Latin America

by Myles Davis, Luiz Carvalho, and Josh Milberg,
Morgan Stanley Dean Witter & Co.

The editors of *TeleGeography* have asked us to address several questions: First, what are the prospects for the region's international long distance providers—both incumbents and new entrants? Second, what were the key events of 1998 and what do we expect next year and beyond? Third, how much debt and equity was raised in 1998, and what's on the calendar after 1998? Finally, what will be the important issues for international carriers in the next year?

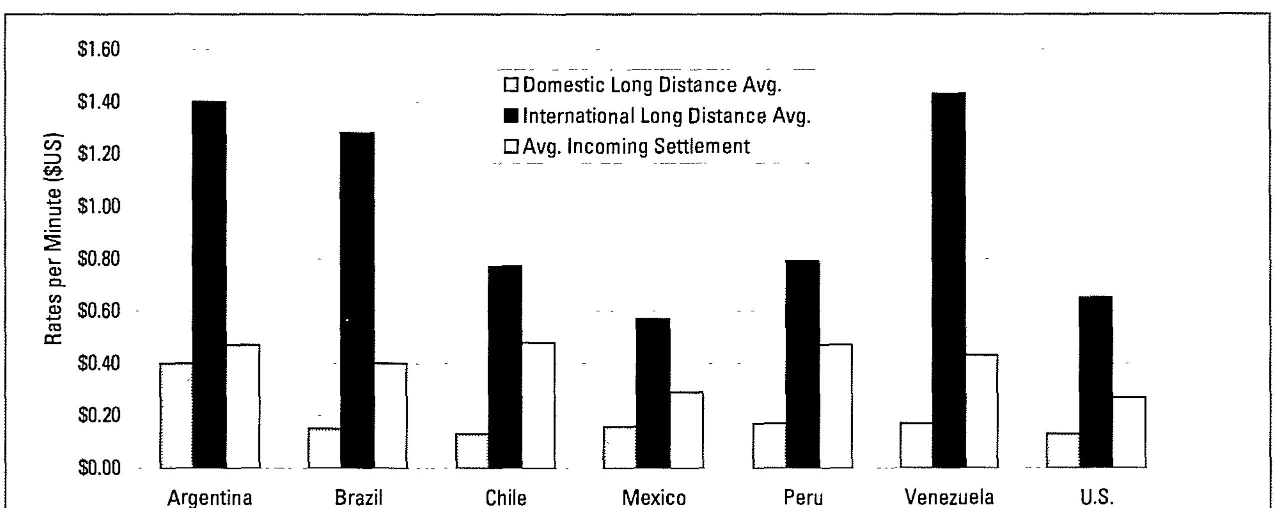
Telecommunications in Latin America is stepping across the threshold of liberalization. Some countries have moved in advance of the rest of the region—Chile and Mexico, in particular—and others have, through referenda or other means, only begun to open their telecom sectors. For the majority of nations in Latin America, however, 1998 and 1999 are the years in which the first major steps are being taken toward liberalized, competitive telecom markets for local service and both national and international long distance.

In our view, two main issues have moved to the forefront. First, regulators and governments are focused on their countries' need for infrastructure, reflecting the relatively low phone penetration rates in Latin America compared to those in North America or Western Europe. This has led to buildout requirements for new licensees in most Latin American nations. Second, the laws of supply and demand suggest that fewer licenses awarded should tend to create a higher price per license. A desire to maximize value—and income—has, in our view, played a part in keeping low the number of new entrants at this stage of liberalization.

The pace from here, then, is deliberate, and offers a relatively benign scenario for incumbent providers. Chile's experience with full-scale competition in national and international long distance might be seen as a cautionary tale for the large Latin American regulators. Although Chilean outbound international traffic has grown an average of 49 percent per year since full competition was introduced in late 1994, rates have fallen over 18 percent per year in the same time frame (on a weighted average basis) and Entel's market share has fallen to approximately 36 percent. Following the initial "free for all," consolidation has begun, leaving Chile with three major long distance competitors.

In this environment, many countries have decided on a duopoly or oligopoly as the first stage of market liberalization. Brazil, for example, has outlined plans that will create one long distance competitor with a nationwide license to compete with Embratel, the incumbent long distance (domestic and international) provider. Embratel itself was purchased in this year's

Figure 1. Comparative Latin American Long Distance Rates



Note: Figures based on carrier estimates and are current to August 31, 1998.

Source: Morgan Stanley Dean Witter & Co.

privatization auction by a consortium led by MCI. The new entrant must fulfill significant requirements for infrastructure deployment. Argentina, according to its liberalization schedule, will license two long distance competitors to the incumbents Telecom and Telefónica before November 1999. As in Brazil, there is a requirement for network buildout. There are exceptions to this trend—El Salvador, one of the smaller markets in the region, has awarded at least eight provisional licenses to long distance competitors since November 1997.

Current Trends

What do these trends signify for new and incumbent providers of international long distance in Latin America?

First, we expect a more gradual transition to competition than we have seen in the U.S. or Europe. We have mentioned the infrastructure deployment required of most new licensees in Latin America, as well as the factors contributing to small numbers of awarded licenses in many countries. These in essence raise high barriers to entry to Latin markets, and keep the number of competitors limited.

Second, the resale market will develop more slowly. The regulatory orientation we have described—and the low phone penetration that drives it—also create another significant difference between the advent of competition in Latin America and that in the U.S. or Europe. In the U.S., resale became a part of the competitive mix in a relatively short time, due to the availability of network elements and the strong regulatory structure in the U.S. As Europe moved toward full liberalization in 1998, network elements were also available for lease. In Latin America, however, there is little network capacity available for resale—with Chile as the notable exception—and little interest on the part of regulators to make it available, given their focus on increasing overall phone penetration and infrastructure buildup.

Third, we forecast only a gradual reduction in the current relatively high rates for international calls in many Latin American markets. These rates have declined over the past few years (see Figure 1) but remain among the highest in the world. We expect only a gradual fall in collection rates in markets when there are only one or two competitors. In many countries, the driving force behind lower international rates will continue to be call-back operators and Internet telephony providers, whether legal or not.

We must add one more variable in the foregoing analysis: the "global contagion" of currency crises which has battered Latin American stock markets in 1998. This environment could lead to slower growth in Latin American economies, in turn, affecting the outlook for telecom growth. We have begun to see the results of this, as at least one potential competitive entrant has deferred its planned investments in Latin America until both the economic and the regulatory environments stabilize. From conversations we have had with other operators, the general consensus is that meaningful entry by competitive operators will not take place in many Latin American countries at least until 2000. By this time, they believe, the economic difficulties facing the region in 1998 will be improving, and the limited com-

Figure 2. Debt and Equity Raised in Latin America, 1998

Date	Operator/Country	Description	Price Paid ($US)
April 98	Tricom (Dominican Republic)	Sole alternative provider of diversified telephone services (ILD, DLD, cellular, and local) in Dominican Republic. Raised $70 million in IPO on New York Stock Exchange, only public offering of equity by Latin American telecom in 1998.	$70 million
June 98	Impsat (Argentina, Colombia, others)	Leading competitive provider of satellite and terrestrial private line and data services throughout South America, primarily to large corporate customers. $225 million high-yield offering.	$225 million
July 98	Telebras (Brazil)	The Brazilian government sold its stake (representing 51.8 percent of voting shares) in each of 12 newly formed companies carved out of Telebras, to a number of strategic investors. The 51.8 percent stake in international carrier Embratel was bought by a consortium led by MCI for $2.65 billion.	$2.65 billion (Embratel)
July 98	CTE (El Salvador)	France Télécom acquired 51 percent of CTE, a corporation formed from ex-monopoly ANTEL. CTE had 380,000 fixed lines in service, 180 million MiTT a year, and an as-yet-uncommercialized license for PCS 1900 MHz. CTE has no exclusivity. France Télécom's offer exceeded the only other bid, made by Telmex, by $4 million.	$275 million
July 98	Intelsa (El Salvador)	Telefónica acquired 51 percent of Intelsa, a corporation holding as-yet-uncommercialized licenses for cellular and fixed telephony.	$41 million

Source: Morgan Stanley Dean Witter & Co.

petition phase of liberalization will be coming to an end, allowing more competitors into the markets.

The Future

What lies ahead? Four key issues face both incumbent and new international operators in Latin America.

First, the presence of a strong regulatory body. Latin America does not have the equivalent of a European Union (EU) to define and to press for relatively uniform rules of liberalization and competitive entry. Although Mercosur, the regional trade alliance between Brazil, Bolivia, Chile, Argentina, Paraguay, and Uruguay has played this role to some extent, it does not encompass all of Latin America, nor are its member states as firmly tied to the organization as are the members of the EU. Given this, whether individual nations are able to create regulatory bodies that can serve as strong and effective arbiters of competition—safeguarding the interests of those operators that "build" while clearing an equitable path toward eventual full competition—will serve as a defining test of national commitment to competition. In the absence of a strong regulator, the road toward open telecom markets will be long and slow, given the role that most incumbents play in the region's national economies—and stock markets.

Second, how well and how quickly the region—and the world—is able to pull itself out of the current economic crisis. Economists here at Morgan Stanley Dean Witter have argued forcefully that most Latin economies are strong relative to other emerging economies and do not deserve the punishment they are receiving. Foreign direct investment has continued at a strong pace even through the turmoil of mid-1998—the strong demand for the Brazilian telecom privatization being a major example. But mutual fund flows into the region have slowed. And global debt and equity markets as a whole have become much more difficult for most smaller international players.

The availability of capital is one of the major drivers behind the rapid pace of competitive entry in Europe, and, without it, reaping the benefits of liberalization in Latin America even in the best regulatory climate would take quite some time. Major global telecom players—MCI, Telefónica and Telecom Italia—have made substantial investments in the region, but these foreign firms have largely invested in incumbents, and we believe it is the next generation of entrants, operating on a smaller scale, that will bring truly competitive services to the region. Two things must occur for this next generation to move: first, access to capital in world markets in general must improve, and second, the riskiness, real or perceived, of investing in Latin America must diminish.

Third, infrastructure development. As mentioned, Latin America has relatively low teledensity rates. Extending telephone networks to a larger percentage of the population, creating backbone networks to carry voice and data, and deploying switches and routers to handle the traffic are much needed. And infrastructure requirements are part of most liberalization and licensing structures in the region. Western Europe, by comparison, was easily adaptable to competition; phone penetration was high, and leased circuits, though an order of magnitude more expensive than in the U.S., were available.

Fourth, and finally, the decline in international settlement and collection rates. This is more of a medium term than near term issue for Latin America, as we expect higher-than-average rates to persist longer in this region than in the U.S. or Europe. Over time, however, both rates to customers and termination rates will move toward cost, and strategies based on rate arbitrage will result in narrower and narrower margins. This will have three effects: First, at the wholesale level, countries which are net traffic importers—those that receive more calls than they make—should lose income from the decline in settlement rates. Second, the decline in collection rates should result in less income to carriers as each minute costs less to the caller. Lastly, this decline in cost should spur traffic growth, as we have seen in Chile, where, as we mentioned, rates have declined 18 percent per year while traffic has risen 49 percent per year.

Ultimately, the health of any international operator will be dependent on an efficient, low cost network in the target country and a sound scheme—enforced by a strong regulator—for interconnection to the local loop at reasonable rates. This network might be owned, or leased from another carrier if a country has developed sufficient infrastructure, as in Chile. But competitive local access is probably a distant point down the road for many countries in Latin America. Nevertheless, facilities-based competition has taken hold in the U.S., and Europe seems to be moving in a similar direction—but at a more rapid pace. Eventually, therefore, we expect Latin America will do the same—probably sooner rather than later.

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Emerging North American Carriers

by Joe Noel and Mark Langner, Hambrecht & Quist,LLC

In 1998, the North American telecommunications market saw a new group of international carriers emerge as a market force. These emerging international long distance (E-ILD) operators have taken advantage of a number of trends, including deregulation of telecom markets worldwide, steady growth in telephone usage, and an expanding number of second and third tier domestic carriers who need international connections.

Emerging ILDs have raised large amounts of capital to support their growth. In so doing, most have moved from a "Light Carrier" resale model to a "Heavy Carrier" facilities-based model (see "International Carrier Evolution" on page 26). This shift, in turn, has raised barriers to entry for other potential entrants to the international telephony market.

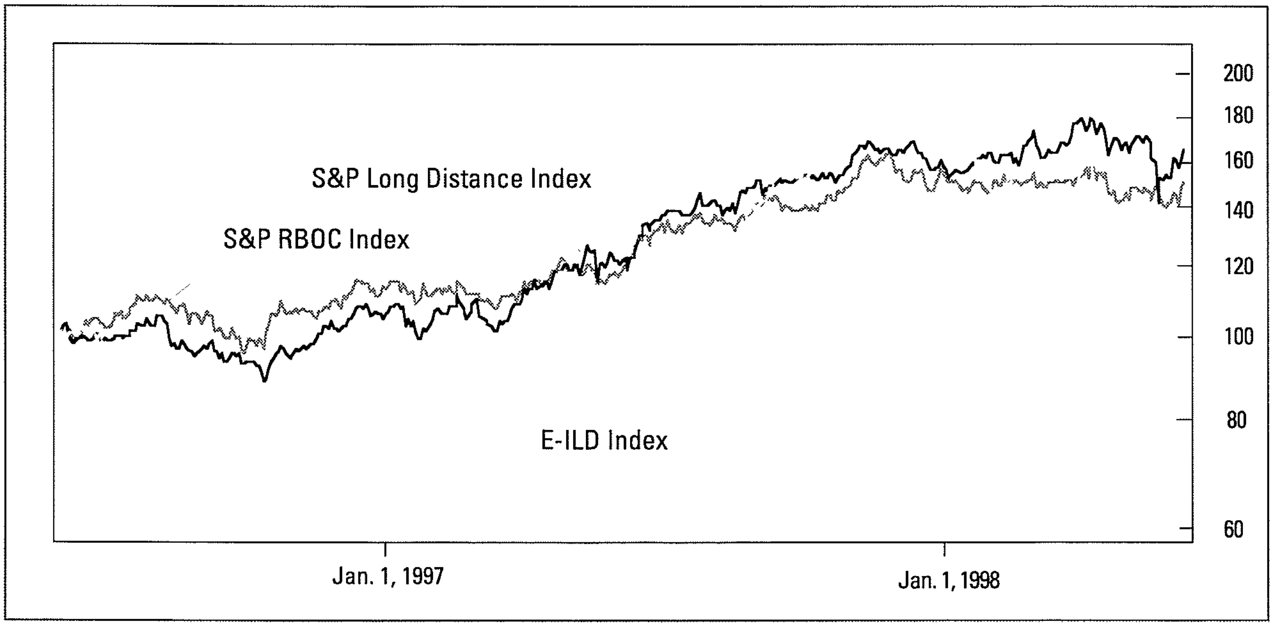
New submarine cable companies, in part supported by E-ILD players, also will bring massive amounts of international capacity on-line. That will put further pressure on prices. It will also aid the emergence of high-bandwidth, data-oriented carriers, which have started the U.S. with companies such as Qwest and Level 3. We discuss these developments in more detail below.

Market Dynamics

In North America, the carriers pursuing the E-ILD market have changed over the last two years. Most are now bigger and more firmly established, with more of their own facilities, operations, and interconnection agreements than at the beginning of 1997. The growth of the early entrants has also effectively closed the window of opportunity for aspiring providers to "bootstrap" their way into the E-ILD market. In contrast, from 1990 to 1996 or so, a low capital market entry path existed, based on the resale and "call-back" services which some current E-ILD players used to launch their businesses.

E-ILD carriers are now intent on increasing their direct interconnections and deployed facilities in order to lower costs, particularly on less competitive routes outside of the primary focus of incumbent providers. At the same time, E-ILDs are increasing their product lines and retail sales channels. We see retail sales as a necessary complement to the E-ILD provider's traditional wholesale business so as to manage growth and to maintain margins.

Figure 1. Performance of Emerging International Long Distance Carriers



Note: Index prices are from January 1, 1997 to September 14, 1998. The benchmark of 100 equals the value of each index on January 1, 1997.
E-ILD Index comprises: Star Telecom—STRX, IDT Corp.—IDTC, Pacific Gateway Exchange—PGEX, Primus Telecommunications—PRTL, RSL Communications—RSLCF, Startec Global Communications—STGC, and Telegroup—TGRP.

Source: Hambrecht & Quist, LLC

Figure 2. Financings of Emerging International Long Distance Carriers

Company	Ticker	Private Equity	IPO	Follow on	Public Debt	Long Term Debt
Startec Global	STGC	$1,003,259	$39,330,000	—	—	$160,266,000 (a)
STAR Telecom	STRX	$13,649,000	$35,550,000	$157,545,000	—	$27,775,000
IDT	IDTC	$2,411,600	$46,000,000	$126,707,031	$100,000,000	$15,936,27 (b)
Primus	PRTL	$29,241,328	$60,375,000	—	$375,000,000	—
RSL COM	RSLCF	$97,787,000	$182,160,000	(c)	$988,969,600	$21,461,000
Telegroup	TGRP	$56,961	$46,000,000	—	$97,000,000	$45,263,118 (d)
Pacific Gateway Exch.	PGEX	$941,734	$59,280,600 (e)	—	—	—

Notes:
(a) Includes $160M private debt placement.
(b) Includes $7.5M of Convertible Debt ($6.5M of which was subsequently converted).
(c) In August, RSL COM filed a registration statement for a $253M follow on offering.
(d) Includes $20M of Senior Sub Debt ($12.4M redeemed with IPO proceeds); includes $25M convertible notes.
(e) Includes $21.6M from sale of shares to individual investors at IPO price.

Source: Hambrecht & Quist, LLC

Market Performance

The performance of E-ILDs in the public market since 1997 has trailed more established segments of the telecom industry. Figure 1 shows the performance of the E-ILD group relative to the S&P RBOC and Long Distance telecom indices. The E-ILD providers' stock values have suffered particularly since the stock market moved off of its historic high in July 1998.

However, if we look at the performance of the individual companies over this same period we see that certain E-ILD providers have experienced strong stock price growth—particularly IDT and STAR Telecom—which approximately doubled in value and outperformed the S&P 500. In this analysis, companies with business models which have flexibility and which have focused on building facilities have fared better than those carriers more reliant on wholesale and/or resale business models.

Ultimately we believe that the E-ILD companies which are best able to manage the disparate environments of network building (a long term process), and the constantly changing day-to-day nature of pricing international services, will be most successful. In today's volatile stock market, it is no longer enough to manage one side or the other of this equation.

Looking to 1999

Although the E-ILD market is already mature, we see the market becoming even more complex due to the influence of data and the Internet on international telephony. Additionally, continuing market volatility will have a tremendous impact on the strategies of international carriers based on the availability of capital to fund acquisitions and growth.

While not discussed in detail here, in 1999 we expect Internet protocol (IP) and larger packet-based telephone services on the networks of new carriers, more than telephony on the public Internet, to play a larger role. For the most part, we expect these types of services to feed into the existing structure of wholesale telephony as another transmission choice for international service retailers, with price, quality and availability as the factors determining the speed at which these types of services grow. We expect E-ILD players to become players in the IP telephony market. Some E-ILDs have already begun IP services, such as IDT's Net2Phone, and RSL's Delta Three. Additionally, we expect that current E-ILD providers will also be likely distributors of IP telephony services sold on a wholesale basis.

The Rise of the International Data Carrier

During 1997 and 1998, the North American market has seen the strong growth of data-oriented carriers such as Qwest, Level 3, IXC Communications, and others. In 1999, this trend will begin to move offshore, supported by the vast amounts of undersea cable being brought on-line by companies such as Global Crossing, FLAG, MCI WorldCom, and others. An early indication of the strong demand for international data services is reflected in the IPO of Equant earlier in 1998, leaving the carrier capitalized at over $6 billion. This trend will have its greatest impact on incumbent providers as these companies' blue chip customers are most eager for global data solutions. In the medium term (two to five years) we expect the increased amount of capacity that these data carriers will bring to the market will have a profound effect on traditional international telephony markets. The resultant drop in voice traffic, however, is expected to be concentrated on tier one countries, which are markets where the E-ILD players have already seen significant competition, and on customer groups that the E-ILD players have not traditionally pursued (the largest of corporate customers).

The Role of Capital as a Competitive Weapon

Based on current trends, we believe that managing capital will be an increasingly important part of the E-ILD players' strategies. Figure 2 shows the group of E-ILD providers that have been most active in the capital markets.

In recent months, however, funding for most communications carriers has dried up. In the U.S. there has not been a significant high-yield debt offering completed during the summer of 1998. Hence, if markets continue to be volatile, there will likely be a significant impact on new carriers' ability to raise funds using the same avenues available to prior entrants. In contrast, carriers with capital—and the necessary cash flow to service debt—are likely to strengthen their market positions and be able to take advantage of acquisition opportunities.

Conclusions

Overall, we continue to see international telecom as an attractive business for established players. We believe this is due to continued strong growth fundamentals for international telephony services in general.

We expect North American incumbents to see continued erosion in overall market share. The one carrier that is likely to escape this trend is Teleglobe. This carrier has "changed its stripes" and acts more like an E-ILD provider than an incumbent (though we expect Teleglobe's Canadian share to continue to erode).

For the E-ILD players, margins will continue to shrink on routes to developed countries. The effect will be offset, however, by continued success in other, less competitive markets, where the E-ILD players have valuable relationships and circuit capacity, where vast amounts of capacity are not likely to come on line soon, and where incumbent players and other retail-oriented providers will continue to need capacity from E-ILDs.

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International Services of U.S. RBOCs

When will the RBOCs compete for international services? The short answer is "they already do," but primarily as resale carriers (see Figure 1). And even though some of the Regional Bell Operating Companies (RBOCs) may acquire their own international facilities, they won't become major competitors until they can sell international services to their own local customers. In most states that will not occur until 1999, at the earliest. To understand why, it is helpful to review briefly America's historic communications reform law, the Telecommunications Act of 1996 (1996 Act).

The 1996 Act was motivated largely by two interrelated objectives. First, the U.S. Congress sought to foster greater competition for local telephone services by, among other things, allowing the country's major long-distance carriers—AT&T, MCI and Sprint—to compete directly for local services with incumbent carriers, such as the RBOCs.

The second goal—and the political *quid pro quo* for the first—was to free the RBOCs from the antitrust constraints imposed in 1984 when they were divested from AT&T. Once freed, the RBOCs would be able to provide interexchange, including international, service in direct competition with their former parent.

The RBOCs are by far the largest local exchange carriers (LECs) in the United States. Each RBOC serves at least 15 million access lines, and collectively the RBOCs account for approximately 85 percent of all U.S. access lines. The 1996 Act permits RBOCs wishing to provide international service for calls originating outside of their local service regions to do so by simply filing a standard application under Section 214 of the Communications Act.

In contrast, for in-region international service, an RBOC must obtain Section 214 authority and file an application, state-by-state, under Section 271 of the Communications Act. The Federal Communications Commission (FCC) may not grant an RBOC Section 271 authority until it has consulted with the U.S. Department of Justice and the agency is satisfied that three competitive safeguards have been met.

First, for each state in which the RBOC seeks to provide service, the RBOC must have entered into a connection agreement with at least one unaffiliated, facilities-based (or predominantly facilities-based) competitor. Alternatively, an RBOC may publish its general terms for access and interconnection, which must have been approved by the relevant state utilities commission.

Second, the RBOC's interconnection agreement or its published terms must satisfy a competitive checklist. Specifically, interconnection must: (1) be unbundled and cost-based; (2) include access to poles and rights of way; (3) include access to emergency and directory services; (4) provide universal directory listings; (5) provide access to telephone numbers; (6) provide for local dialing parity; (7) offer number portability; (8) offer reciprocal compensation arrangements; and (9) permit resale.

Third, once this checklist is satisfied, the FCC may only authorize an RBOC to offer in-region long-distance service if it is pro-

Figure 1. RBOC International Services Authorized by the FCC

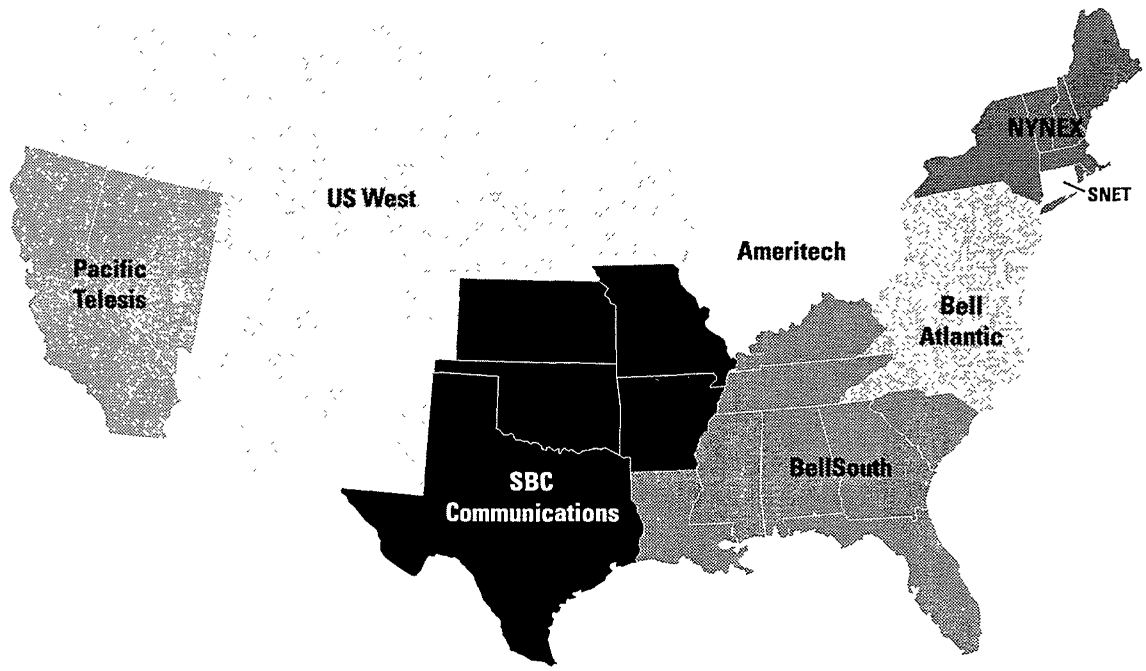
	Out of Region IMTS		In Region IMTS	
	Switched Resale	**Facilities-Based**	**Switched Resale**	**Facilities-Based**
Ameritech Corp.	July 19, 1996 *	July 9, 1997 *	—	—
Bell Atlantic Corp.	July 19, 1996	Feb. 7, 1997 *	—	—
(NYNEX)	July 19, 1996 *	Feb. 6, 1997 *	pending	—
BellSouth Corp.	June 3, 1996	June 3, 1996	pending	—
SBC Communications, Inc.	Oct. 25, 1996	—	—	—
(Pacific Telesis)	Feb. 13, 1997	Sept. 5, 1997*	pending	pending
U S West, Inc.	Dec. 27, 1996	—	—	—

Note: IMTS is International Message Telephone Service. Each application for international service was filed by an RBOC subsidiary separate from the local service provider. All dates are for the earliest application granted. Data current to Sept. 1998.

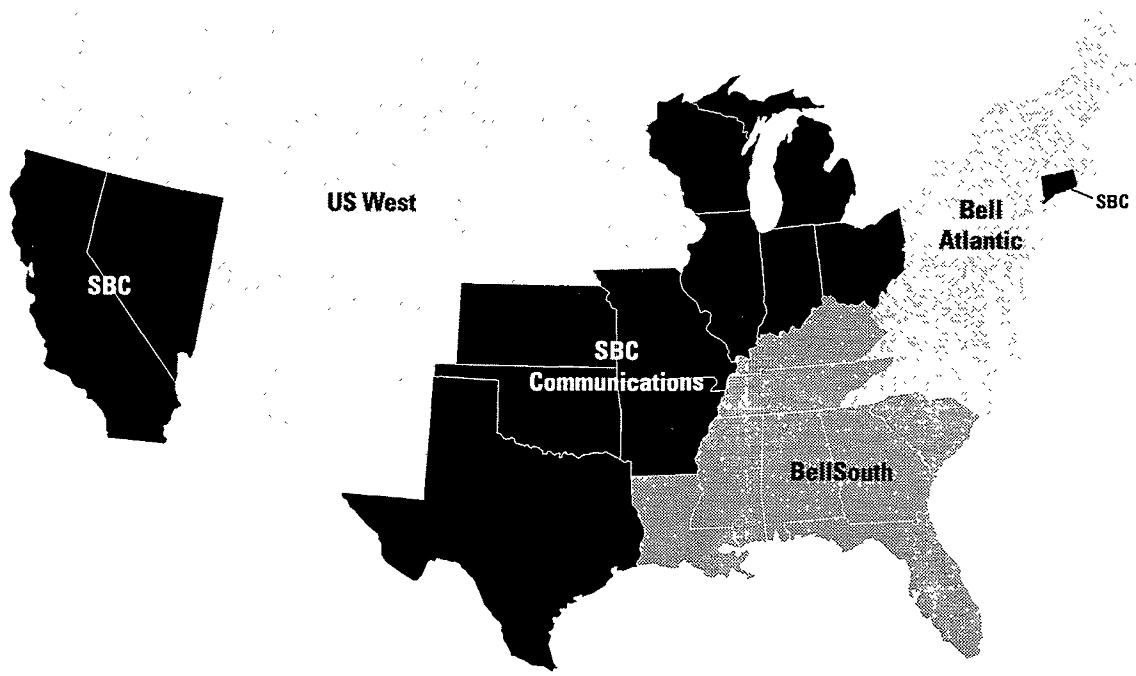
*Indicates route restrictions apply where the RBOC has a foreign carrier affiliate.

Figure 2. Changing Landscape of U.S. Regional Bell Operating Companies

RBOC Territories in 1994



RBOC Territories in 1999



Note: At this printing, SBC's mergers with Ameritech and SNET were still pending final approval. Map does not display territory gained by the pending Bell Atlantic-GTE merger. GTE, although not an RBOC, is the third-ranked local service provider in the U.S, with service territories spread across 28 states.

Figure 3. RBOC Section 271 Applications

	State	Status
Ameritech Corp.	Michigan	denied (8/97)
Bell Atlantic Corp.	—	—
BellSouth Corp.	South Carolina	denied (12/97)
	Louisiana	denied (10/98)
SBC Communications, Inc.	Oklahoma	denied (6/97)
US West, Inc.	—	—

Note: Each application for international service was filed by an RBOC subsidiary separate from the local service provider. Data current to Oct. 1998.

vided through an independent affiliate with separate officers, directors, employees and accounts. This separate affiliate requirement "sunsets" after three years.

Ameritech was the first RBOC to file a Section 271 application for in-region long-distance authority with a January 1997 application to serve Michigan. However, Ameritech's application was later dismissed because its interconnection agreement had not been given final state approval. Ameritech later refiled its application, but the FCC rejected it again in August 1997, this time because the company's interconnection agreement did not satisfy three items in the competitive checklist. Later Section 271 applications by BellSouth and SBC also have been rejected (see Figure 3).

BellSouth has appealed the denial of its South Carolina application in a court case that is currently pending. In a novel argument to the U.S. Court of Appeals, BellSouth claims that Section 271 is unconstitutional because its conditions for long distance market entry apply only to the RBOCs. Under this theory, Section 271 amounts to a "Bill of Attainder"—that is, a law that seeks to punish certain individuals—which is prohibited by the U.S. Constitution. Surprisingly, this argument has been met with some support in the Court of Appeals and is being given serious consideration. Developments in the BellSouth appeal, therefore, bear close watching.

Frustrated in their attempts to receive Section 271 approval, the RBOCs have sought creative ways to provide their customers with bundled local and long distance service offerings. For example, two RBOCs—US West and Ameritech—recently entered into an arrangement with Qwest Communications to provide long distance services to their in-region customers. However, in September 1998 the FCC struck down these arrangements with Qwest, saying that they violated the requirements of Section 271. Qwest and US West promptly filed a court appeal. Bottom line: Absent judicial intervention, the FCC is unlikely to authorize the RBOCs to offer in-region long distance and international services until they make a good faith effort to comply with the competitive requirements of Section 271.

Until the RBOCs have authority to provide long distance services in key states, they will not be able to market international service to their core customers—business and high volume residential customers within their local service regions. The FCC's Section 271 proceedings (and related local interconnection proceedings) thus will require continuing review by anyone interested in the RBOCs' future as international carriers.

This overview is adapted from a paper prepared by Koteen & Naftalin, LLP, entitled "The RBOCs Enter the Market for Domestic and International Long-Distance Services." Koteen & Naftalin, LLP, is one of Washington DC's leading communications law firms. Founded in 1953, its clients now include U.S. and foreign companies in the telecommunications, data networking, electronic equipment, broadcasting and entertainment industries. For further information, contact Greg Staple at +1 202 467 5700 (voice); +1 202 567 5915 (fax); greg.staple@koteen.com.

European Carrier Financings

Figure 1. Major European Financings, January 1997-October 1998

Offer Date	Issuer	Issuer Nation	Type of Security	Principal Amount (US$ millions)
1/10/97	Telenor AS	Norway	Notes	$109.5
1/27/97	France Telecom SA	France	Notes	$142.2
2/17/97	Telefonica	Spain	ADRs	$210.8
2/27/97	Esprit Telecom Group	United Kingdom	ADRs - IPO	$17.1
4/8/97	British Telecom	United Kingdom	Notes	$1,000.0
5/13/98	British Telecom	United Kingdom	Bonds	$1,000.0
10/9/97	Portugal Telecom SA	Portugal	ADRs	$301.4
10/20/97	France Telecom SA	France	Ordinary Shares - IPO	$2,455.9
10/25/97	Telecom Italia	Italy	Common Shares	$1,968.0
11/7/97	Esat Telecom Group	Ireland	ADRs - IPO	$39.0
11/13/97	MagyarCom	Hungary	Ordinary Shares - IPO	$385.8
11/20/97	COLT Telecom Group	United Kingdom	Common Shares	$114.5
11/21/97	COLT Telecom Group	United Kingdom	Global Bonds	$199.1
12/9/97	Energis	United Kingdom	Ordinary Shares - IPO	$119.7
12/12/97	Esprit Telecom Group	United Kingdom	Bonds	$148.0
3/11/98	Telenor AS	Norway	Notes	$100.6
3/20/98	SPT Telecom AS	Czech Republic	Common Shares	$30.4
4/3/98	Telefonica	Spain	Ordinary Shares	$2,740.0
4/23/98	SPT Telecom AS	Czech Republic	Notes	$278.1
5/1/98	Phone Systems & Network	France	Ordinary Shares - IPO	$3.3
5/5/98	SPT Telecom AS	Czech Republic	Notes	$140.5
5/6/98	France Telecom SA	France	Bonds	$500.0
5/15/98	Maltacom	Malta	Global Dep. Rec. - IPO	$46.0
5/18/98	Telenor AS	Norway	Notes	$67.3
5/20/98	VersaTel Telecom BV	Netherlands	Bonds	$225.0
6/2/98	OTE	Greece	Ordinary Shares - IPO	$74.3
6/7/98	NETnet International	Sweden	Ordinary Shares	$2.6
6/11/98	Cable & Wireless	United Kingdom	ADRs	$1,033.3
6/17/98	Helsingin Puhelin	Finland	Ordinary Shares	$168.6
6/18/98	Esat Telecom Group	Ireland	ADRs	$93.0
6/19/98	Esprit Telecom Group	United Kingdom	Senior Notes & Bonds	$198.6
6/26/98	Tele Danmark AS	Denmark	Bonds	$276.3
7/23/98	Telenor AS	Norway	Senior Notes	$112.0
7/24/98	COLT Telecom Group	United Kingdom	Bonds & Stock	$336.9
10/5/98	Swisscom	Switzerland	Ordinary Shares - IPO	$5,500.0

Source: Securities Data Corp. (http://www.securitiesdata.com)

Market Shares of Competing International Carriers

				Percentage of Outgoing MiTT						
Country/Carrier	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
United States										
AT&T	89.1	83.3	78.4	74.8	70.3	62.2	60.1	54.3	50.2	45.3
MCI	7.0	10.2	14.6	17.8	21.2	24.8	26.5	28.5	28.4	26.0
Sprint	3.5	5.8	6.4	6.3	7.3	10.3	11.1	11.3	13.2	12.2
Worldcom						0.6	2.1	3.5	4.5	6.2
Pacific Gateway Exch.										3.3
Others	0.4	0.7	0.7	1.1	1.2	2.1	0.2	2.4	3.7	7.0
United Kingdom										
BT	95.5	91.0	86.0	81.0	76.8	74.2	68.6	67.7	60.0	54.9
C&W Comm	4.5	9.0	14.0	19.0	23.2	24.0	28.1	25.8	26.8	30.3
WorldCom									6.6	5.1
GlobalOne									3.1	1.5
ACC									3.0	3.6
Others						2.2	3.3	6.5	<1	4.6
Japan										
KDD		93.3	88.0	73.3	69.7	66.9	66.3	66.2	63.9	61.0
IDC		3.7	6.5	13.3	15.3	16.9	17.3	17.3	18.7	19.2
Japan Telecom		3.0	5.5	13.4	15.0	16.2	16.4	16.5	17.5	19.8
New Zealand										
TNZ			92.0	82.0	80.0	78.4	74.8	78.0	78.2	74.6
ClearCom			8.0	18.0	20.0	21.6	25.2	22.0	19.8	20.2
Others									2.0	5.2
Republic of Korea										
Korea Telecom					79.9	74.5	68.7	72.6	73.5	69
Dacom					20.1	25.5	31.3	27.4	26.5	27
Onse										4
Chile										
Entel Chile					80.0	57.5	40.0	40.6	37.3	33
Chilesat					20.0	25.0	19.7	19.4	15.2	17
VTR Telecom					<1.0	17.5	10.2	10.3	9.3	11
CTC-Mundo							21.0	20.7	22.2	22
BellSouth Chile							6.6	6.8	10.0	10
Iusatel							1.2	<1	2.8	3
CNT							<1	<1	<1	<1
Transam							<1	<1	2.8	3
Philippines										
PLDT					91.6	84.2	69	68	78	71
Philippine Global Com					8.4	15.8	23	23	6	3
Eastern Telecom							7	6	5	7
Capitol Wireless							<1	<1	1	1
Bayan Tel								<1	4	5
Smart								<1	1	2
Digitel									2	3
Philcom									2	7
Islacom									<1	<1
Australia										
Telstra					98.0	87.0	76.3	73.4	62.0	55
Optus					2.0	13.0	21.9	23.4	27.0	26
AAPT										11
Primus										3
Others							1.8	3.2	11.0	5
Canada (Canada-U.S. route only)										
Stentor						93	80	63	57	56
AT&T Canada Long Distance						2	8	8	8	9
Sprint Canada								13	15	16
Fonorola								9	12	7
ACC								3	4	5
Others						5	12	4	4	7

Percentage of Outgoing MiTT

Country/Carrier	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Dominican Republic										
Codetel						>90	85.8	83.0	77.0	73.8
Tricom						n.a.	6.7	7.5	12.8	12.9
All America Cables and Radio, Inc. (AACR)						n.a	7.5	9.5	10.2	13.3
Sweden										
Telia AB						92	87	76	69	66
Tele-2						8	13	21	22	22
Others								3	9	12
Finland										
Telecom Finland							90	72.8	66.0	58.9
Finnet International							5	19.1	24.2	28.2
Telia							3	7.7	8.8	9.3
Others							2	0.4	0.9	3.5
Indonesia										
PT Indosat							99.5	95.4	89.5	84.8
PT Satelindo							0.5	4.6	11.5	14.2
Denmark										
Tele Danmark									92.5	82
Tele2									4.0	10
Telia A/S									3.5	8
Other										<1
Malaysia										
Telekom Malaysia									90	81
TRI									8	15
Others									2	4
Mexico										
Telmex										84.0
Avantel										7.5
Alestra										7.5
Others										1.0
Ireland										
Telecom Eireann										91
Esat Telecommunications										5
WorldCom Ireland										3
Others										1
Israel										
Bezeq										83
Barak										10
Golden Lines										7
Netherlands										
PTT Telecom (KPN)										95
Enertel										3
Others										2

Notes:

MiTT is Minutes of Telecommunications Traffic. Data based on outgoing international traffic for the public switched network only covering the full calendar or fiscal year. Some data aggregated in "Others" rows include market shares for carriers shown individually in later years. Market shares may not total to 100 percent due to rounding.

United States: Market shares for U.S. carriers prior to 1993 exclude traffic to Canada and Mexico; for the traffic base of second tier U.S. carriers, see page 246. The 1996 figures for WorldCom reflect its acquisition of MFS.

United Kingdom: Carriers' traffic to Ireland is excluded prior to 1994. The figures for Cable & Wireless Communications reflect data for Mercury prior to its April 1997 merger with Bell Cablemedia, Videotron, and NYNEX CableComms. Market shares based on fiscal year reporting. Data for second tier carriers may include traffic refiled via the U.K., thus overstating actual market shares of U.K.-originated traffic.

Japan: The figures for Japan Telecom reflect data for ITJ prior to its October 1997 merger with domestic long distance carrier Japan Telecom Co. Market shares based on fiscal year reporting and are for International Direct Dial traffic only.

New Zealand: Market shares for New Zealand carriers prior to 1996 exclude resellers and are based on fiscal year reporting.

Chile: The 1994 market shares for Chile are based on traffic for the month of December only.

Australia: Market shares for 1994 and 1995 are based on traffic for October to December quarters only and reflect wholesale minutes for facilities-based carriers only. Market shares in 1996 and 1997 are from fiscal year ending 30 June.

Indonesia: PT Satelindo began international service in September 1994.

Netherlands. Competitors to PTT Telecom did not begin service until the second half of 1997.

The Top 40 International Carriers

Rank	Company	Origin Country	Outgoing Traffic (millions of minutes) 1997	1996	Change 96-97	1997 Revenue (US$ billions) Total	Int'l Service
1.	AT&T (a)	United States	10,290	9,459	8.8%	$51.30	$5.63
2.	MCI (a)	United States	5,907	5,356	10.3%	$19.65	$2.62
3.	Deutsche Telekom (a)	Germany	5,333	5,100	4.6%	$37.72	$5.25
4.	BT (a)	United Kingdom	3,735	3,158	18.3%	$25.87	$2.57
5.	France Télécom	France	3,545	3,116	13.8%	$26.17	$2.11
6.	Sprint (a)	United States	2,759	2,480	11.2%	$14.87	$0.81
7.	Telecom Italia	Italy	2,352	2,184	7.7%	$24.30	*$1.80*
8.	Swisscom	Switzerland	2,164	1,936	11.8%	$6.95	*$1.70*
9.	C&W Communications (a,c)	United Kingdom	2,065	1,411	n.a.	$3.78	$1.22
10.	Stentor (d)	Canada	1,778	1,650	7.8%	$4.06	n.a.
11.	Hong Kong Telecom (a,b)	Hong Kong	1,718	1,739	-1.2%	$4.21	$2.25
12.	China Telecom	China	1,632	1,433	13.9%	$18.53	*$4.10*
13.	KPN (a)	Netherlands	1,535	1,534	0.1%	$15.19	*$2.20*
14.	WorldCom (a,e)	United States	1,400	846	65.5%	$7.35	$0.11
15.	Belgacom (a)	Belgium	1,340	1,228	9.1%	$4.13	$0.55
16.	*Telefónica (a)*	*Spain*	1,355	1,189	14.0%	$15.58	$0.89
17.	Singapore Telecom (a,b)	Singapore	1,161	942	23.3%	$2.95	$1.22
18.	KDD (a)	Japan	1,105	1,103	0.0%	$3.09	*$2.5*
19.	Teleglobe (a,f)	Canada	1,112	915	21.5%	$1.37	$0.78
20.	Telmex (a)	Mexico	1,009	1,071	-5.8%	$7.53	*$1.7*
21.	Telekom Austria (a)	Austria	996	960	3.7%	$5.30	*$0.90*
22.	Rostelecom (a)	Russia	939	851	10.3%	$1.96	$0.31
23.	Telstra (b)	Australia	835	829	0.1%	$11.29	$0.90
24.	Chunghwa Telecom	Taiwan	789	674	17.1%	$5.13*	n.a.
25.	Telia	Sweden	747	706	5.8%	$5.90	*$0.70*
26.	Pacific Gateway Exch. (a)	United States	743	166	346.8%	$0.30	$0.01
27.	Etisalat	United Arab Emirates	690	589	17.1%	$1.03*	n.a.
28.	Saudi Com. Ministry	Saudi Arabia	660	584	13.0%	$2.11*	n.a.
29.	Telecom Eireann (a,g)	Ireland	635	580	9.5%	$1.94	*$0.60*
30.	Korea Telecom	Korea, Rep. of	610	520	17.3%	$8.52	n.a.
31.	OTE	Greece	594	516	15.2%	$2.87	*$0.60*
32.	Telekom Malaysia (a,b)	Malaysia	589	571	3.2%	$7.17	$1.18
33.	Türk Telekomünikasyon	Turkey	558	473	17.8%	$2.57*	n.a.
34.	Tele Danmark (a)	Denmark	513	573	-10.5%	$4.25	$0.36
35.	Telekomunikacja Polska	Poland	501	437	14.6%	$2.36	n.a.
36.	UTEL (a,h)	Ukraine	487	341	n.a.	$1.11*	n.a.
37.	Telenor	Norway	481	444	8.5%	$3.49	*$0.60*
38.	Telebras (a)	Brazil	459	367	25.1%	$14.16	*$0.90*
39.	WorldxChange	United States	430	63	682.5%	n.a.	$0.04
40.	VSNL (b)	India	421	384	9.4%	$1.35	*$1.20*

Note: Traffic figures are for public switched network circuits only (service resale is excluded). Data for U.S. and U.K. carriers include International Simple Resale (ISR). International service revenues generally reflect net of revenues after adding or subtracting for settlement payments. All revenue figures converted from original currency at conversion rate current to year end reported. Figures in italics are estimates based on previous year service revenue ratios.

a. Data based on billing point of call, not originating point.
b. Data are for the fiscal year ending 31 March. Telstra FY ends 30 June.
c. Data for C&W Communications in FY 1996/97 include only traffic carried by Mercury prior to its April 1997 merger with U.K. cable companies.
d. Stentor traffic is for the U.S. only, of which approximately 70 percent is originated by Bell Canada.
e. 1996 WorldCom data reflect data from MFS acquisition.
f. Teleglobe data are for Canada only. The company originated a reported 952 million minutes of traffic outside Canada.
g. Telecom Eireann data for 1996 exclude traffic to Northern Ireland.
h. UTEL 1996 data 1996 exclude traffic to countries outside the Commonwealth of Independent States.
* Revenue data for 1996.

Source: TeleGeography, Inc. and company reports

Pricing

Elements of an International Call

Now that competition has finally arrived, what will happen to prices?

This section answers that question by breaking down the cost elements for completing an international call. Referring to the table on pages 60 to 61, let's use a call from New York to Berlin as an example. Not including call-back, refile, and other forms of non-traditional traffic switching, a U.S. carrier has four basic methods of transporting its customer's call to the destination in Germany:

1. *Carrier Settlement.* To switch the call from the customer's telephone to its own long distance network, the international carrier first pays the Local Exchange Carrier (LEC) in New York an origination fee of 1.6¢ per minute. Next, the carrier moves the call along a "backhaul" route; that is, from its national network to the undersea cable landing station on the Atlantic Ocean shoreline. The carrier shifts the call onto the international "half circuit" it owns, then pays the German carrier a settlement fee to transfer the call onto its matching half circuit and to the final destination. The U.S. carrier's marginal cost of using its own backhaul and international half circuit is insignificant: 0.1¢ per minute. The settlement rate, at 10¢ per minute, is not so cheap. Total cost: 12¢ per minute.

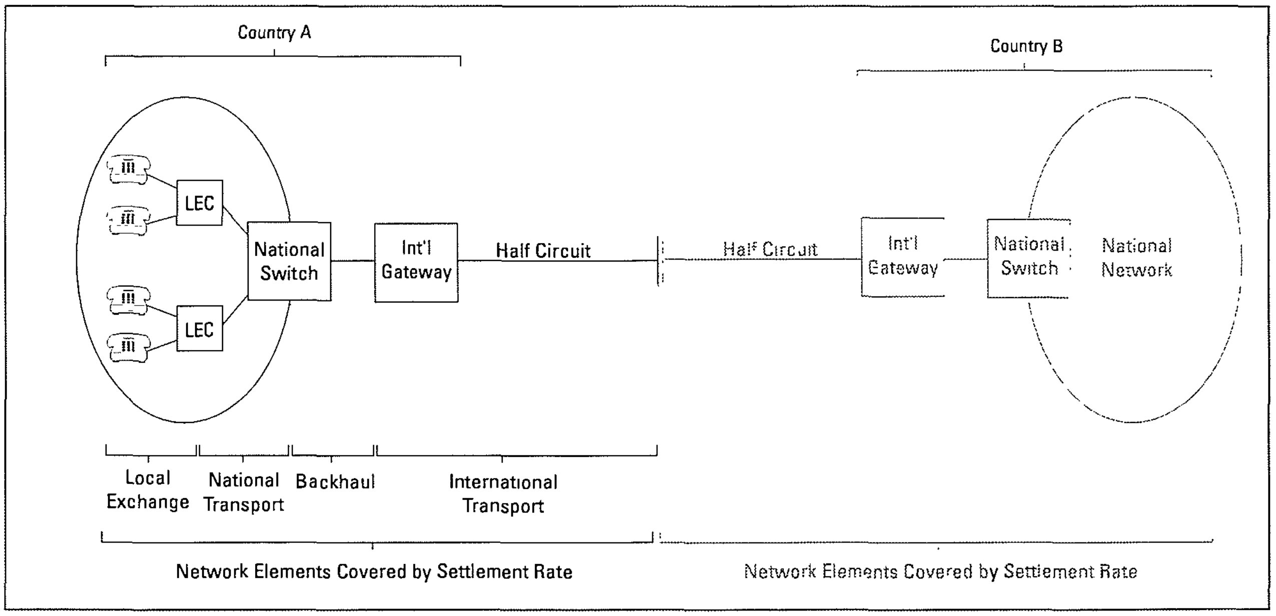
2. *Carrier Interconnect.* New competition rules in Germany permit foreign carriers to interconnect directly with the domestic telephone network. Rather than financing a half circuit and paying a settlement fee, a U.S. carrier can purchase a whole circuit all the way to an international gateway in Germany, then pay the German carrier a 2.8¢ per minute fee to switch the call to Berlin. Total cost, including origination and backhaul: 5¢ per minute.

3. *International Simple Resale (ISR).* A carrier is not required to own its own circuits. Instead, it can switch traffic onto U.S.-Germany private lines leased from other carriers. Total cost, including origination, backhaul, private line lease, and interconnection in Germany: 6¢ per minute.

4. *Service Resale.* A telephone service provider may wish to avoid carrying its own traffic to Germany altogether. To offer its customers access to Berlin, the U.S. company can purchase the minutes transported over another carrier's network in bulk, and market those minutes as its own. The two charges required for end-to-end service resale include a 4¢ per minute "wholesale rate" covering origination and U.S. domestic long distance, plus a 7¢ per minute fee for the underlying carrier's international transport and termination charges. Total cost: 11¢ per minute.

The following pages examine the component costs of provisioning an international call in more detail. Statistics on settlement rates and interconnection charges are also provided. Articles on telecom service and electricity trading examine the new models for purchasing minutes and bandwidth. Finally, tables and maps on retail prices review how carriers are passing along their costs to end users.

Figure 1. International Call Components



International Call Costs for U.S. Carriers

	Per Minute Cost (U.S. Cents)							
	Origination Cost	U.S.-End Int'l Half Circuit Ownership	Foreign-End Half Circuit Ownership	International Whole Circuit Lease	Settlement Rate	Interconnect Rate	Wholesale Rate	**Total**
Americas								
U.S.-Canada (Toronto)								
Retail Price	—	—	—	—	—	—	—	**$0.12**
Carrier Settlement	1.7	0.2	—	—	10.0	—	—	**$0.12**
Carrier Interconnect	1.7	0.2	0.2	—	—	5.3	—	**$0.07**
ISR	1.7	—	—	1.3	—	5.3	—	**$0.08**
Wholesale for resellers	4.0	—	—	—	—	—	5.0	**$0.09**
U.S.-Mexico (Mexico City)								
Retail Price	—	—	—	—	—	—	—	**$0.44**
Carrier Settlement	1.8	0.5	—	—	35.0	—	—	**$0.37**
Carrier Interconnect	1.8	0.5	0.5	—	—	5.7	—	**$0.09**
ISR	3.2	—	—	1.2	—	5.7	—	**$0.10**
Wholesale for resellers	4.0	—	—	—	—	—	18.8	**$0.23**
Europe								
U.S.-Germany								
Retail Price	—	—	—	—	—	—	—	**$0.27**
Carrier Settlement	1.7	0.1	—	—	10.0	—	—	**$0.12**
Carrier Interconnect	1.7	0.1	0.1	—	—	2.8	—	**$0.05**
ISR	1.7	—	—	1.9	—	2.8	—	**$0.06**
Wholesale for resellers	4.0	—	—	—	—	—	7.0	**$0.11**
U.S.-U.K.								
Retail Price	—	—	—	—	—	—	—	**$0.12**
Carrier Settlement	1.7	0.1	—	—	10.0	—	—	**$0.12**
Carrier Interconnect	1.7	0.1	0.1	—	—	1.9	—	**$0.04**
ISR	1.7	—	—	1.6	—	1.9	—	**$0.05**
Wholesale for resellers	4.0	—	—	—	—	—	5.0	**$0.09**

Notes:

All cost components expressed in U.S. cents and are exclusive of taxes. Cost totals expressed in U.S. dollars.

Rates are based on international calls originating from Washington, D.C. only. Data do not reflect costs for international calls terminating in the U.S. Actual carrier costs may vary.

Origination cost includes access charges paid to Local Exchange Carrier (Bell Atlantic) and U.S. domestic network costs for transmitting calls to international gateway.

Assumptions for calculating per minute costs of using international networks include:

Each 64 kbps circuit is compressed at a 5:1 ratio and is used for ten years.

Each voice path is used 4 hours (240 minutes) per day.

Settlement rates are for peak rate traffic terminated by largest foreign carrier.

Direct interconnection by foreign carriers to the domestic public switched network is not permitted in China and India

Retail rates are based on the MCI One International Calling Plan.

All rates current to July 1998.

	Origination Cost	U.S.-End Int'l Half Circuit Ownership	Foreign-End Half Circuit Ownership	International Whole Circuit Lease	Settlement Rate	Interconnect Rate	Wholesale Rate	Total
	Per Minute Cost (U.S. Cents)							
Asia								
U.S.-Australia								
Retail Price	—	—	—	—	—	—	—	**$0.47**
Carrier Settlement	1.8	0.3	—	—	15.0	—	—	**$0.17**
Carrier Interconnect	1.8	0.3	0.3	—	—	1.6	—	**$0.04**
ISR	2.7	—	—	7.3	—	1.6	—	**$0.12**
Wholesale for resellers	4.0	—	—	—	—	—	7.0	**$0.11**
U.S.-China								
Retail Price	—	—	—	—	—	—	—	**$1.31**
Carrier Settlement	1.7	0.6	—	—	68.0	—	—	**$0.70**
Carrier Interconnect	—	—	—	—	—	—	—	**n.a.**
ISR	—	—	—	—	—	—	—	**n.a.**
Wholesale for resellers	4.0	—	—	—	—	—	42.0	**$0.46**
U.S.-India								
Retail Price	—	—	—	—	—	—	—	**$1.22**
Carrier Settlement	1.7	0.6	—	—	79.0	—	—	**$0.81**
Carrier Interconnect	—	—	—	—	—	—	—	**n.a.**
ISR	—	—	—	—	—	—	—	**n.a.**
Wholesale for resellers	4.0	—	—	—	—	—	60.0	**$0.64**
U.S.-Japan								
Retail Price	—	—	—	—	—	—	—	**$0.35**
Carrier Settlement	1.7	0.1	—	—	14.0	—	—	**$0.16**
Carrier Interconnect	1.7	0.1	0.1	—	—	6.0	—	**$0.08**
ISR	1.9	—	—	11.1	—	6.0	—	**$0.19**
Wholesale for resellers	4.0	—	—	—	—	—	18.0	**$0.22**

Sources Federal Communications Commission, MCI WorldCom, Inc., Star Telecommunications, Inc., Band-X, Ltd.; TAT 13 and SEA ME WE 3 cable marketing; Global Crossing, Ltd ; concept TeleGeography, Inc

The Accounting Rate Regime in Transition

Accounting rates provide a common method of compensating originating and terminating carriers for carrying telephone calls over both networks. The system is largely transparent to users and generally works as follows:

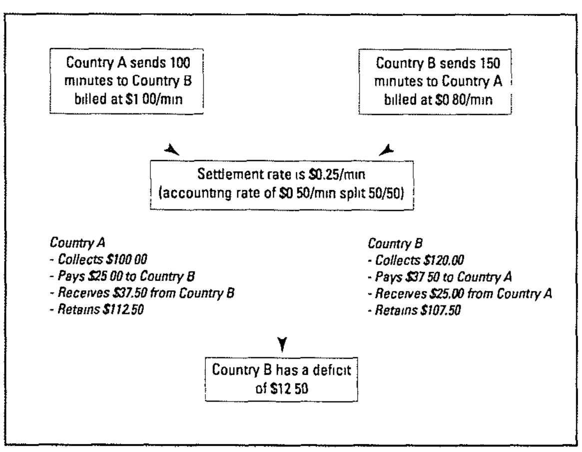
1. International carriers negotiate accounting rates on a route-by-route basis. A per minute rate is agreed for landing traffic in either direction. Theoretically, this rate is based on the sum of both carriers' costs, although the cost-linkage is often quite loose. The rate is commonly stated in U.S. dollars or Special Drawing Rights (SDRs), a monetary unit whose value reflects a basket of major currencies.

2. On any given route, one carrier pays settlements to another carrier only to the extent that there is a traffic imbalance—that is, one carrier has terminated a greater volume of telephone minutes than the other carrier. The originating and terminating carriers usually divide the accounting rate 50/50 to determine the per minute settlement rate.

3. A carrier's net revenue for international service is a function of the accounting rate as well as the collection charge (see Figure 1). If traffic is balanced, the value of the accounting rate is essentially irrelevant since no settlement is necessary and each carrier's revenue will depend directly on its collection charge.

4. Where traffic is imbalanced, the accounting rate may have a significant effect on the commercial options of the two carriers. If a carrier has a significant traffic deficit, the settlement payments which it must make to its foreign correspondent limit its ability to reduce its collection charges. Conversely, a carrier with a net traffic surplus has little incentive to operate more efficiently or to reduce the accounting rate because of the net settlement benefits it receives under the status quo.

Figure 1. How Accounting Rates Work



Source: Adapted from *Direction of Traffic 1996*, ITU/TeleGeography, Inc.

Few international carriers are entirely satisfied with the present accounting rate regime. Some want it abolished outright so that they can strike the best commercial deals possible. Others are content to exploit the system (e.g., by supporting call-back carriers or refiling traffic through third countries) so as to lower rates while profiting along the way (see Figure 2). Even carriers with large settlement surpluses know reform is essential, if only to ensure a "soft landing" rather than an abrupt fall-off in settlement payments.

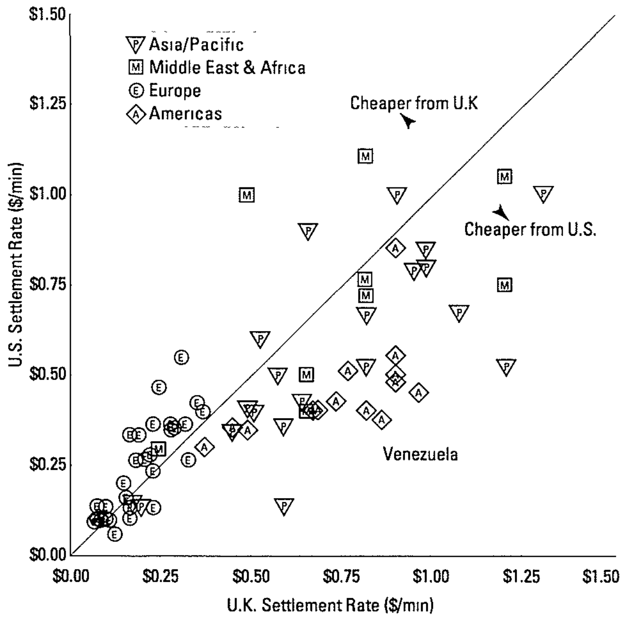
FCC Settlement Rate Benchmarks

Since 1996, spurred by the $8 billion annual settlement outflow of U.S. carriers, the U.S. Federal Communications Commission (FCC) has been the most active proponent of settlement rate reform. The centerpiece of the FCC's policy is an August 1997 order establishing a set of "benchmark" or model settlement rates which all U.S. international carriers must respect beginning in 1999 (see pages 68 to 69). The benchmark rates range from $0.15 to $0.23 per minute—often 50 percent or more below the current rate—and will be phased in (see Figure 3). U.S. carriers must negotiate benchmark rates with carriers from richer countries by January 1999; benchmark rates must be implemented with carriers from middle income and poorer countries between 2000 and 2003. While these new benchmarks primarily apply to public switched telephone services, the FCC's order also prohibits International Simple Resale (ISR) on a route unless 50 percent of the U.S. outbound traffic is already settled at or below the benchmark rate.

The FCC calculated its new benchmarks using a controversial model for estimating foreign carriers' actual costs in terminating U.S. calls. The estimates are based on the per minute tariff or tariff proxy for three foreign network components: the international transmission facility (cable/satellite half-circuit); the international gateway facility; and the national extension (domestic transport and local termination). Tariff component prices (TCPs) were calculated for 65 countries and these countries were then divided into four economic groups based on their 1995 Gross Domestic Product (GDP) per capita. The

Figure 2. The Logic Behind Refile

U.S. and U.K. Settlement Rates to Selected Countries, July 1998



Each marker represents the U.K. and U.S. settlement rate to one international call destination. If U.S. settlement rates exactly tracked U.K. rates, destination coordinates would align along the 45° diagonal line. Clearly, the 45° rule fails to hold. Notice, for example, how settlement rates to countries in the Americas tend to be significantly cheaper from the U.S. than from the U.K.

A refiler can use these price differences to its own advantage. In July 1998, the actual settlement rate with Venezuela was 40¢ from the U.S. and 82¢ from the U.K. By charging British carriers a rate somewhere between the U.S. and U.K. costs—say, 70¢—to send traffic to Venezuela, a refiler could turn a hefty profit. Imagine that the refiler's costs equal 60¢ per minute—5¢ to transfer traffic from the U.K. to the U.S., 15¢ to move the call from the U.S. to Venezuela, and 40¢ to land the call abroad. In our hypothetical example, the British customer saves money by refiling, and the refiler reaps a 10¢ per minute profit. It's a shame about the Venezuelan carrier, though—it earns 42¢ less settlement revenue than if the U.K. carrier had sent traffic directly.

Source: FCC, Office of Telecommunications (OFTEL), TeleGeography, Inc. © TeleGeography, Inc. 1998

average TCP for each economic group was then adopted by the FCC as the benchmark for all countries within a given income category (again, see Figure 3).

Despite the one to five year transition period for U.S. carriers, on January 1, 1998, the FCC began to apply its new settlement benchmarks to foreign carriers wishing to enter the U.S. market. Since then, any foreign-affiliated U.S. carrier seeking to provide telephone service to its home country must satisfy the applicable benchmark. Foreign affiliated carriers already operating in the U.S., however, were given a reprieve pending further review. Some foreign-affiliated U.S. carriers have asked the FCC to waive the benchmarks unless the U.S. carrier controls 25 percent or more of U.S. traffic on a route or its affiliate controls bottleneck facilities at the foreign end.

More than a dozen foreign carriers have challenged the FCC's benchmark rules in the U.S. courts. They argue, among other things, that the agency overstepped its jurisdiction because the benchmarks amount to a de facto price cap on the termination charges of foreign operators. The case was argued in September 1998 and a decision is expected by January 1999. Most observers expect the FCC's order to be upheld, although the court may direct the agency to reconsider the level of the benchmarks for some countries.

Even if the FCC's order is upheld by the courts, lower settlement rates must still be negotiated by U.S. carriers. The FCC's order is not self executing; it only holds out the threat of FCC intervention if private carrier-to-carrier negotiations fail to produce more cost-based settlement rates. Since August 1997 though, U.S. carriers have had considerable success in negotiating lower rates. As of September 1998, U.S. rates were at or below the $0.15 settlement benchmark on approximately 20 routes reflecting over 40 percent of U.S. outbound traffic. And carriers in several other foreign countries (notably, Mexico, Egypt, Turkey, Venezuela, Korea, Dominican Republic, and South Africa) had agreed to meet the benchmarks within the FCC's stated time frame.

In the year since the benchmarks order was adopted, the FCC has also taken other steps to place economic pressure on car-

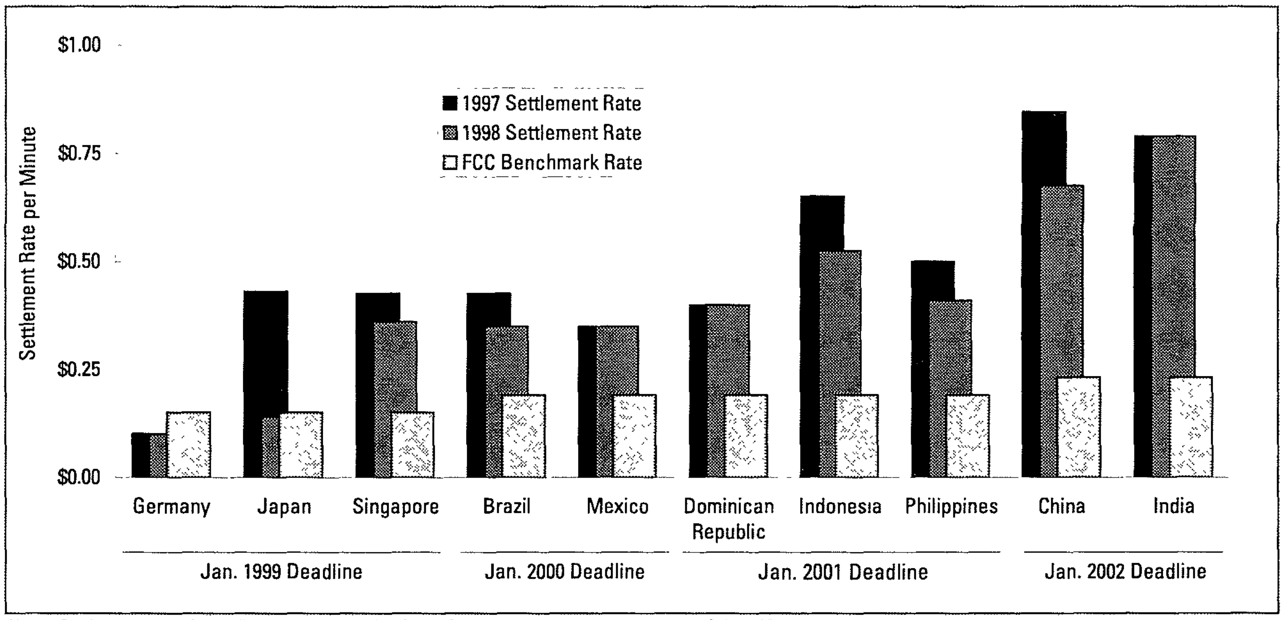
Figure 3. FCC Settlement Benchmarks (US$)

Income Group	GDP per capita	Benchmark	Effective Date
Low	0-$726	$0.23	1 Jan. 2002
Lower Middle	$726-$2,985	$0.19	1 Jan. 2001
Upper Middle	$2,896-$8,955	$0.19	1 Jan. 2000
High	$8,956 +	$0.15	1 Jan. 1999

For countries with less than 1 telephone line per 100 people, the effective date is 1 Jan. 2003. Waivers of the effective date may also be requested in certain cases.

Source: FCC © TeleGeography, Inc. 1998

Figure 4. FCC Benchmark Deadlines Approaching



Note: Settlement rates for 1997 are an average for the entire year; 1998 rates are current to July 1998.

Source: TeleGeography, Inc.

© TeleGeography, Inc. 1998

riers which persist in maintaining significantly above-cost settlement rates. First, as soon as the benchmark rate has been met on a given U.S. route, the FCC has opened it to ISR. Because ISR traffic uses international private lines, it bypasses the accounting rate regime. Thus, each of the 12 new U.S. routes opened to ISR since 1997—routes include Japan, France, Germany, and Italy—has placed downward pressure on the settlement rates charged to neighboring destinations. Second, in August 1998, the FCC proposed to permit U.S. carriers dispense with accounting rates altogether when exchanging international traffic with a non-dominant foreign carrier (see www.fcc.gov/Bureaus/International/Notices/1996/FCC98190.pdf). The FCC's proposed rules would also permit U.S. international carriers to negotiate the best termination rates they can with any foreign carrier in a country where ISR is permitted. In addition, the FCC has proposed to allow U.S. carriers to offer ISR services to countries which do not meet the FCC's benchmark rates if the service would only involve a comparatively small percentage of traffic. These FCC proposals have been widely supported by both U.S. and foreign carriers, and are likely to be adopted by Spring 1999.

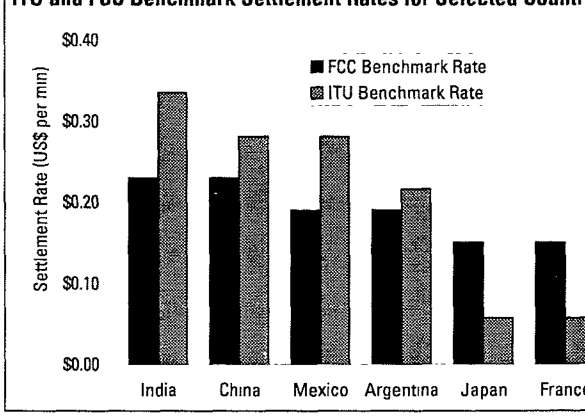
The economic thrust of these FCC reforms was given a further boost on October 1, 1998 when the Canadian Radio-Television Commission (CRTC) adopted a "light handed" set of settlement

Figure 5. ITU Settlement Benchmarks

Settlement Rate Categories (US$)

Country Teledensity (Phone Lines per 100 people)	Benchmark Rate	Example Countries
>50	0.043 SDRs ($0.057)	Germany, U.S.
35-50	0.088 SDRs ($0.118)	Belgium, Italy
20-35	0.118 SDRs ($0.158)	Bahrain, Hungary
10-20	0.162 SDRs ($0.216)	Chile, South Africa
5-10	0.210 SDRs ($0.281)	Mexico, China
1-5	0.251 SDRs ($0.335)	India, Philippines
<1	0.327 SDRs ($0.437)	Bangladesh, Ghana

ITU and FCC Benchmark Settlement Rates for Selected Countries



Source: ITU

© TeleGeography, Inc. 1998

rules for new competitive international carriers in Canada. Under the new rules, an unlimited number of carriers will be permitted to compete with the Canadian incumbent, Teleglobe. Settlement terms will be a matter for commercial negotiation, subject to general competition rules; there will be no settlement benchmarks and ISR will be permitted on any route where it is lawful at the foreign end (see www.crtc.gc.ca/ENG/telecom/decision/1998/d9817-o.txt). Thus, given that ISR is already permitted on the U.S.-Canada route, the CRTC's action gave both U.S. and Canadian carriers a significant new option for refiling traffic to and from "high cost" overseas carriers.

Enter the ITU

A focus group within the International Telecommunication Union (ITU), the rules-making body for global telecommunications, is considering its own proposals for settlement rate benchmarks (see www.itu.int/intset/focus/index.html). The ITU's plan differs from the FCC benchmarks policy in a number of ways:

1. Benchmarks are assigned to a country according to that country's teledensity (number of telephone lines per 100 inhabitants) rather than GDP (see Figure 5). The ITU proposals include an additional benchmark category (39 U.S. cents per minute) for small island nations. The ITU targets are based on current published settlement rates for 224 countries, with the target rate established as the average of the lowest 20 percent in each category.

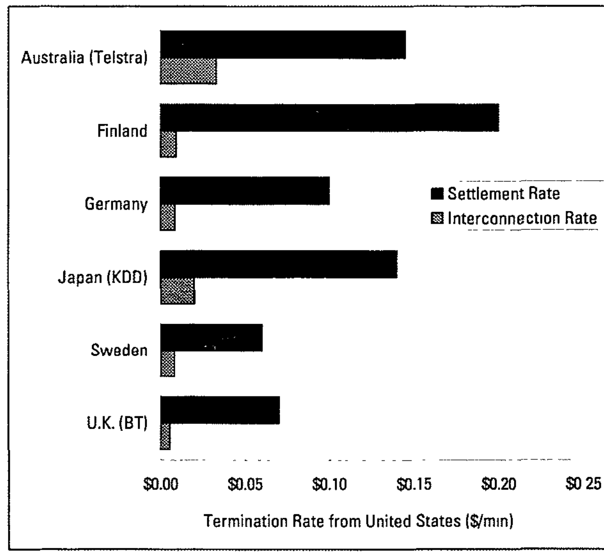
2. FCC benchmarks may be phased in from 1999 to 2002, depending on a country's per capita GDP. ITU recommendations set December 31, 2001 as the date for achieving target settlement rates, but propose a longer transition period—up to the year 2005—for countries where net settlement payments constitute a significant source of telecommunications revenue.

3. The ITU's proposed rates cover a much wider range than the FCC's prescribed band—from 6 to 44 cents per minute compared to the FCC's 15 to 23 cents.

4. While the FCC benchmarks relate to fewer than 250 outgoing routes from the U.S., ITU target rates cover more than 40,000 international routes. Settlement rates between two countries in different teledensity categories would be set at or below the target rate for the country with lower teledensity. The ITU proposals also suggest the use of asymmetric accounting rates—with a variation by a few percentage points from the traditional 50/50 division—for countries with low teledensities.

The ITU focus group has also offered target rates for routing traffic through third countries. Transit rates would vary according to the amount of telephone traffic sent over a route, ranging from 4 cents per minute on routes with more than 1.5 million minutes of international traffic to 6 cents per minute for routes with less than 350,000 minutes each year.

Figure 6. Termination Rates Compared



Note: Rates valid as of July 1998. Interconnection rate includes domestic long distance and local switching, but excludes cost of foreign half circuit.

Source: EU Commission, FCC © TeleGeography, Inc. 1998

Despite attempts to reach consensus, the ITU's proposals may have little effect. The FCC's regulations have teeth because most countries enjoy a traffic surplus with the U.S. and hence any rules limiting U.S. outpayments are almost certain to bite. In contrast, the ITU cannot exert financial pressure to enforce compliance; target rates remain subject to the bilateral agreement by both parties on an international route. Whether carriers will choose to adopt these rates remains to be seen.

Direct Interconnection

Reform efforts notwithstanding, settlement rates are of declining importance to many carriers because competitive markets typically offer the option of obtaining access to the "foreign" phone network directly. Where market entry has been liberalized, instead of paying settlement charges, many carriers prefer to acquire a whole circuit to the destination country and pay a domestic interconnection fee (see Figure 6). Fees are often unbundled so that the more local facilities a foreign carrier owns, the less it has to pay for the "last mile." The table on page 70 illustrates how these pricing bands apply.

Regulatory action is reinforcing the movement toward low interconnect fees. For example, the Commission of the European Union (EU) has authorized national regulatory authorities in the fifteen EU member states to order lower interconnect fees charged by incumbent carriers if the fees they charge fail to reflect their actual costs. The EU Commission has also published recommended "best practice" rates to encourage cost transparency (see www.ispo.cec.be/infosoc/telecompolicy).

International Settlement Rates

Destination	United States 1996	United States 1997	United States 1998	United Kingdom 1996 (US$)	United Kingdom 1998 (US$)
Andorra	0.31	0.29	0.28	0.26	0.22
Argentina	0.72	0.63	0.38	0.85	0.86
Australia	0.23	0.21	0.15	0.27	0.17
Austria	0.22	0.21	0.14	0.24	0.20
Bahamas	0.30/0.15	0.30/0.15	0.30/0.15	0.33	0.38
Bahrain	0.80	0.80	0.72	1.04	0.82
Bangladesh	1.00	1.00	0.80	1.04	0.99
Belarus	0.60	0.50	0.43	0.34	0.35
Belgium	0.28	0.20	0.14	0.15	0.10
Bolivia	0.63	0.60	0.48	0.91	0.90
Brazil	0.52	0.52	0.35	0.70	0.49
Canada	0.12/0.10	0.12/0.10	0.12/0.10	0.14	0.08
Chile	0.50	0.55	0.55	0.94	0.90
China	1.07	0.89	0.68	1.14	1.08
Colombia	0.63	0.59	0.50	0.88	0.90
Costa Rica	0.58	0.58	0.40	1.02	0.69
Croatia	0.51	0.34	0.27	0.28	0.33
Cyprus	0.65	0.55	0.47	0.31	0.25
Czech Republic	0.36	0.34	0.27	0.21	0.21
Denmark	0.15	0.14	0.11	0.10	0.10
Dominican Republic	0.45	0.40	0.40	0.58	0.67
El Salvador	0.55	0.55	0.44	1.30	1.54
Finland	0.26	0.25	0.20	0.18	0.15
France	0.18	0.13	0.10	0.12	0.11
French Polynesia	1.25	1.25	1.25	1.39	1.64
Germany	0.12	0.11	0.10	0.10	0.08
Ghana	0.50	0.50	0.50	0.56	0.66
Greece	0.51	0.48	0.36	0.30	0.29
Guyana	0.85	0.85	0.85	0.84	0.90
Hong Kong	0.47	0.40	0.35	0.42	0.45
Hungary	0.51	0.42	0.27	0.17	0.18
Iceland	0.47	0.44	0.37	0.26	0.23
India	0.80	0.79	0.79	0.96	0.95
Indonesia	0.70	0.65	0.53	1.07	1.21
Iran	1.50/1.25	1.50/1.25	1.05	1.02	1.21
Ireland	0.18	0.17	0.16	0.13	0.16
Israel	0.59	0.59	0.30	0.35	0.25
Italy	0.26	0.19	0.11	0.27	0.16
Japan	0.46	0.43	0.14	0.63	0.59
Jordan	0.75	0.75	0.75	1.02	1.21

Notes:

1. All rates expressed in US$. Equivalent dollar values are presented for accounting rates that are established in Special Drawing Rights (SDRs), gold francs, or pounds sterling.
2. The average U.S. accounting rate for 1996 and 1997 is weighted by the total minutes between the U.S. and each location in that year. U.K. 1996 rates date to October 1996. U.S. and U.K. 1998 rates current to July 1998.
4. U.K. 1996 rates sometimes appear lower than July 1998 rates due to the lower 1998 value of the U.S. dollar against pound sterling.
5. Where two rates are shown, there are peak/off-peak rates or growth-based rates (traffic above a benchmark level is eligible for a lower rate).
6. Rates are for largest carrier serving the route. Different accounting rates may apply to competing carriers.

Destination	United States 1996	1997	1998	United Kingdom 1996 (US$)	1998 (US$)
Kazakhstan	1.05	1.05	0.67	1.10	0.82
Korea, Republic of	0.62	0.49	0.43	0.70	0.64
Kuwait	0.84	0.78	0.77	0.70	0.82
Luxembourg	0.29	0.21	0.14	0.20	0.23
Macau	0.68	0.68	0.60	0.56	0.53
Malaysia	0.45	0.45	0.40	0.50	0.51
Mexico	0.34	0.35	0.35	0.56	0.45
Moldova	1.04	1.04	1.00	0.50	0.30
Netherlands	0.18	0.17	0.10	0.20	0.07
New Zealand	0.22	0.14	0.14	0.35	0.20
Norway	0.15	0.14	0.11	0.17	0.07
Oman	1.20	1.13	1.11	0.77	0.82
Pakistan	1.10/0.70	1.00/0.60	0.90/0.50	1.11	0.66
Panama	0.63	0.60	0.51	1.02	0.77
Paraguay	0.73	0.73	0.50	0.90	0.90
Peru	0.62	0.57	0.43	0.90	0.74
Philippines	0.50	0.50	0.41	0.77	0.49
Poland	0.48	0.35	0.35	0.26	0.28
Portugal	0.42	0.34	0.24	0.29	0.23
Russia	1.06	1.06	0.40	0.36	0.37
Saudi Arabia	1.10	1.01/0.81	1.00/0.80	0.91	1.27
Singapore	0.45	0.42	0.36	0.50	0.59
Slovak Republic	0.65	0.42	0.34	0.20	0.19
Slovenia	0.36	0.34	0.34	0.24	0.16
South Africa	0.50	0.50	0.40	0.90	0.66
Spain	0.32	0.30	0.14	0.29	0.16
Sri Lanka	1.00	1.00	1.00	0.77	0.90
Sweden	0.09	0.08	0.06	0.10	0.12
Switzerland	0.26	0.19	0.14	0.14	0.07
Taiwan	0.60	0.60	0.50	0.77	0.57
Thailand	0.75	0.75	0.53	0.84	0.82
Turkey	0.58	0.55	0.37	0.27	0.32
Ukraine	0.70	0.65	0.55	0.95	0.31
United Arab Emirates	1.00/0.65	1.00/0.65	1.00/0.65	1.02	0.49
United Kingdom	0.18/0.11	0.10/0.07	0.10/0.07	n.a.	n.a.
United States	n.a.	n.a.	n.a.	0.17	0.08
Uruguay	0.85	0.85	0.45	0.82	0.97
Uzbekistan	0.85	0.85	0.85	0.97	0.99
Venezuela	0.50	0.50	0.40	0.82	0.82
Vietnam	1.15/1.00/0.93/0.85	1.15/1.00/0.93/0.85	1.15/1.00/0.93/0.85	1.46	1.31
Yugoslavia	0.58	0.56	0.37	0.33	0.28

Source: FCC; Office of Telecommunications (OFTEL)

FCC Settlement Benchmarks

Benchmarks Methodology

These Tariffed Component Prices (TCPs) were calculated by the staff of the Federal Communications Commission (FCC) and were used to derive average benchmark settlement rates for U.S. international telephone carriers in the FCC's Report and Order IB Docket No. 96-261, FCC 97-280, released August 18, 1997 (Benchmarks Order). Implementation of the Order is staggered over several years, according to national incomes, from January 1, 1999 for high income countries to January 1, 2003, for low income countries (see "The Accounting Rate Regime in Transition" on pages 62 to 65).

The TCP for each country is derived from the prices for the three network elements used to provide international phone service as identified by Recommendation D.140 of the International Telecommunication Union Telecommunication Standardization Sector (ITU-T). These elements are: (1) International transmission facilities (cable/satellite half circuits); (2) International switching facilities; (3) National extension (domestic transport and termination).

The FCC used 1996 tariff rates for the largest carrier in each country to calculate the price for the international transmission and national extension elements. For the international transmission portion, the FCC used the rate for a high capacity (1.5 Mbps or more) international private line, assuming 4/1 compression on each 64 kbps circuit, and a usage level of 8,000 minutes per 64 kbps circuit per month. For the national extension, the FCC relied upon national long distance tariffs, making some adjustments for the expected distribution of inbound traffic by time of day and distance. The per minute cost of the international switching element was derived from the accounting rate share figures stated in the ITU-T Recommendation D.300R for the international exchange component.

Details on the FCC's methodology can be found in Appendix E to the Benchmarks Order. See also the December 1996 "Foreign Tariffed Components Prices" report prepared by the FCC's International Bureau, at Appendices C and D, which contains the relevant international private line and domestic long distance tariffs.

Tariffed Component Prices for FCC Benchmarks

Country	International Transmission (US¢) +	International Switching (US¢) +	National Extension (US¢) =	Tariffed Component Price (US¢ Total)	FCC Settlement Benchmarks (US¢)
Upper Income Bracket: Effective 1 January 1999					
Australia	4.8	1.9	12.0	18.7	15.0
Austria	8.1	1.9	21.4	31.4	15.0
Bahamas	5.2	1.9	12.8	19.9	15.0
Belgium	3.0	1.9	9.2	14.1	15.0
Denmark	5.9	1.9	6.6	14.4	15.0
France	2.9	1.9	12.7	17.5	15.0
Germany	4.3	1.9	13.6	19.8	15.0
Hong Kong	5.1	1.9	0.0	7.0	15.0
Ireland	2.7	1.9	13.4	18.0	15.0
Israel	4.2	1.9	2.4	8.5	15.0
Italy	4.8	1.9	11.5	18.2	15.0
Japan	6.5	1.9	11.3	19.7	15.0
Kuwait	7.1	1.9	0.0	9.0	15.0
Netherlands	2.6	1.9	5.3	9.8	15.0
New Zealand	5.7	1.9	16.2	23.8	15.0
Norway	3.2	1.9	6.5	11.6	15.0
Portugal	4.6	1.9	17.4	23.9	15.0
Singapore	5.0	1.9	0.7	7.6	15.0
Spain	4.8	1.9	11.4	18.1	15.0
Sweden	3.6	1.9	4.5	10.0	15.0
Switzerland	4.4	1.9	14.3	20.6	15.0
Taiwan	5.7	1.9	6.3	13.9	15.0
United Arab Emirates	3.3	1.9	2.5	7.7	15.0
United Kingdom	2.4	1.9	8.7	13.0	15.0

Tariffed Component Prices for FCC Benchmarks (continued)

Country	International Transmission (US¢) +	International Switching (US¢) +	National Extension (US¢) =	Tariffed Component Price (US¢ Total)	FCC Settlement Benchmarks (US¢)
Upper Middle Income Bracket: Effective 1 January 2000					
Argentina	6.7	3.4	22.0	32.1	19.0
Barbados	8.6	3.4	0.0	12.0	19.0
Brazil	6.6	3.4	17.8	27.8	19.0
Chile	2.9	3.4	12.3	18.6	19.0
Czech Republic	8.1	3.4	7.5	19.0	19.0
Greece	5.2	3.4	14.4	23.0	19.0
Hungary	6.1	3.4	4.9	14.4	19.0
Korea	5.1	3.4	4.3	12.8	19.0
Malaysia	6.6	3.4	12.4	22.4	19.0
Mexico	0.9	3.4	12.5	16.8	19.0
South Africa	5.2	3.4	8.3	16.9	19.0
Trinidad	3.6	3.4	7.6	14.6	19.0
Uruguay	12.7	3.4	6.2	22.3	19.0
Lower Middle Income Bracket: Effective 1 January 2001					
Colombia	5.1	4.8	8.6	18.5	19.0
Costa Rica	3.3	4.8	2.2	10.3	19.0
Dominican Republic	3.6	4.8	6.1	14.5	19.0
Ecuador	2.9	4.8	2.6	10.3	19.0
El Salvador	5.9	4.8	1.1	11.8	19.0
Guatemala	3.1	4.8	2.4	10.3	19.0
Indonesia	6.8	4.8	23.9	35.5	19.0
Jamaica	2.9	4.8	1.0	8.7	19.0
Jordan	15.9	4.8	2.3	23.0	19.0
Panama	4.7	4.8	9.9	19.4	19.0
Peru	5.8	4.8	5.5	16.1	19.0
Philippines	6.5	4.8	12.6	23.9	19.0
Poland	4.7	4.8	15.1	24.6	19.0
Russia	5.4	4.8	25.2	35.4	19.0
Thailand	4.0	4.8	8.3	17.1	19.0
Turkey	5.4	4.8	7.7	17.9	19.0
Venezuela	3.7	4.8	15.3	23.8	19.0
Lower Income Bracket: Effective 1 January 2002					
China	8.7	4.8	4.2	17.7	23.0
Egypt	10.4	4.8	2.0	17.2	23.0
Guyana	6.6	4.8	0.6	12.0	23.0
Haiti	8.6	4.8	17.0	30.4	23.0
Honduras	3.1	4.8	8.7	16.6	23.0
India	8.1	4.8	18.3	31.2	23.0
Kenya	25.5	4.8	12.3	42.6	23.0
Nicaragua	3.8	4.8	3.7	12.3	23.0
Pakistan	14.7	4.8	7.2	26.7	23.0
Vietnam	9.3	4.8	10.6	24.7	23.0

Source: FCC

National Interconnection Rates

	Local Termination (US cents)	Regional Termination (US cents)	National Termination (US cents)
Australia	1.62	5.30	9.90
Austria	2.00	2.00	2.63
Belgium	1.23	2.33	3.26
Canada (Toronto)	n.a.	5.33	n.a.
Denmark	1.09	2.02	2.46
Finland	1.56	1.58	3.12
France	0.78	1.90	2.80
Germany	1.10	1.88	2.86
Greece	2.01	2.01	2.87
Italy	1.68	2.74	n.a.
Ireland	2.44	4.61	5.75
Japan	0.71	1.73	5.98
Luxembourg	2.23	2.23	2.23
Netherlands	1.30	1.78	2.29
Portugal	1.33	2.63	19.98
Spain	1.65	1.65	4.63
Sweden	1.27	1.96	2.68
Switzerland	n.a.	2.72	3.73
U.K.	0.68	0.96	1.88
U.S. (Washington, D.C.)	n.a.	0.79	n.a.

Notes:
All interconnection charges are for peak period and are current to July 1998.
Local termination is the lowest level of interconnection, typically giving a carrier access to a single town or part of a city.
Regional termination generally gives a carrier access to all subscribers within a metropolitan area or a North American area code
U.S. termination fees vary according to Local Exchange Carrier (LEC). U.S. national average was 1.49¢ as of July 1998.

Source: European Union Commission, FCC, CRTC (Canada), MPT (Japan), OFCOM (Switzerland)

Trading Minutes and Bandwidth

Telecom wholesale markets—where carriers buy and sell minutes and capacity from each other—can save telephone companies substantially. Rather than building links to numerous countries, a start-up operator can cut costs by purchasing other carriers' bandwidth on a route-by-route, as needed basis. And large carriers benefit from reselling capacity on their networks that otherwise would have lain idle.

Internet-based "bandwidth exchanges," which permit telcos to buy and sell network access online, bring a new level of efficiency to wholesale telecom markets. This article takes a nuts-and-bolts look at how bandwidth markets operate. Will these markets soon make telecom capacity a global commodity? Perhaps. But bandwidth exchanges must first overcome some significant obstacles before they can live up to their potential.

How They Work

Numerous bandwidth exchanges have sprung up on the Internet (see Figure 2). Band-X, Ltd., which began service in July 1997, was among the first. Rather than serving as a spot market, the London-based exchange first saw the light of day as an Internet dating service of sorts for telcos, providing a central meeting place for introducing potential buyers and sellers of international bandwidth and wholesale minutes. Here's how a sale is conducted using the standard Band-X service:

1. A carrier wishing to sell minutes carried on its network posts an offer on the Band-X web site. The seller provides details on the origin, destination, number of minutes available, and per minute rate. The carrier's identity remains undisclosed.

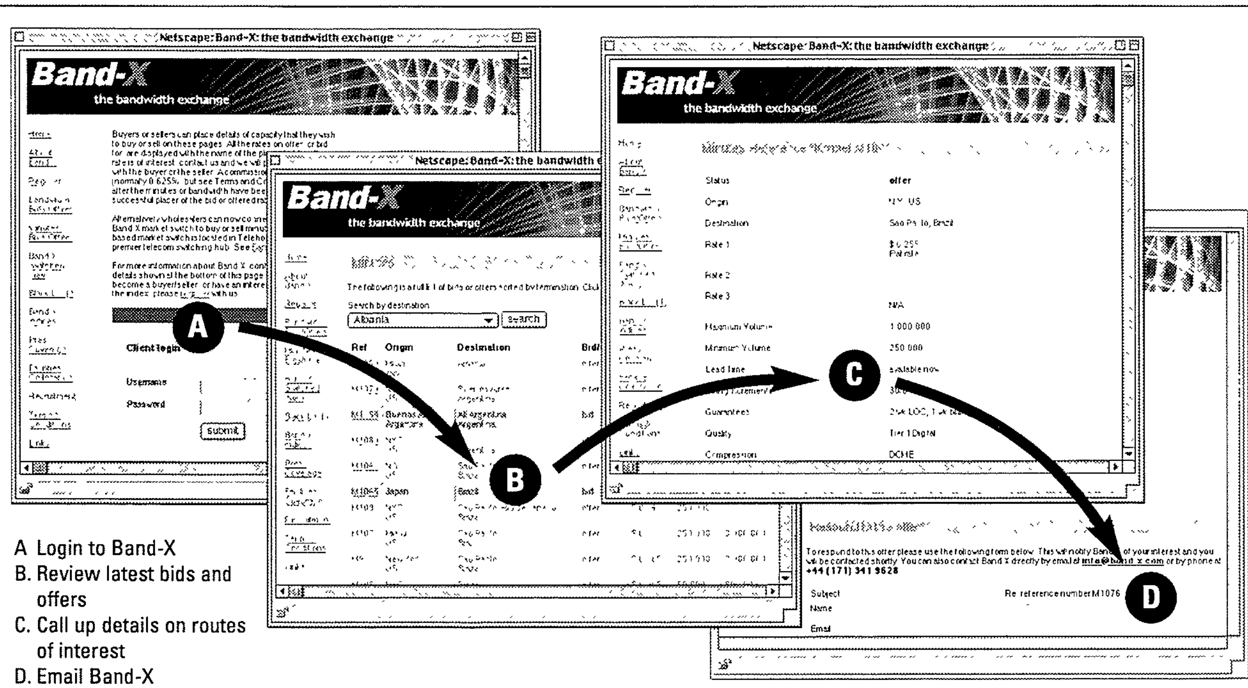
2. A buyer interested in the carrier's offer e-mails a response to Band-X management.

3. Band-X management introduces buyer and seller.

4. On their own, buyer and seller establish the details for interconnecting their networks and determine how many minutes are to be sold.

5. If an agreement is reached, the seller pays Band-X a commission within seven days of receiving payment. The commission rate varies according to the size of the sale—2.25 percent on the first $200,000 invoiced, 1.125 percent on

Figure 1. Buy Your Minutes Online



A Login to Band-X
B. Review latest bids and offers
C. Call up details on routes of interest
D. Email Band-X

Source: Band-X, Inc. (www.band-x.com) © TeleGeography, Inc. 1998 the next $200,000, and 0.625 percent on all payment thereafter.

6. Upon receipt of commission, Band-X passes on 25 percent of its fee to the buyer. By holding out the promise of this sum, Band-X gives the buyer an incentive to see that the seller carries through with payment of commission.

When a buyer posts a bid to purchase minutes or capacity, the process works in reverse—the buyer pays commission and seller receives the 25 percent refund.

In addition to offering its standard service as a bandwidth broker, Band-X is introducing a new service that more closely mirrors the functions of a true spot market, such as instant and anonymous exchange of money for network access. Band-X first introduced a preliminary version of its "Band-X Switched" service in the summer of 1998. When fully operational, a sale will proceed as follows:

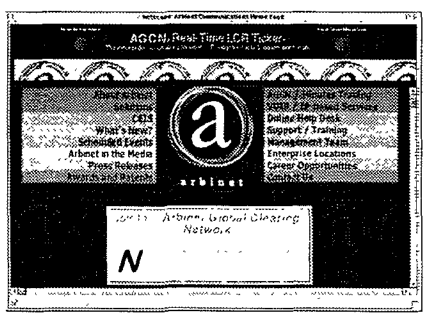
1. Band-X establishes switches at prominent international switching hubs such as London's Telehouse and New York's 60 Hudson Street. Potential buyers and sellers connect to the Band-X switch.

2. A carrier wishing to sell wholesale minutes posts details on the destination and per minute rate at the Band-X web site.

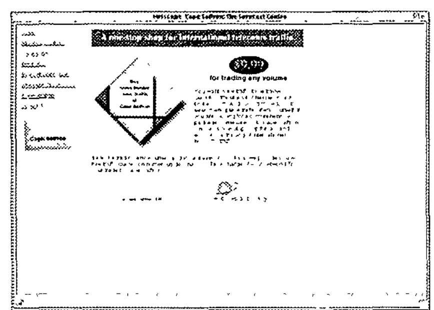
3. An interested buyer pays Band-X a deposit equal to the value of minutes it wishes to buy. The buyer's traffic is immediately routed onto the seller's network. Unlike the standard Band-X service, both parties remain anonymous, even after the deal is concluded. Because capacity is sold on a first-come, first-served basis, buyers and sellers have an incentive to pre-establish network interconnection and payment accounts with Band-X.

Figure 2. Arbinet and Company

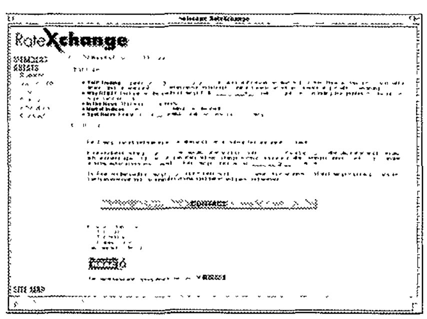
In the late nineteenth century, when substantial improvements in transportation had opened new avenues for supply but had not yet created an integrated national market, more than 1,200 commodity exchanges operated in the United States. The market for international wholesale telecom service has attracted its fair share of Internet-based market places, each with its own strategy for attracting potential buyers and sellers. Cape Saffron specializes in Internet telephony; IP telephony guru Jeff Pulver plans to launch a Voice over IP minutes exchange (www.min-X.com); Amsterdam-based InterXion is the first bandwidth exchange on the European continent; RateXchange has established real-time switching in New York and Los Angeles.



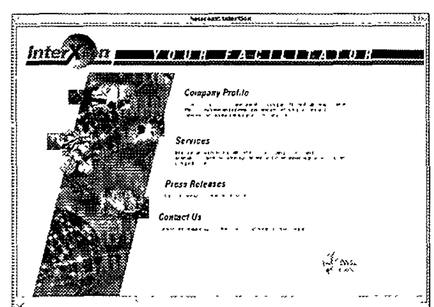
www.arbinet.com



www.capesaffron.com



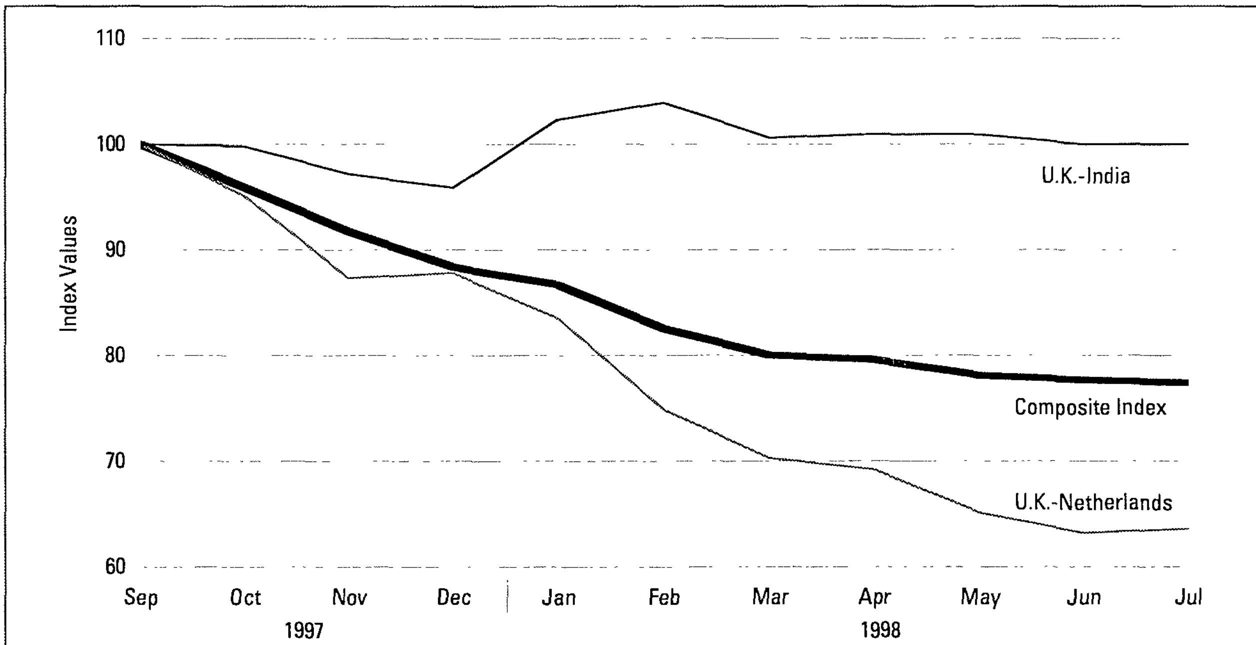
www.ratexchange.com



www.interxion.com

Perhaps the most interesting example is the eponymous Arbinet. The company owes its moniker to the unique service it provides—ARBItrage NETworks. Arbinet's Global Clearing Network (GCN) is an automated, real-time switching service that allows carriers to draw on an international least cost routing database to find the cheapest way to send an international call abroad. Arbinet manufactures and sells its own switches to carrier participants which communicate with the routing database. Carriers wishing to sell capacity enter into the database when they wish to open their networks to the GCN, specifying route quality details and rates. Buyers then refile their traffic via the carrier participating in the Global Clearing Network, accessing sellers' networks via the Arbinet switches on carrier premises. In a sense, then, Arbinet offers the reverse of the "Band-X Switched" service: whereas Band-X encourages carriers to interconnect with centrally located switches, Arbinet sends the switches to the carriers.

Figure 3. The Band-X Index of U.K. International Wholesale Prices, 1997-1998



Note: The Band-X U.K. Index measures relative price movement for the top twenty U.K. outbound routes. The composite index is an average of price changes to those twenty destinations, with each route weighted according to its proportion of U.K. outgoing traffic as reported by TeleGeography.

Source: Band-X (www.band-x.com)

4. Band-X passes on payment to the carrier after charging a two percent fee to the buyer and a three percent fee to the seller.

5. Using call quality monitoring software, Band-X periodically tests the voice grade on the seller's network to ensure that call quality meets the minimum standard established for the route.

Back to Basics

In their current form, Band-X and its peers greatly facilitate the exchange of network access among carriers. Some observers have even speculated that these exchanges may soon resemble commodity markets, where one unit is fully interchangeable with any other, and anonymous buyers and sellers trade at a price determined by the forces of supply and demand. In addition to serving as "spot" markets—on which goods are traded for immediate delivery—commodity exchanges often feature a secondary derivatives market where investors can purchase standardized contracts for delivery at a specified future date and price. A derivatives market for telecom services would permit carriers to hedge their future revenues and costs.

A review of the economic conditions underlying successful commodity markets may tell us where bandwidth exchanges may be heading:

• *Large number of buyers and sellers.* A market in which only a handful of players operates does not require a centralized exchange; instead, companies can rely on industry acquaintances to conclude deals. A growing pool of buyers and sellers encourages companies to seek out central market places for exchange. Also, a large number of market participants helps guarantee that prices are not arbitrarily established by a handful of powerful players, but rather are set by the forces of supply and demand.

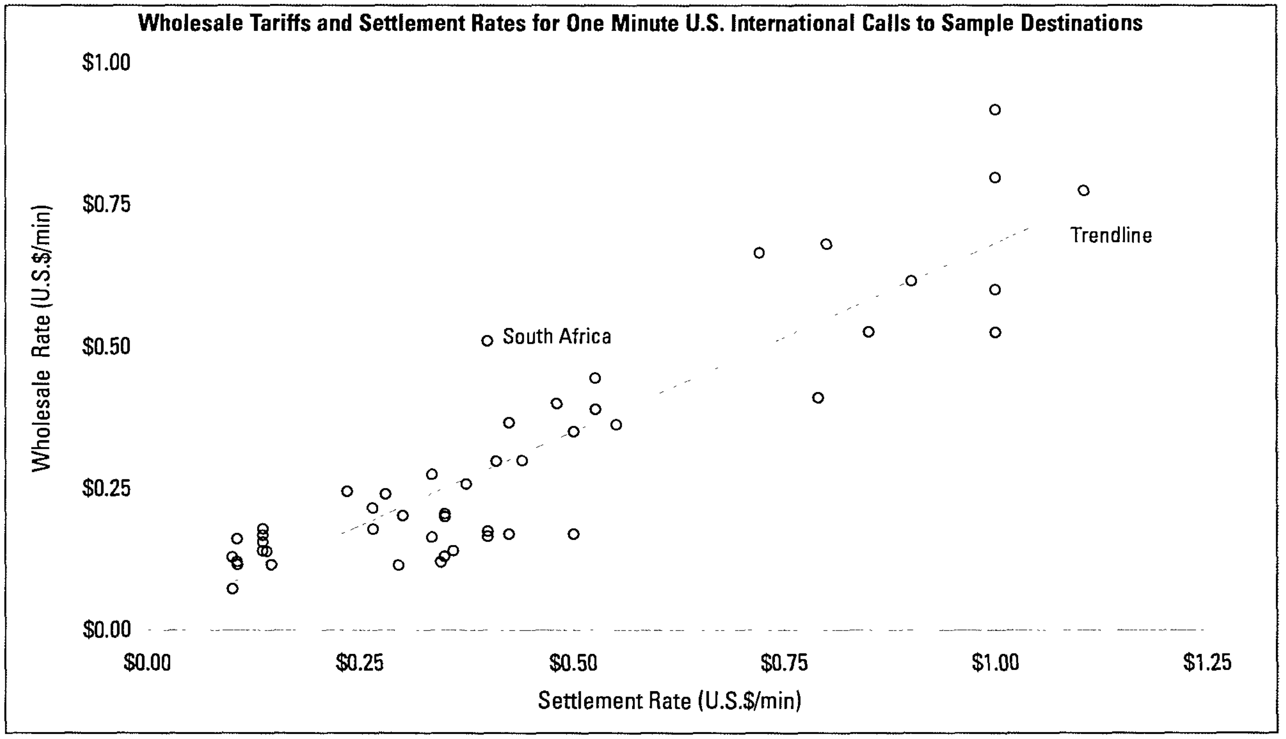
• *Transparent price information.* Commodity markets feature equal access to price information by buyers and sellers. This condition is important if market forces are to determine a single price for a good.

• *Homogenous product.* For a single price to emerge for a given commodity, all units of that commodity must also be interchangeable. To enforce homogeneity, most commodity exchanges feature pre-established, standard contracts that specify quality, quantity, and delivery terms.

• *Confidence in market mechanisms.* Face-to-face negotiation helps buyers to determine that they will get their money's worth. In the anonymity of a commodity market, however, buyers need to trust that they will get what they paid for before they engage in large-scale purchases.

• *Volatile prices.* Some price movement is necessary to spur interest in a spot market. Otherwise, buyers would simply purchase long-term contracts from suppliers. The likelihood of price fluctuation, which gives buyers and sellers an incentive to hedge against damaging price swings, is especially important in creating a role for futures markets.

Figure 4. Why Settlement Policy Matters



Note: Each circle represents the settlement rate and wholesale tariff for one call destination. For example, the U.S. settlement rate to South Africa is $0.40 and the wholesale rate is $0.51. A statistical test between settlement and wholesale rates yields a correlation (r^2) of 0.8205. That is, 82 percent of the variance among countries' wholesale tariffs is explained by the variance in the settlement rate to those countries.

Source: FCC, RateXchange (www.ratexchange.com)

How Bandwidth Exchanges Fit the Bill

So how does the market for wholesale international telephone service stack up? Presently, wholesale telecom service trading is oriented around private, negotiated contracts. Taken point by point, it is clear that bandwidth exchanges address a number of the present system's shortcomings:

- *Large number of buyers and sellers.* Telecom liberalization has created hundreds of licensed operators interested in buying and selling network access from other carriers. At least initially, however, these newcomers do not always have the means of surveying all sources of supply or of being noticed by potential customers. Deals with established players or time-consuming search and negotiation with newer participants are their choices.

  Helping to introduce new market players represents a chief function of bandwidth exchanges. The implementation of real-time switching and exchange will boost the volume of carrier interaction even further.

- *Transparent price information.* Selling network access on a private, contract-by-contract basis offers suppliers scope to discriminate in favor of their largest buyers. In contrast, bandwidth exchanges increase transparency by publishing all available bids and offers for a given international route.

- *Homogenous product.* When trading raw bandwidth, product homogeneity is rarely a concern. One E-1 circuit between Telehouse (London) and 60 Hudson (New York) is pretty much like any other E-1 connection between the two global switching centers. With minutes trading, however, guaranteeing call quality is a real problem. Such factors as method of switching (circuit versus packet), number of networks traversed, and degree of digital compression can affect the quality of a call. Fortunately, bandwidth exchanges can enforce product homogeneity by using call testing software. Bandwidth exchanges will use the software to ensure that traded minutes measure up to a pre-established benchmark quality rating for calls.

- *Confidence in market mechanisms.* Although many new sellers of wholesale minutes exist, the reliability and quality of their products is often unknown. Face-to-face negotiation thus remains an important component of minutes deals. For a reseller concerned about the call quality its customers will experience, the choice of suppliers is self-limited to carriers it trusts. Trusted suppliers can command a premium.

A reliable quality testing system by the bandwidth exchanges would go a long way toward encouraging buyers to make purchases from anonymous suppliers. Overcoming the trust barrier would enhance the efficiency of telecom service trading by expanding the pool of market participants with whom a telco can reliably trade and by eliminating time-consuming negotiation in favor of instant exchange.

- *Volatile prices.* When combined with price transparency, a shift from negotiated contracts to instant and anonymous exchange could increase price volatility by speeding market reaction to changes in the underlying fundamentals of supply (e.g., a new undersea cable comes on-line) and demand (e.g., a government permits new resellers to enter its international market).

Remaining Problems

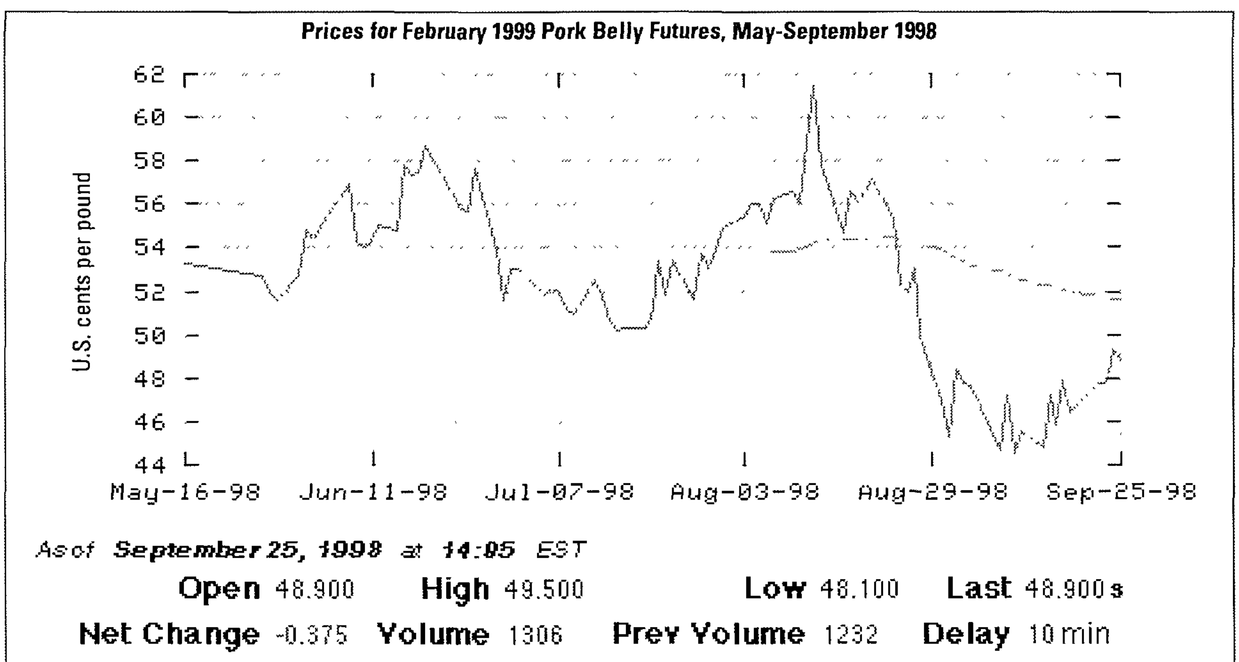
If the creation of an active forward market for minutes and bandwidth is the ultimate goal for bandwidth exchanges, two significant obstacles remain.

- *Fragmented global market.* Commodity markets in which worldwide prices move together attract greater liquidity than exchanges with a narrower geographic scope. Coffee represents one commodity whose market has a global reach. A bumper coffee crop in Brazil, for example, affects Indonesian coffee growers by lowering the price of coffee traded in New York. This price link works because Brazilian and Indonesian coffee beans are close substitutes.

Unfortunately, calls to different international destinations make poor substitutes. A U.K.-India and U.K.-Netherlands call minute are hardly interchangeable—and the recent price trends for calls on these international routes show it (see Figure 3.)

By arbitraging price differences among different routes, aggressive least cost routing would go some way toward tying international wholesale call prices together (see "The Logic Behind Refile" on page 63). But this link would likely remain only tenuous, largely because national government policies still exert a considerable influence over termination rates and competition within country barriers. Although real factors of supply, such as increased international capacity, do influence prices, wholesale tariffs mostly have fallen to destinations where the national government has enforced a transition to lower interconnection rates and competition. (For example, see Figure 4 on the correlation between settlement rates and wholesale prices.) Until telecom deregulation is more widespread and mature, prices for different routes will continue to move out of sync with each other, and no single, global market for international network access will develop.

Figure 5. Wave of the Future?



Note: This chart shows day-to-day variance in the price for a pork belly futures contract traded on the Chicago Mercantile Exchange. The smooth line from August through September shows a 50 day moving average. The traded commodity is not actually pork bellies, but rather standard contracts to obtain a set quantity (40,000 pounds) of pork bellies at a future date (February).

Source: QuoteWatch (www.quotewatch.com)

• *Insufficient price volatility.* Even if wholesale prices for most international routes began to move in tandem, predictability of price movements could dampen interest in a futures market. In most commodity markets, prices move up and down. On many routes in the wholesale minutes market, however, prices have moved only downward. Theoretically, a buyer of telecom minutes might hedge against the volatility of the *degree* of price decrease. Without the possibility that prices might actually rise, however, a buyer often lacks the psychological imperative to rely on a derivatives market to cover his or her future position.

Prospects

By introducing the growing number of buyers and sellers to each other, offering improved price transparency, providing central points for instantaneous traffic switching, and enforcing measurable standards for call quality, bandwidth exchanges promise to increase significantly the efficiency of the international telecom services market. Commodity markets, they are not. As long as the international market for telephone service remains fragmented by national boundaries, a central benchmark that tracks prices on multiple routes will not emerge.

Of course, an exchange need not offer worldwide scope to become an active commodity market. Many mercantile exchanges are regional. In the medium term, a market may converge around traffic to and from countries with advanced competition regimes, where further government deregulation has less scope to alter costs radically and where prices already do appear to be bottoming out.

Alternatively, carriers might soon offer futures contracts for delivery on a limited, route-by-route basis. Enron Corp., the Texas-based conglomerate with experience in wholesale energy trading, announced in September 1998 that it was holding preliminary talks with Band-X regarding standard futures contracts for telecom services. (For more on the parallels between electricity and telecom service trading, see "What is Sparking New Markets for Power?" on pages 77 to 79.)

The lack of liquidity attracted by a unified global benchmark price for international wholesale minutes and bandwidth, however, will hamper the development of an active derivatives market. Until liquidity grows and prices bottom out, investors wishing to take positions in a fully developed commodity exchange will have to turn to more traditional markets. Pork bellies may be the best bet.

What is Sparking New Markets for Power?

by Donald Weightman

When Indiana utilities turned off power for large industrial customers in the midwestern U.S. last June 25, some of the blame went to familiar causes: surging demand from a heat wave, outages at key generating plants, a transmission line brought down by lightning. But other parts of the story are new—a turbulent wholesale power market where a supply squeeze and panicked traders sent prices from $30 to more than $7500 per megawatt hour.

The June price shock in the U.S. market is evidence of some—but not all—of the dramatic changes in once pervasively-regulated wholesale power exchanges. Besides the spot markets, there are also new paper markets in electricity futures and options. Each of these markets—spot and paper—will be surveyed in turn, with an eye toward identifying the structural problems and prospects that might face a market in bandwidth.

Some critical facts about the electric utility industry have not changed. Electricity, unlike wheat, oil, and silver, cannot be stored, and the transmission grid continues to have the economies of scale and other characteristics associated with the "natural monopoly" rationale for regulation. But decades of rising power prices—in the face of declining fuel costs—have brought on a customer-driven push toward competition.

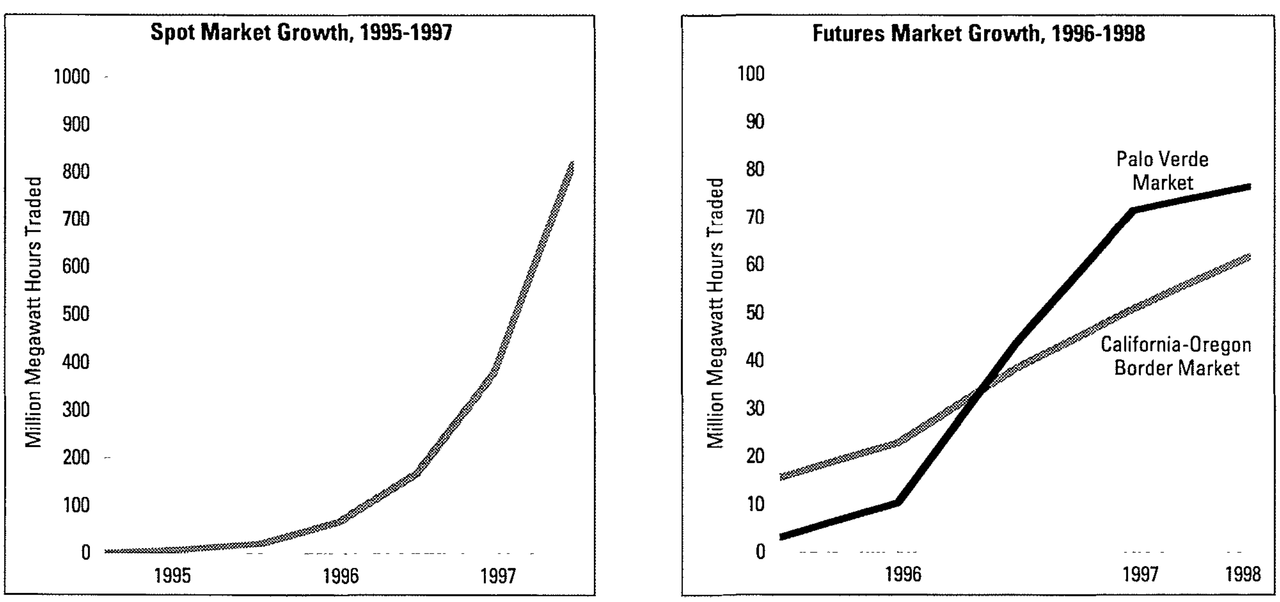
What's New At Wholesale

There are new players. Aside from sales to retail utilities without generation of their own, wholesale exchanges were largely the province of vertically integrated utilities. Regulatory policy favoring fuel diversity brought in new sellers of generation after the energy crisis of the 1970s. Under new U.S. laws, since 1992, almost anyone can trade kilowatts at wholesale, and as of 1997 some 100 power marketers—a few dozen utility affiliates, the rest independent—were active traders.

Where once there were regulated rates based on costs (with seasonal or emergency exchanges between utilities at nominal markups), now prices are set by bargains struck over the telephone, based on reports from market news wires, or reported futures trades from the New York Mercantile Exchange (NYMEX).

Operating needs—emergencies, spikes in demand, or the chance to share savings by dispatching efficient units—drove deals under the old regime. But trading was also constrained

Figure 1. U.S. Wholesale Electricity Trades



Source: Edison Electric Institute, *Power Marketers Yearbook—1997*

Source: New York Mercantile Exchange (NYMEX)

Note: Spot market totals include all U.S. wholesale electricity trades. Futures for only four regional markets (including the California-Oregon Border and Palo Verde exchanges) are traded on NYMEX.

Figure 2. Power Markets Overview

	Traditional Wholesale Exchanges	Spot Markets	Futures Markets
Method of Price Establishment	Regulation	Negotiation	Auction
Basis of Prices	Costs	Supply & Demand	Trader Expectations
Participants	Utilities	Registered Marketers	Open
Reliability of Supply	Standards for Reserves	Set by Contract	Physical Delivery Offered through Exchange
Purpose of Transaction	Operating Problems & Shared Efficiencies	Operations or Speculation	Hedging or Speculation
Contractual Terms	Complex Tailored Negotiated	Complex Standardized Intermediaries Involved	Simple Standardized Posted on Exchange

Source: Donald Weightman

by scarce transmission and by the fact that utilities were not eager to open their power lines and switchyards to competitors. The 1992 statute, aiming to spark competition, opened up the transmission grid. Although there are still emergency and similar operational exchanges, there is a rapidly growing wholesale market for resale.

Dependable service had been the touchstone of utility practice: reserve supplies were required by reliability councils, and paid for by ratepayers. As "excess inventory," such reserves are foreign to competitive markets. "Firm" power assured for delivery, however, commands a hefty price premium, especially when demand surges. As the June 1998 outage suggests, the risk of non-delivery is now allocated by contract, often by liquidated damages clauses where the defaulting seller must pay the cost of replacement.

Even under regulation, there were spot markets growing up around the delivery points where utilities exchanged seasonal or emergency reserves. The critical next step was to open these markets to new competitors with access to the grid.

Surging Spot Markets

Traders work over the telephone. The difference after the 1992 statute is in how transmission is arranged if deals are struck. Federal regulations now require utilities to post data on available transmission capacity at Internet web sites. Under the Open Access Same Time Information System (OASIS), being developed in phases, traders needing transmission for power may use passwords to log in and query utility data bases for next day capacity. The user may then reserve capacity by filling out a data template, much as one would now make a plane reservation elsewhere on the Net. In another phase under discussion, the OASIS system would increase posted information to include purchaser and price data.

Because the utilities owning transmission for a regional market also do business there, competitors claim that data from the templates is being used to spot and poach customers. These critics also call for more rigorous structural separation between power transmission and power generation, even to the point of mandating divestiture of the transmission grids to independent operators.

Market Interest in Futures?

The growth in spot markets and speculative power trading has created interest in laying off the risk of price swings. Utilities recovering costs under traditional rate regulation had little concern for hedging against volatile prices. But high volume buyers and sellers with bottom line exposure to large scale price movements are potential customers for forward and derivative contracts to hedge their risks. Electric power thus meets some of the classic conditions for derivative markets in other commodities: large numbers of price-taking buyers and sellers and price volatility. Indeed, some observers reckon that wholesale power price swings will become more frequent as natural gas—itself a commodity with volatile prices—becomes the fuel of choice for new electric generation.

To exploit these possibilities, NYMEX in March 1996 introduced trading in futures contracts, using prices at transfer points for two Western U.S. spot markets (each with a history of sharp swings in prices) for reference. NYMEX has since added contracts based on prices in two Eastern U.S. regional markets, and futures and options trading for other spot markets is in the works at NYMEX and other exchanges. But the paper markets, like their physical counterparts, remain localized to regional rather than national prices, and trading has not grown at the rate some had projected.

Points of Resistance

Some of the obstacles facing spot and futures markets seem susceptible to relatively straightforward resolution. Technical problems facing the OASIS system, for example, look to be worked out with design changes and regulatory pressure to support trader confidence. Redesign of futures contracts from 30 day blocs of peak capacity to different terms may offer hedges better suited to short-term price swings.

On the other hand, even more powerful computers may not be enough to map the power grid into real time information systems, and so spot markets could always face some degree of lag. And faster computing and better contractual design may not offset the central facts of market life. Storage is not practical for power; for both technological and competitive reasons, transmission will be a scarce resource for some time to come. In contrast to telecom markets, here the enduring barriers appear to be technical rather than legal. Transmission bottlenecks mean that both spot and futures markets may remain regional rather than national. Traders will aim to arbitrage the price differences between markets, but, as Morgan Stanley's John Woodley notes, "transportation is inherently an issue in any forward market." Without centralized price discovery, futures markets in electrons may remain too thin to manage risk and supply liquidity for the underlying regional spot markets.

The economic and political factors which opened the U.S. grid to market forces have not, however, gone away. Notwithstanding the June 1998 scare, U.S. wholesale spot markets in electricity seem likely to continue growing. Yet to come are ways for participants to manage the uncertainties now turning up here as in other commodities markets.

Donald Weightman is a Washington, D. C. attorney. His practice concentrates on competition issues for the electric utilities and telecommunications industries. He can be reached by email at dweightman@radix.net.

Retail Prices for a Three Minute Call

From/To	Australia	Belgium	Canada	Denmark	Finland	France	Germany	Greece	Ireland	Italy
Australia (Telstra) peak	n.a.	3.35	2.62	2.99	2.99	2.82	2.82	3.72	2.55	2.73
Australia off peak	n.a.	2.44	1.75	2.26	2.26	2.26	2.08	2.55	1.73	1.73
Belgium peak	3.25	n.a.	1.62	1.22	1.62	1.22	1.22	1.62	1.62	1.62
Belgium off peak	3.25	n.a.	1.62	0.88	1.42	0.88	0.88	1.42	1.42	1.42
Czech Rep. peak	4.39	2.16	3.64	2.16	2.82	2.16	1.49	2.82	2.90	2.16
Czech Rep. off peak	3.49	1.71	2.90	1.71	2.82	1.71	1.19	2.82	2.30	1.71
France peak	2.34	0.88	0.94	0.94	1.04	n.a.	0.88	1.04	1.04	0.88
France off peak	1.90	0.71	0.77	0.77	0.85	n.a.	0.71	0.85	0.85	0.71
Germany (DT) peak	3.17	1.23	1.23	1.23	1.41	1.23	n.a.	1.23	1.23	1.23
Germany off peak	3.17	1.11	1.11	1.11	1.11	1.11	n.a.	1.11	1.11	1.11
Greece peak	1.71	1.52	1.71	1.52	1.52	1.52	1.52	n.a.	1.52	1.52
Greece off peak	1.37	1.17	1.37	1.17	1.17	1.17	1.17	n.a.	1.17	1.17
Italy peak	3.70	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	n.a.
Italy off peak	3.34	1.31	1.45	1.31	1.31	1.31	1.31	1.31	1.31	n.a.
Japan (KDD) peak	4.78	5.40	3.12	5.40	5.40	5.33	5.33	5.40	5.40	5.40
Japan off peak	3.74	4.36	2.56	4.36	4.36	4.29	4.29	4.36	4.36	4.36
Switzerland peak	3.02	1.70	1.45	1.70	1.70	1.45	1.45	2.02	2.02	1.45
Switzerland off peak	2.33	1.39	1.13	1.39	1.39	1.13	1.13	1.51	1.51	1.13
Brazil peak	5.44	4.38	4.16	4.38	4.38	4.38	4.38	5.06	4.38	4.38
Brazil off peak	4.35	3.49	3.32	3.49	3.49	3.49	3.49	4.05	3.49	3.49
India peak	4.41	4.41	5.29	4.41	4.41	4.41	4.41	4.41	4.41	4.41
India off peak	3.94	3.94	4.41	3.94	3.94	3.94	3.94	3.94	3.94	3.94
Malaysia peak	1.68	3.86	2.19	3.28	3.93	3.28	4.37	5.46	3.93	3.86
Malaysia off peak	1.60	3.06	1.75	2.62	2.62	2.62	2.91	3.64	3.06	2.62
South Africa peak	1.77	4.36	1.77	4.36	3.86	3.15	3.15	4.36	3.15	4.36
South Africa off peak	1.55	3.86	1.55	3.86	3.26	2.43	2.43	3.86	2.43	3.86
UAE peak	3.77	5.88	3.77	5.07	4.08	3.77	4.45	4.45	3.77	3.77
UAE off peak	2.07	4.60	2.07	4.20	3.68	2.62	3.68	3.68	2.62	2.62
U.K. (BT) peak	2.05	1.19	0.99	1.19	1.61	1.19	1.19	1.48	0.96	1.48
U.K. (BT) off peak	1.75	1.11	0.94	1.11	1.45	1.11	1.11	1.24	0.82	1.24
U.K. (ACC) peak	1.25	0.72	0.59	0.72	0.98	0.72	0.72	0.90	0.63	0.90
U.K. (ACC) off peak	1.06	0.68	0.57	0.68	0.88	0.68	0.68	0.75	0.54	0.75
U.S. (MCI) basic flat	8.25	6.24	1.59	5.94	6.84	5.85	5.94	6.66	4.11	4.56
U.S. (MCI One)	1.14	0.87	0.36	0.87	0.87	0.87	0.87	0.87	0.87	0.87
U.S. (AT&T) basic flat	4.53	4.65	1.47	4.38	4.44	3.99	3.75	5.85	4.05	4.50
U.S. (AT&T One Rate)	1.44	0.87	0.36	0.87	0.87	0.87	1.17	0.87	0.87	0.87
U.S. (USA Global Link)	0.89	1.13	0.74	0.93	1.19	0.96	0.89	1.47	1.42	1.35
U.S. (Excel WorldRate One)	0.87	0.78	0.33	0.87	0.87	0.78	0.75	1.02	0.84	0.84
U.S. (Delta Three IP Telephony)	0.57	0.81	0.38	0.69	0.90	0.69	0.69	1.26	0.96	0.96

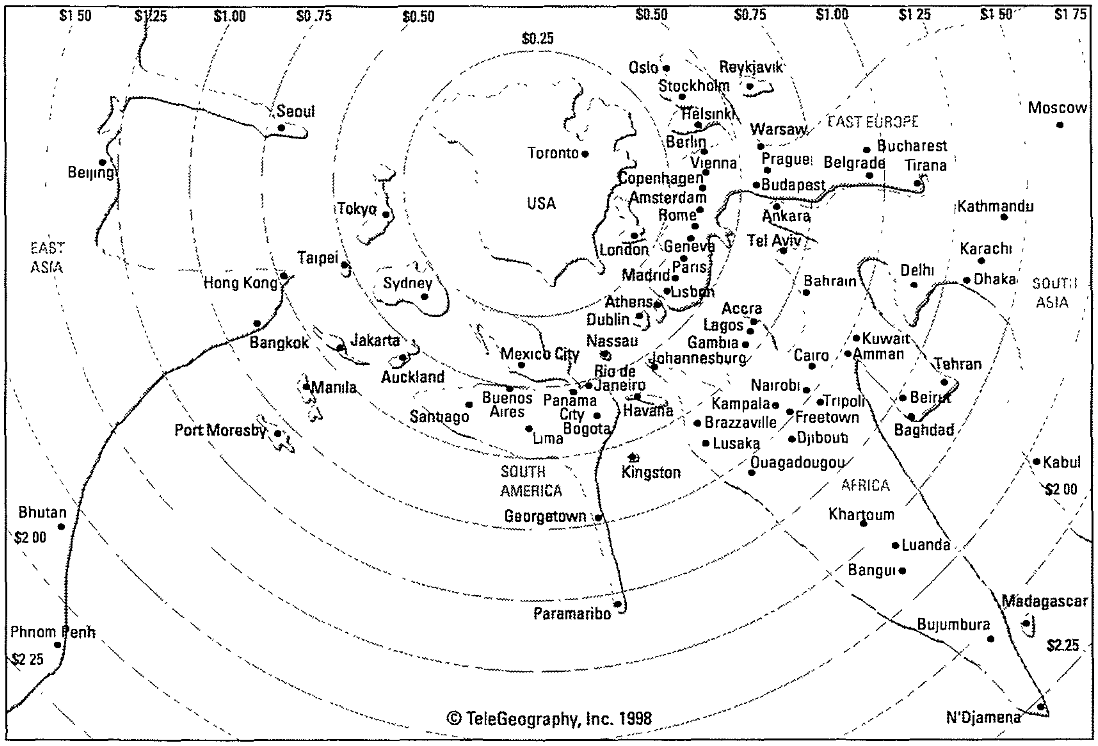
Notes:
1. All rates are in US $ and exclusive of taxes
2. Rates were current on July 31, 1998
3. Rates have been calculated in real time using meter step (rounded up to next meter step for a 3 minute call)
4. Fees are $3 per month for AT&T One Rate, MCI One, and Excel WorldRate One plans. Excel Prime Business has a minimum monthly billing of $100
5. Rates for calls from the U.S. to Canada and Mexico are from Washington, D.C. to Toronto and Mexico City.

Japan	Korea	Mexico	Neth'lands	Portugal	Spain	Sweden	Turkey	U.K.	U.S.	To/From
3.01	3.37	3.72	2.99	3.72	3.72	2.99	3.72	2.28	2.28	Australia (Telstra) peak
2.46	2.57	3.53	2.26	3.19	3.19	2.61	3.01	1.75	1.75	Australia off peak
3.25	4.46	5.68	1.22	1.62	1.62	1.62	2.43	1.22	1.62	Belgium peak
3.25	4.46	5.68	0.88	1.42	1.42	1.42	2.03	0.88	1.62	Belgium off peak
4.39	5.57	8.18	2.16	3.87	2.82	2.82	2.82	2.01	3.27	Czech Rep. peak
3.49	5.57	8.18	1.71	3.87	2.82	2.82	2.82	1.64	2.68	Czech Rep. off peak
2.46	2.34	2.89	0.94	1.04	0.88	0.94	1.25	0.88	0.94	France peak
1.98	1.90	2.32	0.77	0.85	0.71	0.77	1.02	0.71	0.77	France off peak
3.17	3.17	4.46	1.23	1.41	1.23	1.41	1.64	1.23	1.23	Germany (DT) peak
3.17	3.17	4.46	1.11	1.11	1.11	1.11	1.41	1.11	1.11	Germany off peak
2.74	2.74	2.74	1.52	1.52	1.52	1.52	1.32	1.52	1.71	Greece peak
2.33	2.33	2.33	1.17	1.17	1.17	1.17	0.99	1.17	1.37	Greece off peak
3.70	4.86	4.86	1.60	1.60	1.60	1.60	2.39	1.31	1.60	Italy peak
3.34	4.06	4.06	1.31	1.31	1.31	1.31	1.89	1.23	1.45	Italy off peak
n.a.	3.88	5.13	5.40	5.40	5.40	5.40	6.23	5.33	3.12	Japan (KDD) peak
n.a.	3.05	4.16	4.36	4.36	4.36	4.36	5.06	4.29	2.56	Japan off peak
3.02	4.03	4.03	1.45	2.02	2.02	1.70	2.46	1.45	1.45	Switzerland peak
2.33	3.02	3.02	1.13	1.51	1.51	1.39	1.95	1.13	1.13	Switzerland off peak
5.44	8.11	4.16	4.38	4.33	4.38	4.38	5.06	4.38	2.75	Brazil peak
4.35	6.49	3.32	3.49	3.46	3.49	3.49	4.05	3.49	2.20	Brazil off peak
4.41	4.41	5.29	4.41	4.41	4.41	4.41	4.41	4.41	5.29	India peak
3.94	3.94	4.41	3.31	3.31	3.31	3.31	3.31	3.31	4.41	India off peak
2.40	2.84	5.46	3.28	5.46	3.86	3.28	3.93	2.33	2.19	Malaysia peak
2.11	2.26	3.64	2.62	3.64	2.62	2.62	2.91	1.82	1.68	Malaysia off peak
4.36	3.86	4.80	3.15	3.70	4.36	4.36	3.86	2.43	1.99	South Africa peak
3.86	3.26	4.31	2.43	3.04	3.86	3.86	3.26	1.71	1.55	South Africa off peak
5.07	4.45	9.19	4.45	5.88	4.45	5.07	5.88	3.77	3.77	UAE peak
4.45	3.68	5.88	3.68	4.60	3.68	4.20	4.60	2.62	2.45	UAE off peak
3.22	4.51	4.51	1.19	1.48	1.48	1.19	2.82	n.a.	0.99	U.K. (BT) peak
3.05	4.29	4.29	1.11	1.24	1.24	1.11	2.39	n.a.	0.94	U.K. (BT) off peak
1.64	2.70	2.70	0.72	0.90	1.00	0.72	1.85	n.a.	0.59	U.K. (ACC) peak
1.43	2.58	2.58	0.68	0.75	0.75	0.68	1.60	n.a.	0.57	U.K. (ACC) off peak
4.41	5.43	3.51	3.93	4.89	4.86	3.90	5.40	3.36	n.a.	U.S. (MCI) basic flat
1.05	1.95	1.32	0.87	0.87	0.87	0.87	1.86	0.36	n.a.	U.S. (MCI One)
4.35	5.46	3.48	3.93	4.95	4.86	3.93	5.52	3.27	n.a.	U.S. (AT&T) basic flat
1.53	1.95	2.88	0.87	0.87	0.87	0.87	1.86	0.36	n.a.	U.S. (AT&T One Rate)
1.16	2.14	2.20	1.08	1.64	1.51	0.81	2.19	0.80	n.a.	U.S. (USA Global Link)
1.14	1.62	1.14	0.78	1.02	0.87	0.78	1.77	0.33	n.a.	U.S. (Excel WorldRate One)
0.84	1.77	1.20	0.69	1.24	1.14	0.45	1.71	0.48	n.a.	U.S. (Delta Three IP Telephony)

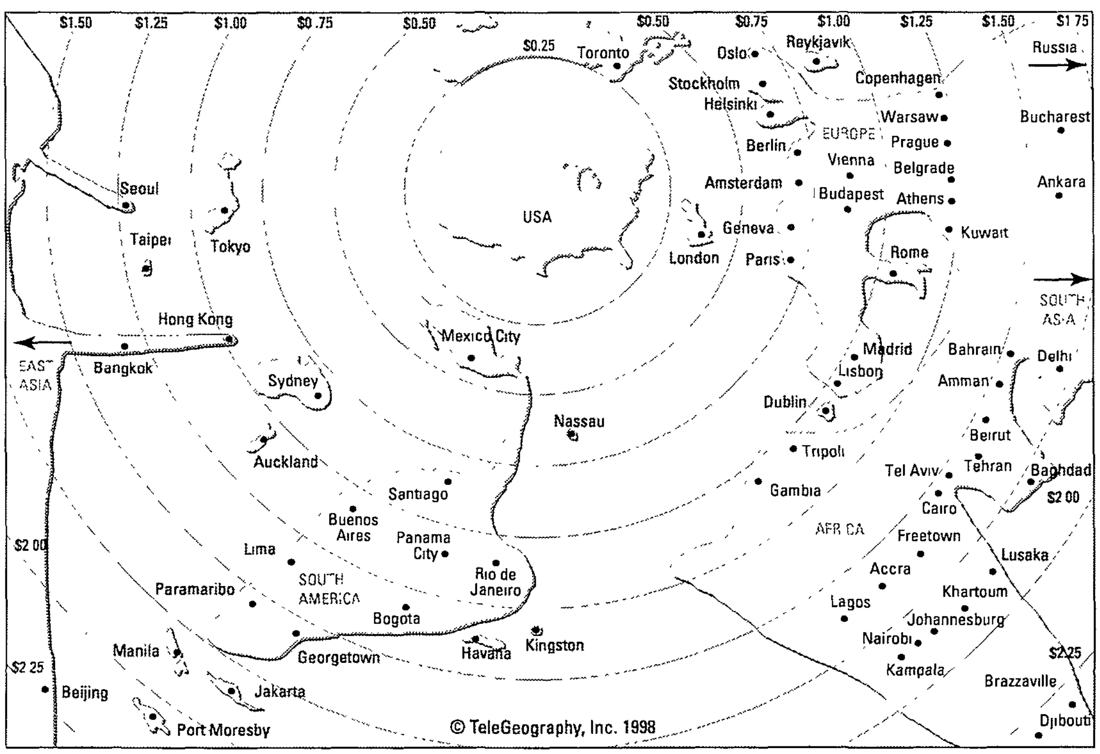
Source Phillips Tarifica Ltd, 40 Furnival St, London EC4A 1JQ, U.K
Tel +44 171 4406500 • Fax +44 171 8318552 • Email: consult@tarifica.com • http://www.tarifica.com
Source for U.S rates: TeleGeography, Inc.

U.S. and U.K. International Tariff Maps

United States: 1998

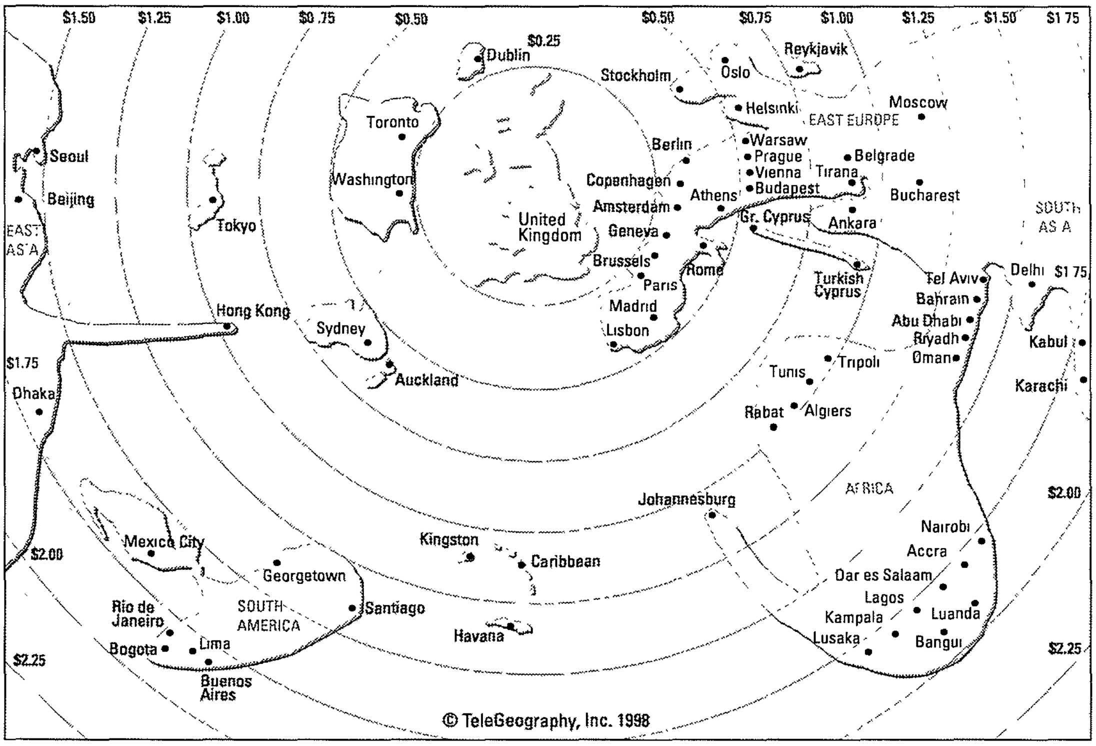


United States: 1994

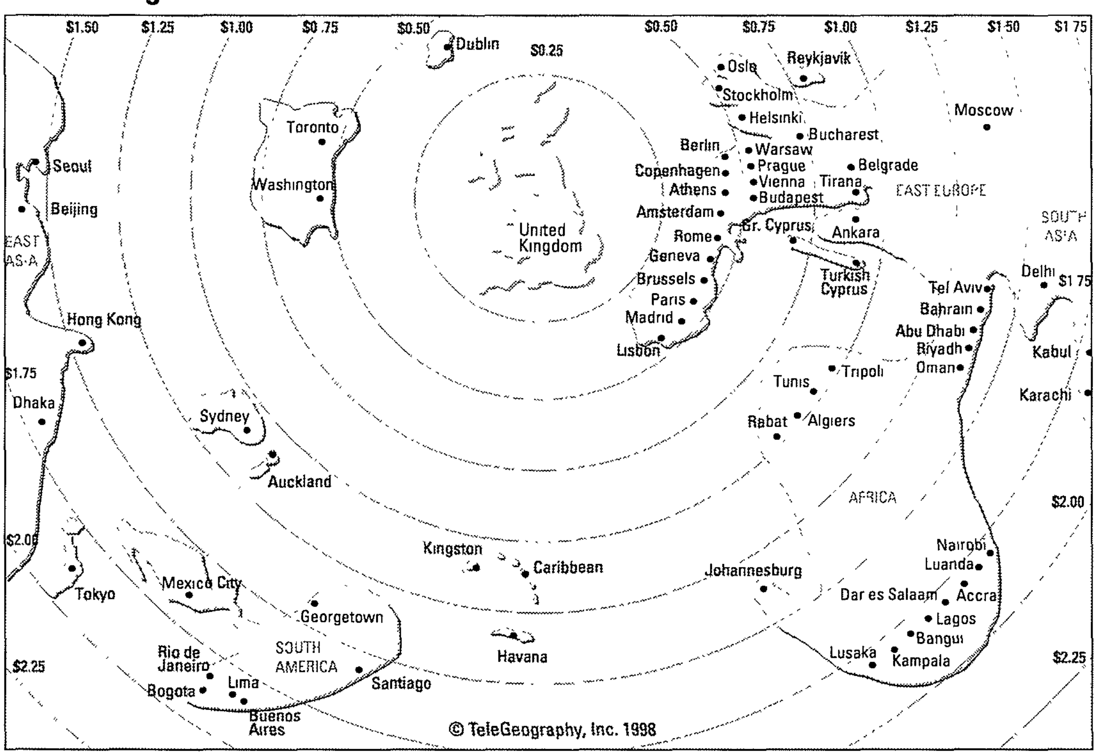


Note: These four maps compare the price per minute of making an international telephone call from the U.S. and the U.K. in 1994 and 1998. Countries are arranged according to the US$ price per minute of calls made from the center country. Call charges are based on June 1994 and July 1998 published peak rates from MCI and BT.

United Kingdom 1998



United Kingdom: 1994



Origin of U.S. Carrier Revenues

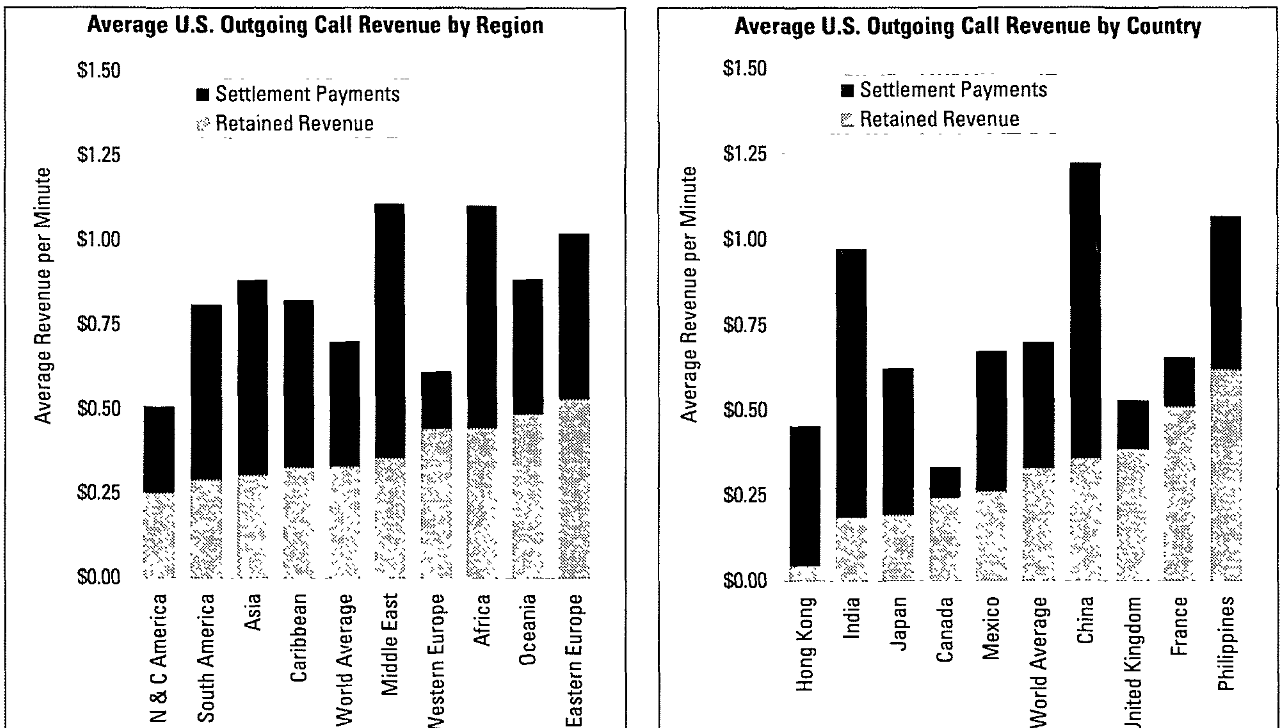
Figure 1. U.S. Carrier Revenues for International Voice Service, 1997

	Total Receipts (US$ millions)					Average Revenue per Minute (US$/minute)			
	Billed Revenue	Settlement Outpayment	Retained Revenue	Settlement Inpayment	Net Revenue	Billed Revenue	Settlement Outpayment	Retained Revenue	Settlement Inpayment
AT&T	8,077.0	3,754.5	4,322.6	1,305.4	5,628.0	0.78	0.36	0.42	0.30
MCI	4,234.4	2,296.1	1,938.2	681.9	2,620.2	0.72	0.39	0.33	0.30
Sprint	1,455.8	992.3	463.5	341.6	805.1	0.53	0.36	0.17	0.20
WorldCom	500.0	521.8	-21.8	135.8	114.0	0.36	0.37	-0.02	0.31
Pac. Gateway Exch.	174.2	183.2	-9.0	23.3	14.3	0.23	0.25	-0.01	0.20
Total	*14,441.5*	*7,747.9*	*6,693.5*	*2,488.0*	*9,181.5*	*0.68*	*0.37*	*0.32*	*0.28*

Note: This table breaks down international voice service revenue for the five largest U.S. international carriers in 1997. For example, WorldCom collected $500 million from customers for U.S. international outgoing calls, and paid foreign carriers $521.8 million to terminate those calls. Thus, the company lost $21.8 million by carrying U.S. outgoing calls. Because FCC regulations entitle each U.S. carrier to terminate incoming calls based on the percentage of U.S. outgoing traffic it originates, WorldCom collected a significant sum ($135.8 million) on foreign settlement inpayments, netting $114.0 million on international voice service.

Source: FCC carrier filings.

Figure 2. U.S. Carrier International Call Revenue by Destination, 1997

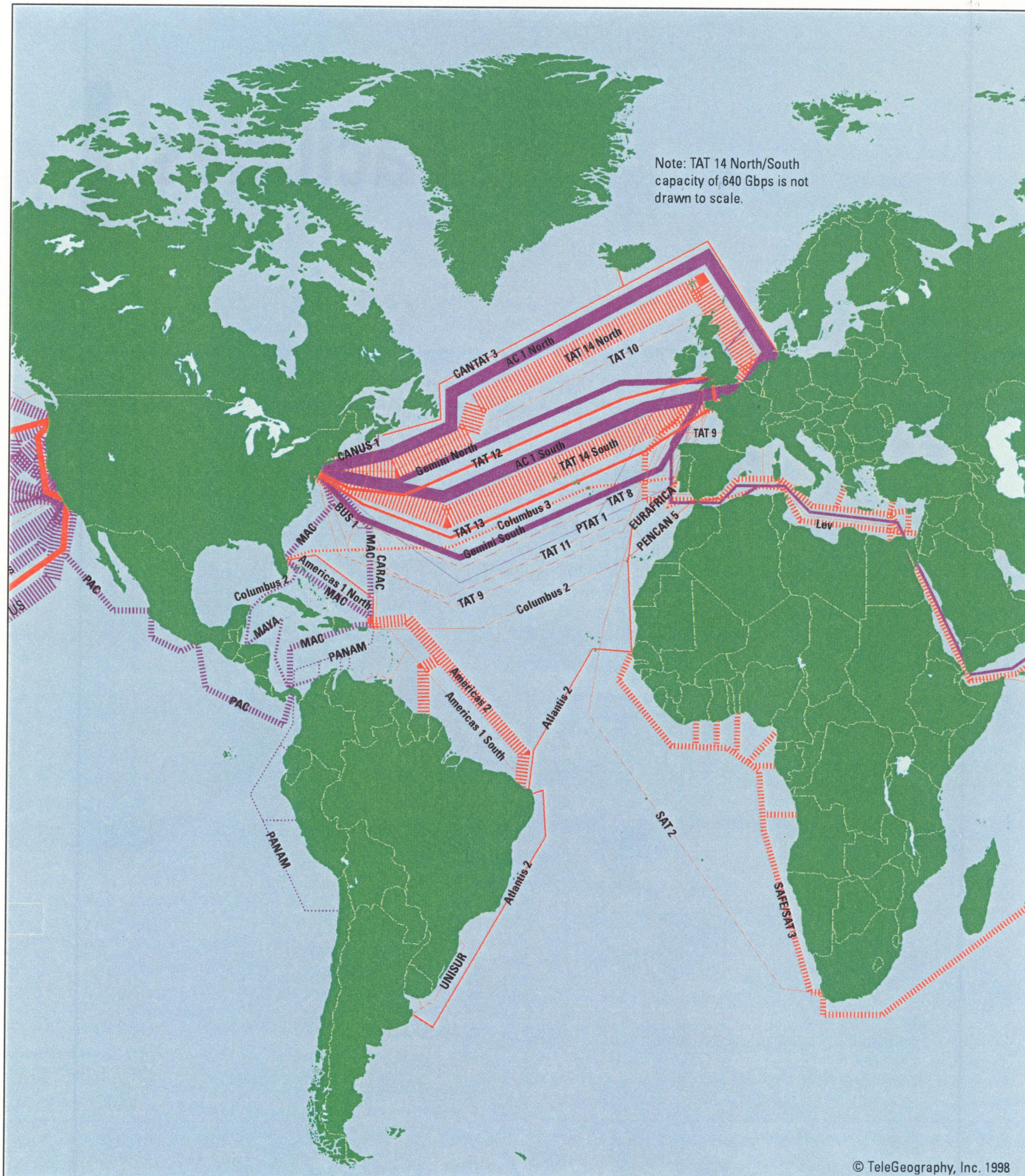


Note. Charts show average revenue on U.S. international outgoing calls for the four largest U.S. international carriers. Total column height shows the average price for calls on a given route. Retained revenue equals average price minus settlement payment, and includes such components as access fees for origination, network costs, and profit.

Source: FCC carrier filings.

Facilities

International Submarine Cables



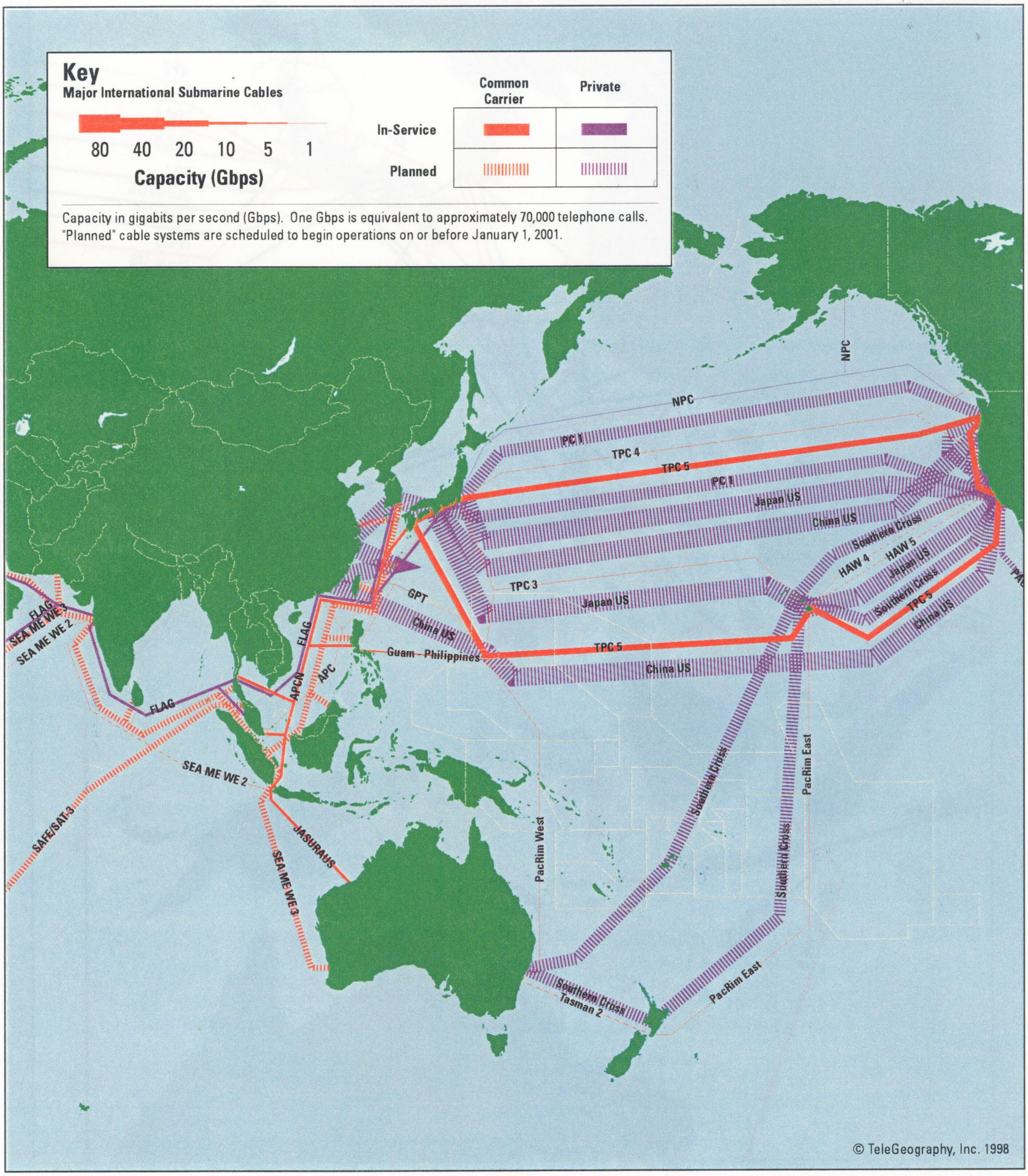

Key
Major International Submarine Cables
80 40 20 10 5 1
Capacity (Gbps)
Common Carrier
Private
In-Service
Planned
Capacity in gigabits per second (Gbps). One Gbps is equivalent to approximately 70,000 telephone calls.
"Planned" cable systems are scheduled to begin operations on or before January 1, 2001.
NPC
PC 1
TPC 4
TPC 5
Japan US
China US
Southern Cross
HAW 4
HAW 5
TPC 3
GPT
Guam - Philippines
FLAG
SEA ME WE 3
SEA ME WE 2
APCN
APC
SAFE/SAT-3
JASURAUS
PacRim West
PacRim East
Tasman 2
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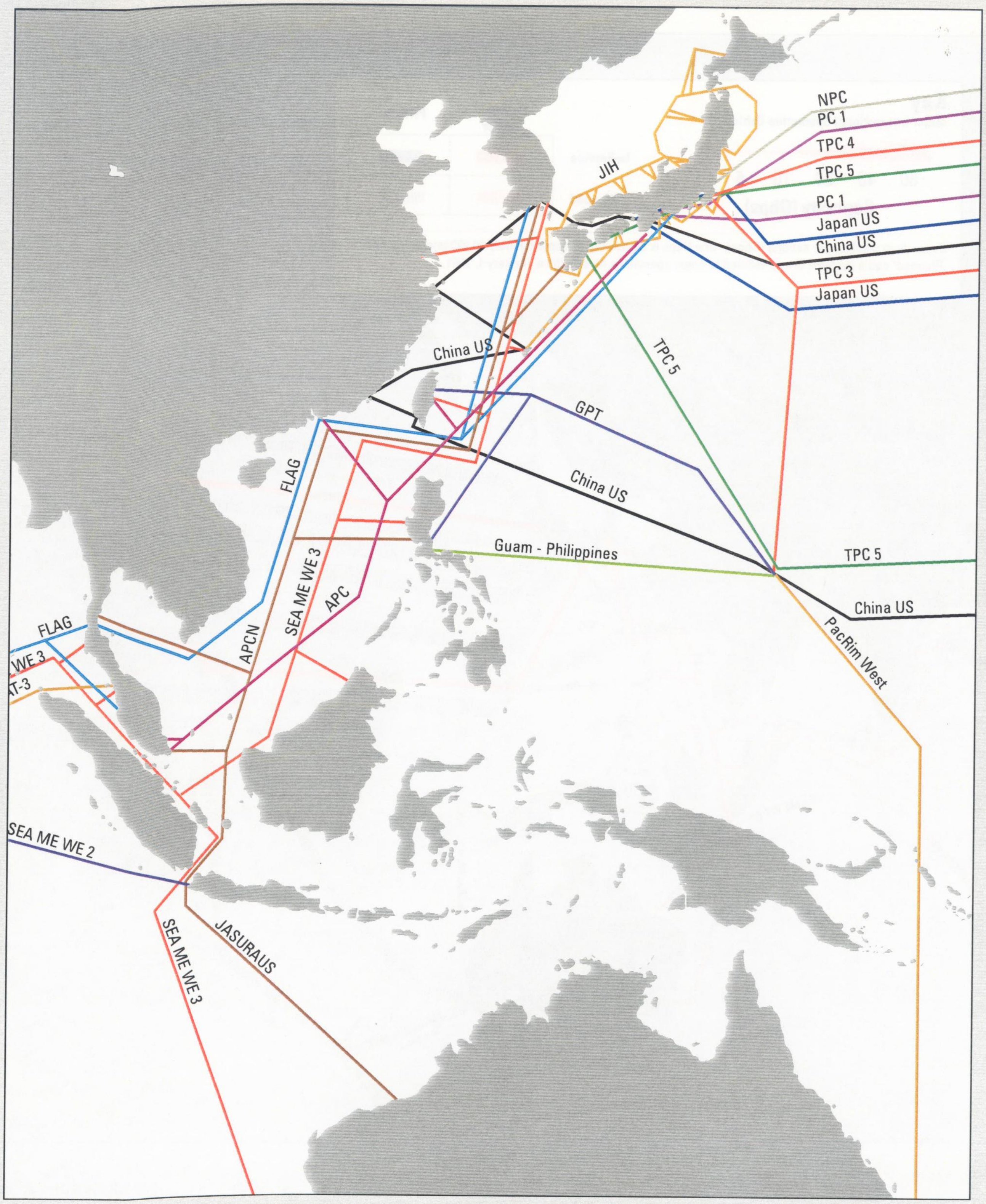
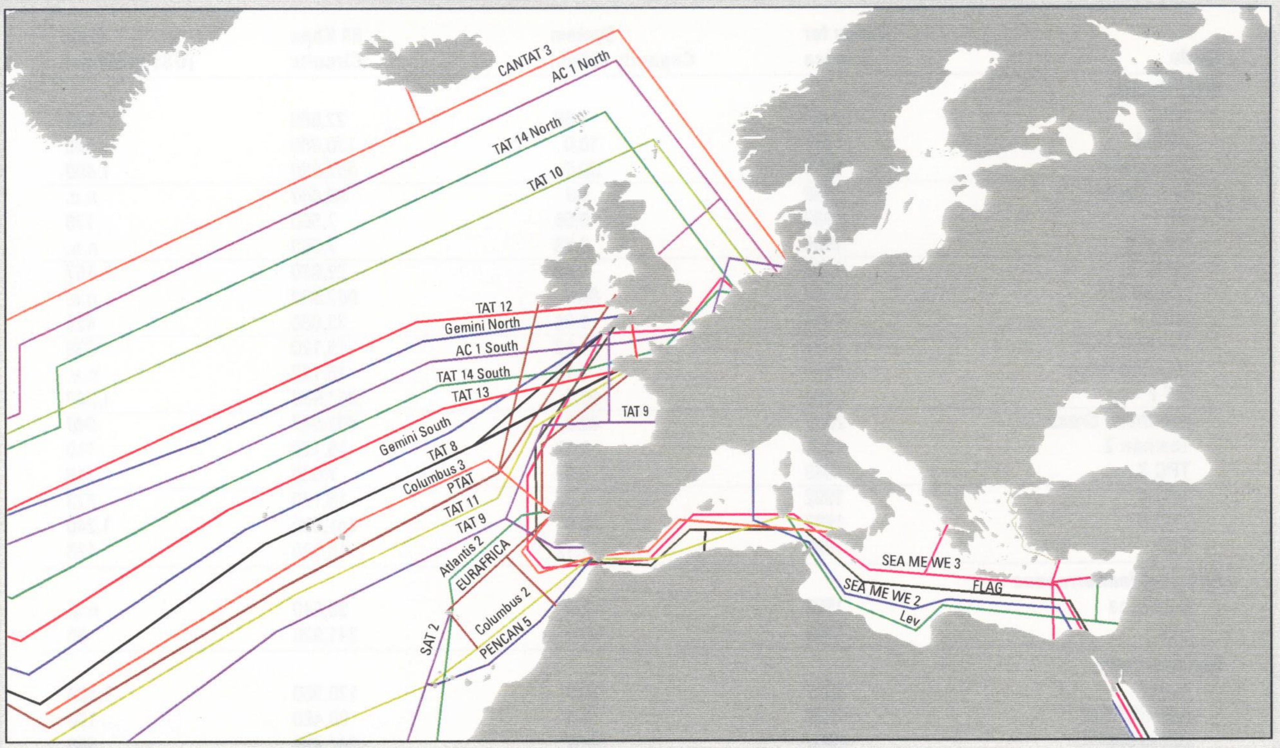
Figure 1. Map of Major Submarine Cables in Asia/Pacific



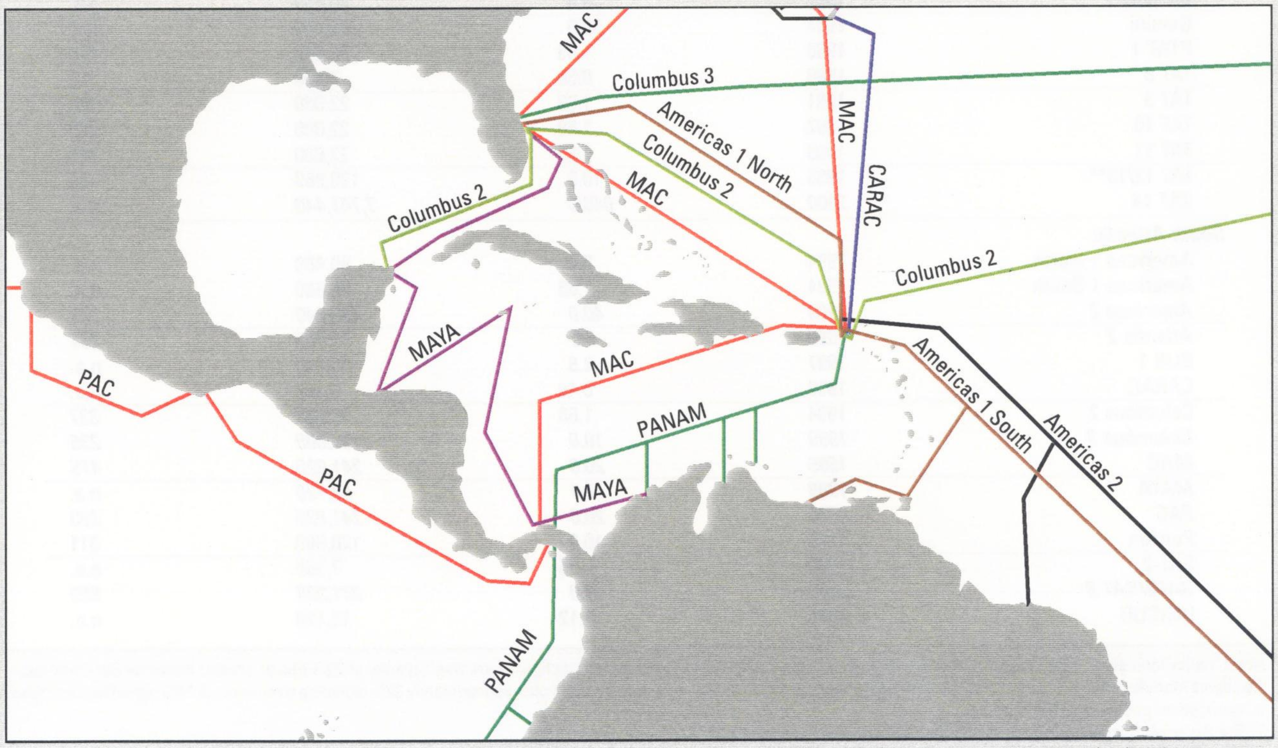
Note: The color scheme used in these regional focus maps is intended only to help distinguish cable systems. The maps depict major international submarine cables in service or scheduled to begin service before January 2002. Domestic cable systems are omitted with the exception of the Japan Information Highway (JIH), which is under construction with service scheduled to commence March 1999. JIH was included because of its large capacity (100 Gbps).

Figure 2. Map of Major European Cables



Note: Map depicts major international submarine cables in service or scheduled to begin service before January 2002. Regional cables are omitted.

Figure 3. Map of Major Caribbean Cables



Note: Map depicts major international submarine cables in service or scheduled to begin service before January 2002. Regional cables are omitted.

Figure 4. Major International Submarine Cables by Region

Cable	Ready for Service	System Capacity (Gbps)	64 Kbps Circuits	Cost (US$ millions)
Asia Pacific				
APC	1993	1.68	22,680	332
APCN	1996	10.0	120,960	550
China-U.S.	*1999*	*80.0*	*967,680*	*1,400*
G-P Cable	*1999*	*5.0*	*60,480*	*n.a.*
GPT	1989	0.56	7,560	178
HAW 4	1989	0.56	7,560	n.a.
HAW 5	1993	1.68	22,680	157
Japan-U.S.	*2000*	*80.0*	*967,600*	*n.a.*
NPC	1991	1.68	22,680	425
PacRim East	1993	1.12	15,120	233
PacRim West	1994	1.12	15,120	n.a.
PC 1	*2000*	*80.0*	*967,680*	*1,240*
*Southern Cross**	*2000*	*40.0*	*483,840*	*940*
Tasman 2	1991	1.12	15,120	110
TPC 3	1988	0.56	7,560	718
TPC 4	1992	1.12	15,120	373
TPC 5	1997	20.0	241,920	1,240
TVH	1995	1.12	15,120	128
Europe-Mediterranean				
Eurafrica	1992	2.5	30,240	n.a.
Lev	1998	20.0	241,920	66
Indian Ocean				
FLAG	1997	10.0	120,960	1,500
JASURAUS	1997	5.0	60,480	100
SAFE/SAT 3	*2000*	*20.0*	*241,920*	*550*
SEA-ME-WE 2	1994	1.12	15,120	n.a.
SEA-ME-WE 3	1998	20.0	241,920	1,300
North Atlantic				
AC 1	1998	40.0	483,840	750
CANTAT 3	1994	5.0	60,480	302
CANUS-1	1995	5.0	60,480	n.a.
Gemini	1997	30.0	362,880	500
PTAT 1	1989	1.68	22,680	510
TAT 8	1988	0.56	7,560	360
TAT 9	1991	1.68	22,680	406
TAT 10	1992	1.68	22,680	300
TAT 11	1993	1.68	22,680	280
TAT 12/13**	1995	10.0	120,960	750
TAT 14	*2000*	*640.0*	*7,741,440*	*n.a.*
South Atlantic				
Americas 1 North	1994	5.0	60,480	n.a.
Americas 1 South	1994	1.68	22,680	n.a.
Americas 2	*1999*	*40.0*	*483,840*	*375*
Atlantis 2	*1999*	*5.0*	*60,480*	*231*
BUS 1	1997	2.5	30,240	n.a.
CARAC	1990	0.48	6,480	n.a.
Columbus 2	1994	1.68	22,680	337
Columbus 3	*1999*	*10.0*	*120,960*	*236*
MAC	*1999*	*20.0*	*241,920*	*415*
MAYA	*1999*	*7.5*	*90,720*	*n.a.*
PAC	*2000*	*20.0*	*241,920*	*280*
PanAm	1998	10.0	120,960	311
SAT-2	1993	0.56	7,560	n.a.
SAFE/SAT 3	*2000*	*20.0*	*241,920*	*550*
UNISUR	1994	1.12	15,120	n.a.

Note: Italics indicate systems that are planned or under construction. A 64 Kbps voice circuit figure assumes capacity of 2.5 Gbps or greater based on Synchronous Transport Module (STM) hierarchy; i.e., 16 STM-1 (30,240 64 Kbps voice channels) per 2.5 Gbps plus approximately 23% signaling overhead. A 14% signalling overhead is assumed on cables of lesser capacity.

* The Hawaii-U.S. mainland leg of this cable will have a capacity of 60 Gbps.

** The TAT 12/13 ring was upgraded to 10 Gbps in 1998 and will be upgraded to 15 Gbps in 1999.

Figure 5. Out of Service Trans-Oceanic Cable Systems

Region	Lifetime	System	System Capacity (Voice Paths)	Landing Points
Trans-Atlantic				
	1956-1978	TAT 1	89	U.K.-Canada
	1959-1982	TAT 2	89	France-Canada
	1961-1985	CANTAT 1	160	Canada-U.K.
	1963-1986	TAT 3	276	U.S.-U.K.
	1965-1987	TAT 4	138	U.S.-France
	1970-1993	TAT 5	1,440	U.S.-Spain
	1976-1994	TAT 6	8,400	U.S.-France
	1976-1995	CANTAT 2	3,800	Canada-U.K.
	1983-1994	TAT 7	8,400	U.S.-U.K.
Trans-Pacific				
	1957-1989	HAW 1	89	California-Hawaii
	1963-1984	COMPAC	160	Canada-U.S.-Fiji-N.Z.-Australia
	1964-1994	HAW 2	1,690	California-Hawaii
	1964-1990	TPC 1	167	Guam-Philippines-U.S.-Japan
	1974-1993	HAW 3	1,440	California-Hawaii
	1975-1994	TPC 2	1,690	Guam-Japan-U.S.
	1983-1997	ANZCAN "D"	6,900	Australia-N.Z.-U.S.-Canada

The Rise of Private Cable Systems

The Club

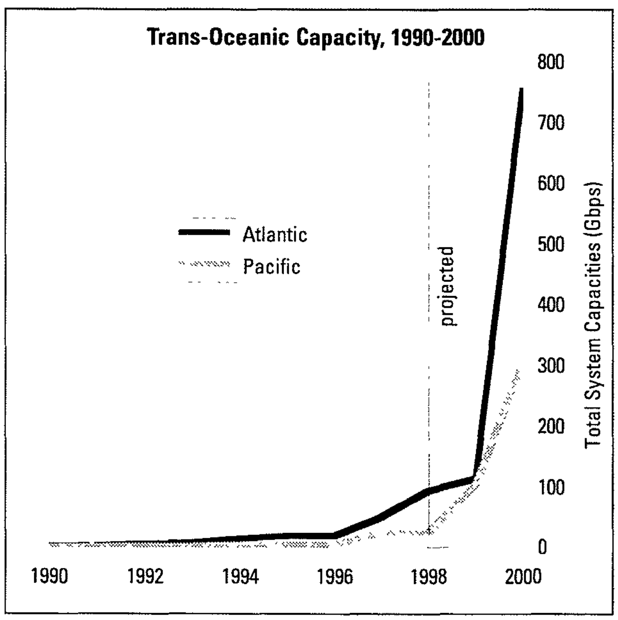
Until the late 1980s, all commercial submarine cables for telecommunications were built, used, and paid for by large groups of incumbent (usually monopoly) carriers. The systems were designed to work within the half-circuit correspondent relationship common to international telephony through most of the 20th century (for more, see "International Carrier Evolution" on page 26).

The "Club" members that built these systems shared costs and worked together without fear of competition from their partners. Members would forecast their expected capacity needs on international routes based on fairly predictable growth rates for telephone services and plan cables accordingly. Capacity was allocated and payment was made before or during construction of the system. U.S. and other regulators typically treated Club members as "common carriers;" that is, members were required to sell capacity to non-members on a non-discriminatory basis and close to cost.

Evidence of Change

When international service competition began, the Club system began to break down. Because Club members controlled both supply and price on the cables, capacity for non-members was limited and expensive. In addition, Club systems only provided connectivity from shore to shore, forcing new carriers to lease "backhaul" capacity from the former monopoly in order to connect the cable to their network, usually many miles inland. New international carriers needed to find a more cost-effective way of carrying their trans-oceanic traffic.

Figure 1. The History of Submarine Cable Capacity



Source: TeleGeography, Inc.

Trans-Oceanic Cable Voice Paths, 1988-2001

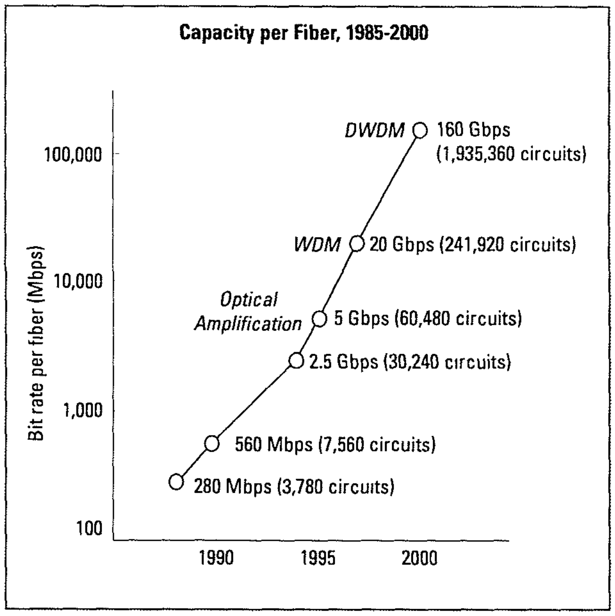
	Trans-Atlantic	Trans-Pacific
1988	43,750	1,857
1989	43,750	43,750
1990	175,000	43,750
1991	175,000	135,000
1992	437,500	222,500
1993	568,750	222,500
1994	1,090,625	310,000
1995	1,481,250	310,000
1996	1,481,250	310,000
1997	3,825,000	1,872,500
1998	7,340,625	1,872,500
1999	8,903,125	8,122,500
2000	58,903,125	23,747,500

Note Voice paths represent the number of simultaneous conversations that can be carried on a particular link Various encoding and compression techniques are used to carry more than one conversation on each 64 Kbps circuit. Figures in this table assume a 5:1 signal compression ratio. Data represents year end totals.

Source: TeleGeography, Inc., Euroconsult

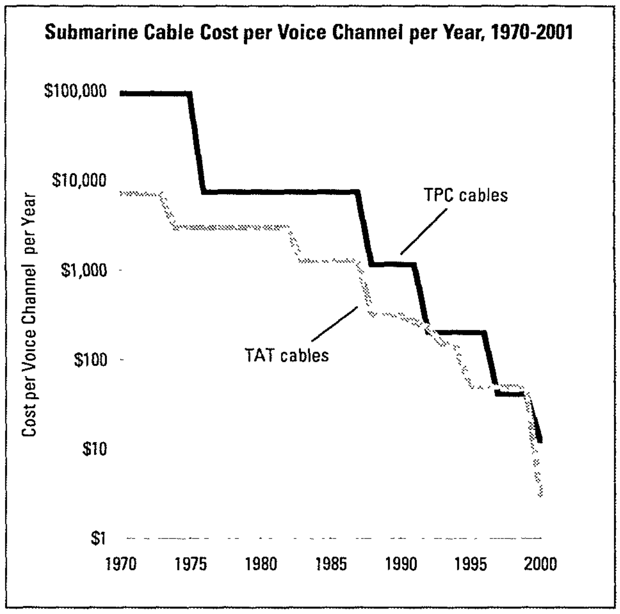
Three years ago, approximately 32 Gigabits per second (Gbps) of trans-oceanic submarine cable capacity landed in the U.S. As of this writing, however, there is over 100 Gbps of additional capacity. By 2001, the total will exceed one Terabit per second (1,000 Gbps)—enough capacity to carry more than 70 million simultaneous telephone calls. To put these numbers in context, a rough rule of thumb is that one Gbps of capacity can provide approximately 70,000 telephone channels (this assumes five voice paths can be derived from a standard 64 Kbps circuit). The primary reason for the growth in bandwidth is technological; the capacity of a pair of fiber optic strands have increased from five to 160 Gbps over the last five years of this decade (see Figure 2). The timing of the bandwidth explosion is critical for two reasons. First, Internet growth is generating a very large new demand for trans-oceanic bandwidth. And second, new international carriers need bandwidth to build their own networks.

Figure 2. International Submarine Cable Capacity and Cost



Note: Circuit figures indicate the number of 64 Kbps circuits plus signaling overhead.

Source: Alcatel Alsthom (www.alcatel.co.fr)



Note: System cost is derived from total construction costs divided by the system's lifetime. Figures assume compression ratio of 5:1 on post-1988 systems.

Source: TeleGeography, Inc. and Euroconsult

The first visible sign that the Club system was in decline came when new carriers began building their own cables and landing facilities. PTAT, a 1.68 Gbps trans-Atlantic cable built in 1989 (and now owned by Sprint and Cable & Wireless), was the first "private" (i.e., non-Club) cable system since the entrepreneurial telegraph cables of the 19th century. Like Club cables, private cables sold capacity to other parties, but unlike Club systems, they could choose to whom they sold (i.e., they could discriminate).

Later came FLAG, a system financed by telecom concerns as well as private investors, which was designed from the start to sell capacity rather than to reserve it for its builders. Today the biggest private cable player is Global Crossing, a publicly traded company with the sole purpose of building a global submarine cable network, including backhaul facilities to the 50 biggest cities in the world. Although the first leg of the system, Atlantic Crossing-1, was only partially operational as of this writing, it has already matched bandwidth with the largest (and sold-out) Club system on the Atlantic, TAT 12/13.

The Club rules for building and managing submarine cables will never be the same again. Here's why:

Proliferation of new carriers - Market liberalization has generated hundreds of new carriers that need low cost options for bandwidth, and many new entrants do not have the up-front capital required to participate in the construction of Club systems.

The Internet - The growth of data services, both in the form of private intranets and the public Internet, has placed unpredictable yet very large new demands on the cable planning process. Club rules, nonetheless, compel newcomers to purchase capacity at the outset in the form of Indefeasible Rights of Use (IRUs), which typically last the lifetime of the cable. For many players, however, the incremental acquisition of bandwidth is much more practical. To meet this demand, some private systems, like FLAG, have abandoned the IRU purchase model and are selling capacity in short leases, even as short as three years.

Competition among incumbents - Former monopoly carriers are now competing against one another, both through alliances (e.g., BT/AT&T vs. Global One) and through foreign affiliate operations. Club members are less likely to find the motivation to cooperate on long term projects with partners who may end up becoming competitive threats. Thus they are more willing to let private investors fund new cables.

The rise of private cables has not, however, stopped the planning and building of "quasi-Club" systems. In fact, a new quasi-Club Atlantic cable, TAT-14, scheduled to begin service in 2000, will have more than four times the capacity of all existing cables on the route. Future regulation and access terms for this cable (private or common carrier model) will be closely watched (see the map of "International Submarine Cables" on page 86).

New Cross-Border Networks in Europe

by Graham Finnie, Yankee Group Europe

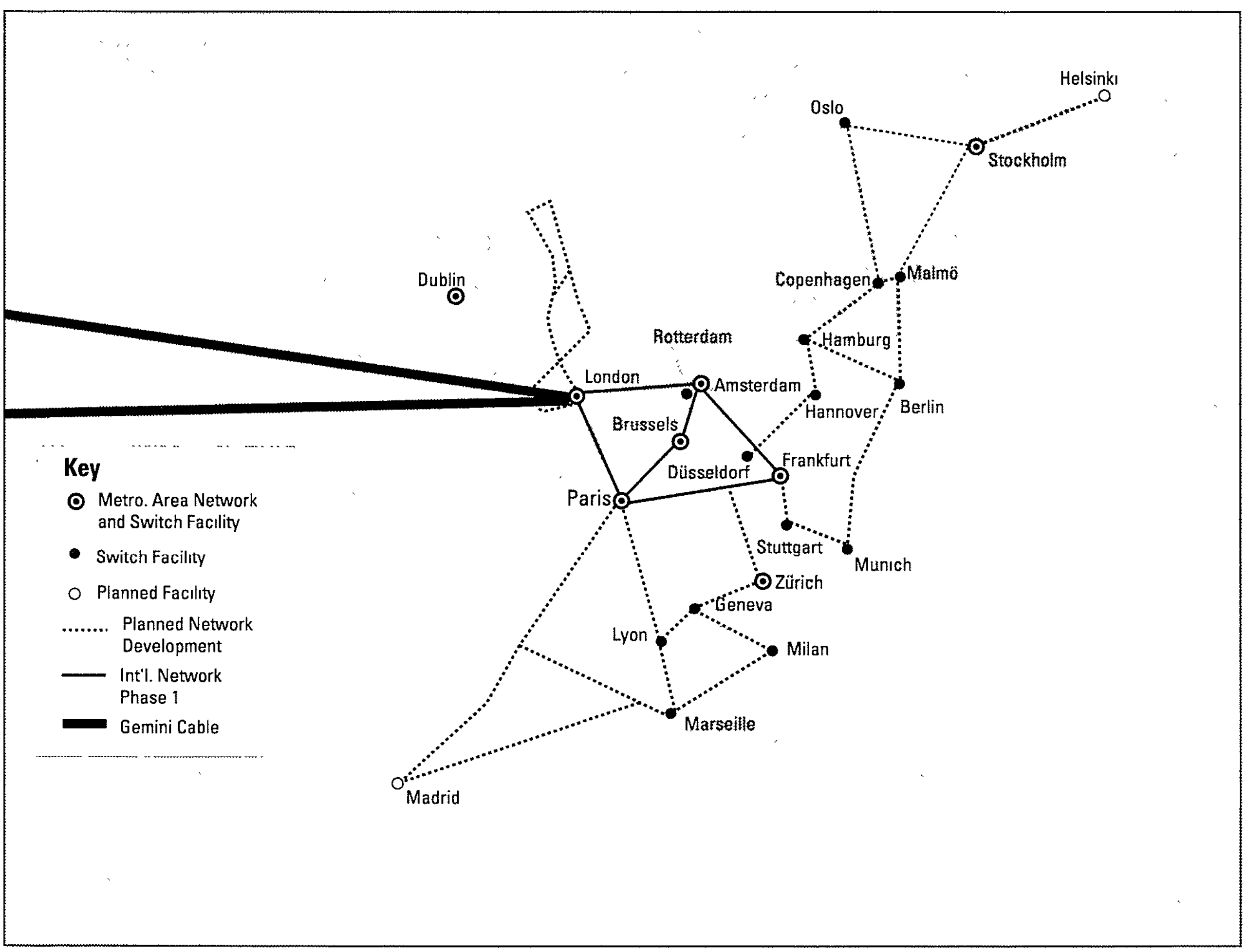
Of one thing we can be quite sure: Europeans will have access to a lot more cross-border bandwidth in the next two years. But trying to decide exactly how much new bandwidth is being installed or is actually commercially available is like counting bees—difficult at the best of times, and near-impossible when they are flying.

Unlike submarine cable systems, which are relatively transparent, Europe has an intricate web of fiber optic cables in the ground. And they are largely owned by a disparate group of national utilities. Information on the web is patchy, and not all of it has been made commercially available. Quite a bit is in the hands of utilities which have signed exclusive deals with one partner, often a foreign telco—an approach which has attracted the interest of anti-trust authorities. Meanwhile, new integrated networks are being laid alongside this existing patchwork infrastructure, and new technologies are being deployed which greatly boost bandwidth per fiber pair on both new and old cables. On top of all that, a vigorous market in dark fiber has developed, and a market in wavelengths is just beginning to gather speed. Yet neither dark fiber, which is not in service, nor lit fiber, which is, has a determinate bandwidth.

Background

Europe's long-distance and cross-border infrastructure market was liberalized in 1996. It looked hugely attractive for poten-

Figure 1. MCI WorldCom's European Network



Source: MCI WorldCom, Inc. (http://www.wcom.com)

Map design by TeleGeography, Inc. © 1998

Figure 2. New European International Networks

Organizations	Major Cities	Bandwidth	Commercial Launch	Type
BT/Concert	Amsterdam, Antwerp, Brussels, Düsseldorf, Frankfurt, London, Marseille, Milan, Munich, Paris, Rotterdam, Strasbourg, Zürich	200 Gbps	1999	Mostly laid cable owned by European domestic partners; estimated 7,000 route kilometers.
Cable & Wireless	Amsterdam, Barcelona, Brussels, Geneva, London, Madrid, Milan, Paris, Zürich Plans to add more second-tier cities in Austria, Denmark, France, Ireland, Italy, Portugal, Sweden	2 x 155 Mbps initially; more planned	1998	Leasing dark fiber from third parties where it can; otherwise leasing conventionally. Will not dig.
Carrier One	1998: Amsterdam, Geneva, Frankfurt, London, Paris, Vienna 1999: Brussels, Copenhagen, Dublin, Madrid, Milan, Stockholm	34 Mbps initially; more planned	1998	Currently based on leased capacity but intends to lay fiber (national net in Germany) and lease dark fiber on some routes.
Esprit	1998: Amsterdam, London, Paris Planned: Brussels, Düsseldorf, Frankfurt, Lyon, Marseille, Strasbourg, Stuttgart	2.5 Gbps initially; upgrade likely	1998 (London to Paris)	Based almost entirely on dark fiber.
Flute	Amsterdam, London	2.5 Gbps initially; more in response to demand	1999	Submarine cable venture with 12 fiber pairs; will lease bandwidth and dark fiber to third parties.
Global Crossing	1999: Amsterdam, Antwerp, Brussels, Cologne, Copenhagen, Düsseldorf, Frankfurt, Hamburg, Hanover, London, Paris, Rotterdam, Strasbourg. 2000: Lyon, Marseilles, Milan, Turin, Zürich Later: Barcelona, Berlin, Madrid, Munich, Rome, Stuttgart, Vienna	Total available bandwidth is 9.6 Tbps or more, depending on cable size; initial lit capacity not known	1999	Almost entirely laid cable; minimum 24 fiber pairs, 48 on terrestrial routes, 144 within Germany. Global Crossing will be a carriers' carrier only, and will link network to other transcontinental and regional networks in the Americas and elsewhere.
Hermes	1998: Amsterdam, Antwerp, Brussels, Düsseldorf, Frankfurt, Geneva, London, Milan, Munich, Paris, Rotterdam, Strasbourg, Stuttgart	180 Gbps +	1998	Will increase capacity to 320 Gbps next year.
Level 3	n.a.	n.a.	1999	Planning 5,000 km European network based on laid cable or dark fiber and linking ten mainly financial centers .
Viatel	Amsterdam, Antwerp, Brussels, Düsseldorf, Frankfurt, London, Paris, Rotterdam, Strasbourg, Stuttgart	20 Gbps initially; will move to 160 to 320 Gbps within 12 months	1999	More laid cable than dark fiber; 3,700 route kilometers in total.
MCI WorldCom	1998: Amsterdam, Brussels, Frankfurt, London, Paris 1999-2000: Berlin, Copenhagen, Düsseldorf, Geneva, Hamburg, Lyon, Madrid, Marseille, Milan, Munich, Oslo, Stockholm, Stuttgart	40 Gbps; likely to be upgraded	1998	More laid cable than dark fiber (over 3,000 route kilometers); laid cable is 2x24 fiber pairs.

Source: Yankee Group Europe

tial entrants: the price of bandwidth was (and is) very high, and—incredibly—Europe did not (and does not) have a pan-continental network managed and run by a single operator. Rather, it's a hodgepodge of national networks linked up at border points. Early in the 1990s, under pressure from frustrated multinational end users, Europe's national monopoly telcos made a belated attempt to create a common infrastructure, variously known as GEN and METRAN. But at best it did no more than ameliorate the situation slightly. And prices remained far above costs, despite the passage in 1992 of a so-called Open Network Provision (ONP) directive on leased circuits that called specifically for cost-oriented tariffs. Right up until this year, prices were still typically five to ten times higher for a cross-border circuit in Europe than for comparable circuits in the U.S.

Yet despite this tempting backdrop, early entrants soon found that simply setting up an office and laying cable across the continent was easier said than done. Continent-wide fiber cable networks built to a single specification, and entirely owned by one group, do not yet exist, and likely will not for some years yet. Instead, the new players, many of which are consortia owned or operated by more than one company, are using a patchwork of laid and leased cable.

The earliest entrant, Hermes Europe Railtel BV, was conceived eight years ago. It planned to lay cable along rights of way owned by railway companies, but the problems of working with a large group of state-owned national railway authorities proved unmanageable. Now, only two railway authorities are in the group (it's almost 90 percent owned by U.S. entrepreneur Global TeleSystems), and the network is a mix of laid fiber and dark fiber. Fully 70 percent of the network is based on dark fiber leased from a variety of utilities, including railway authorities such as the Belgian Railway Authority and Eurotunnel. Other utilities selling capacity in Europe include highway management companies such as France's SANEF, gas and pipeline companies, electricity companies, and waterways.

Most entrants have followed Hermes' lead to varying extents. Esprit Telecom, for instance, is building a network that is based almost entirely on leasing dark fiber. Cable & Wireless is following suit.

New technology makes a network based on dark fiber rather than laid cable doubly attractive. Because dense wavelength division multiplexing (DWDM) componentry became widely available in 1998, most entrants don't believe they need to light more than one or two fiber pairs to supply what they need. Hermes, for example, is using 40-wavelength technology that will allow each fiber pair to operate at 100 Gbps, and will move to 80-wavelength technology next year. It only has two pairs lit, and doesn't believe it will need to light any more in the foreseeable future. Viatel has gone further, using Lucent's new DWDM technology, which allows 40 x 10 Gbps capacity per pair.

Despite that, some companies clearly have the strategic intent to lay cable if they can. Though MCI WorldCom won't say how much of its network is based on dark fiber leased from utilities, we believe it's less than 30 percent, and certainly a lower proportion than Hermes. The same is true of Viatel, despite the very high capacity it can achieve per fiber pair. And big new entrants with huge ambitions, such as BT and its European partners, will build a network that is based almost entirely on their own laid cable. They, of course, have the advantage that much of the network either already exists or is being laid anyway. Most ambitious of all, Global Crossing Ltd., a Los Angeles-based start-up which raised $400 million in an August 1998 IPO and already has completed a trans-Atlantic cable (AC-1), announced plans in October to build out a pan-European network with between 48 and 144 fiber pairs, yielding a minimum 10 Tbps capacity, dwarfing other networks. It will link 13 cities by the end of 1999, and another five the following year.

Meanwhile, other options are muddying the distinction between owners and lessors of infrastructure. As well as leasing dark fiber to third parties, some cable owners such as Racal in the U.K. (which bought out the British Rail national fiber network) are considering leasing specific wavelengths, or 'lambdas' in industry jargon. Others (including for example Viatel) are leasing capacity to customers for the lifetime of the cable, on the same principle (the so-called indefeasible rights of use or IRUs) as capacity in submarine cables.

So How Much Bandwidth Exists?

Figure 2 only includes those companies that have firm, declared plans to lay cable or to build a network based on dark fiber, or that have already begun to do so.

There are several other companies that had not declared their hand at the time of writing, but are likely or possible entrants. These include in particular Global One, the joint venture between Deutsche Telekom, France Télécom and Sprint; Global Crossing, the U.S. start-up that has already commissioned Atlantic Crossing and Pacific Crossing; and Qwest, the U.S. national Internet Protocol (IP) network operator that bought one of Europe's biggest Internet operators, EUnet, in April 1998.

What does all of this mean for bandwidth availability? It's difficult to be definitive. All that can be said with confidence is that bandwidth potentially available will increase by several orders of magnitude in a very short period. On key routes in northwestern Europe—especially to and from Amsterdam, Brussels, Frankfurt, London, and Paris—there is likely to be between 500 Gbps to one Tbps of lit capacity by the end of 1999 compared to no more than ten Gbps before the boom began. Beyond that, capacity will increase quickly to major cities to the east, south, and north, such as Zürich, Geneva, Milan, Düsseldorf, and Stockholm, and also to many smaller intermediary cities such as Stuttgart and Strasbourg. Some players, including WorldCom and Viatel, are planning to build extensive national networks in the bigger countries like Germany.

In principle, then, it sounds like a glut is on the way: even the most enthusiastic of Internet, IP and e-commerce zealots might find it difficult to argue that actual utilization will increase 50-100 fold in two years. In reality, though, in the same way that quite a bit of bandwidth on new trans-Atlantic routes has vanished into the vaults of old and new telcos and service providers (and one or two futures entrepreneurs), so the new bandwidth in Europe may not actually be utilized by or available to ultimate end users, but rather hoarded for a whole variety of reasons. That might pose some new issues for regulators in Europe who are anxious to ensure that Europeans get enough long-distance, cross-border bandwidth to allow electronic commerce to flourish and knit the continent's member states together.

Yet even in the worst-case scenario, there's no going back to the bad old days that beleaguered Europe's bandwidth junkies. Bandwidth will be plentiful, prices will in time fall to U.S. levels, and most mainstream telcos will need to do some very rapid rethinking about tariffs. As the falling price of commodity bandwidth feeds through to the price of commodity international phone calls, rapid revenue attrition is a near-certainty. Cutting dependence on phone usage revenues will be the key to success in the new decade.

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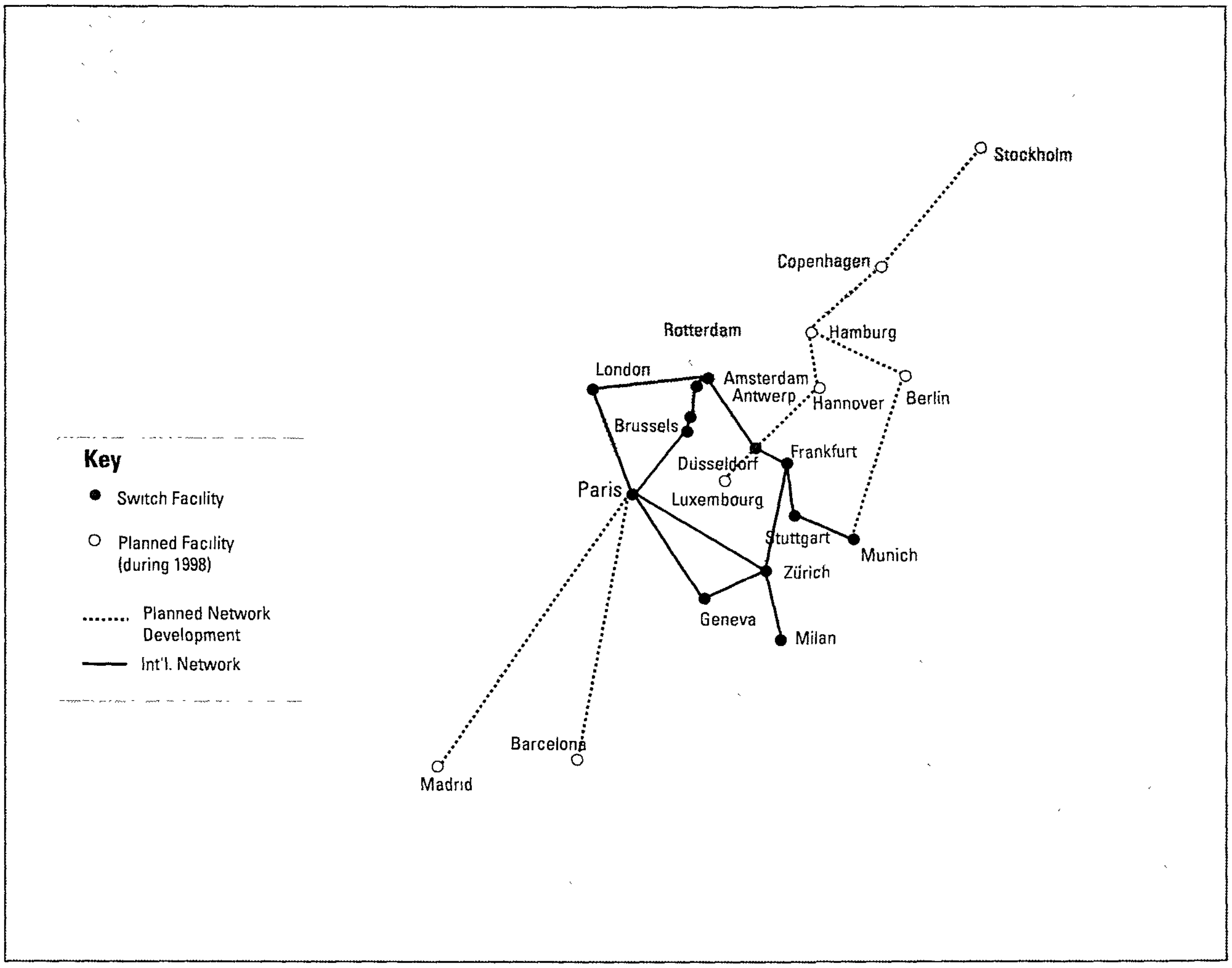
Figure 3. Hermes' European Network



Source: Hermes Europe Railtel BV (http://www.her.com) Map design by TeleGeography, Inc. © 1998

International Circuit Usage by U.S. Carriers

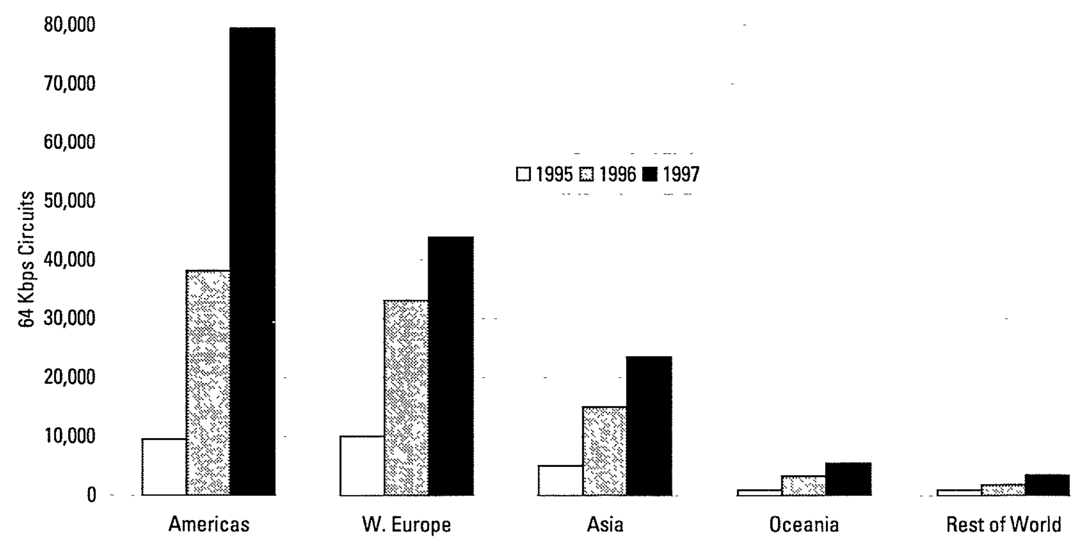
Figure 1. International Circuit Usage by Region, 1995-1997

U.S. Carrier 64 Kbps Circuit Usage

		For Private Lines	For Public Switched Network	Total Circuits In Use	Idle Circuits	Total Available
Americas	1995	9,489	79,892	89,381	10,789	100,170
	1996	38,170	82,801	120,971	9,432	130,403
	1997	79,358	102,367	181,725	11,496	193,221
W. Europe	1995	9,997	22,389	32,386	54,593	86,979
	1996	33,083	29,536	62,619	33,053	95,672
	1997	43,784	34,476	78,260	46,245	124,505
E. Europe	1995	241	2,886	3,127	1,470	4,597
	1996	478	3,344	3,822	1,704	5,526
	1997	1,326	3,742	5,068	1,719	6,787
Middle East	1995	506	2,560	3,066	266	3,332
	1996	908	2,836	3,744	560	4,304
	1997	1,432	3,096	4,528	479	5,007
Africa	1995	199	2,051	2,250	181	2,431
	1996	406	2,416	2,822	327	3,149
	1997	699	2,608	3,307	292	3,599
Asia	1995	5,067	13,185	18,252	26,605	44,857
	1996	15,015	16,475	31,490	27,163	58,653
	1997	23,545	19,567	43,112	30,830	73,942
Oceania	1995	998	3,125	4,123	1,628	5,751
	1996	3,302	3,110	6,412	2,523	8,935
	1997	5,430	4,861	10,291	1,690	11,981
Total	*1995*	*26,497*	*126,150*	*152,647*	*n.a.*	*n.a.*
	1996	*91,362*	*140,518*	*231,880*	*74,762*	*306,642*
	1997	*155,574*	*170,717*	*326,291*	*92,751*	*419,042*

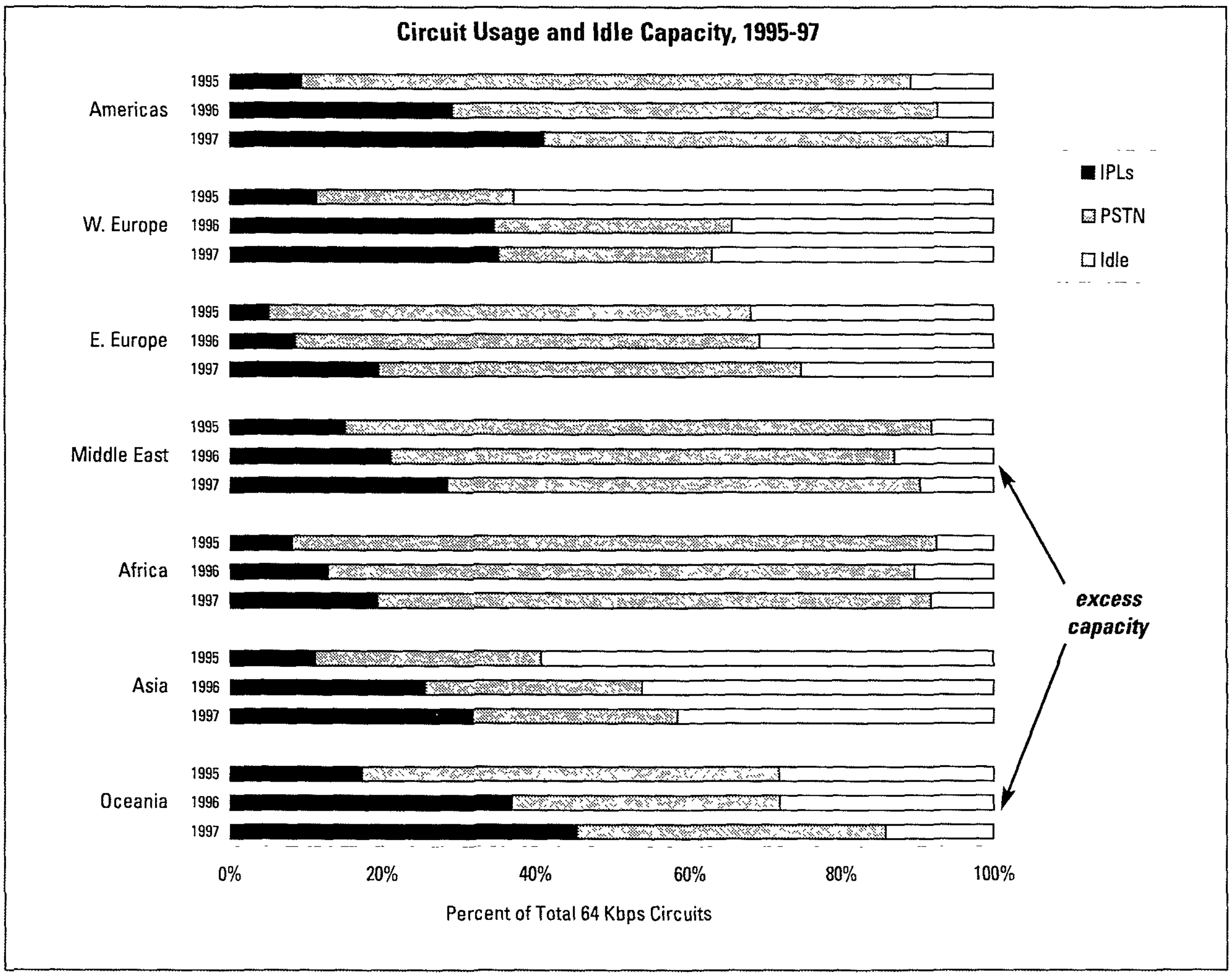
Note: Data based on year-end FCC circuit status reports filed by AT&T, MCI, Sprint, and WorldCom for circuits originating in continental U.S. only. "Idle" circuits are circuits owned by a carrier at year end but not in use. Satellite capacity utilization is generally not reflected in this data because U.S. carriers do not acquire international satellite capacity in advance. The FCC estimates that 25-30 percent of total submarine cable capacity landed in the U.S. is controlled by foreign carriers and thus not reported here. Also, up to 100 percent of used capacity goes unreported because it is reserved for restoration purposes only.

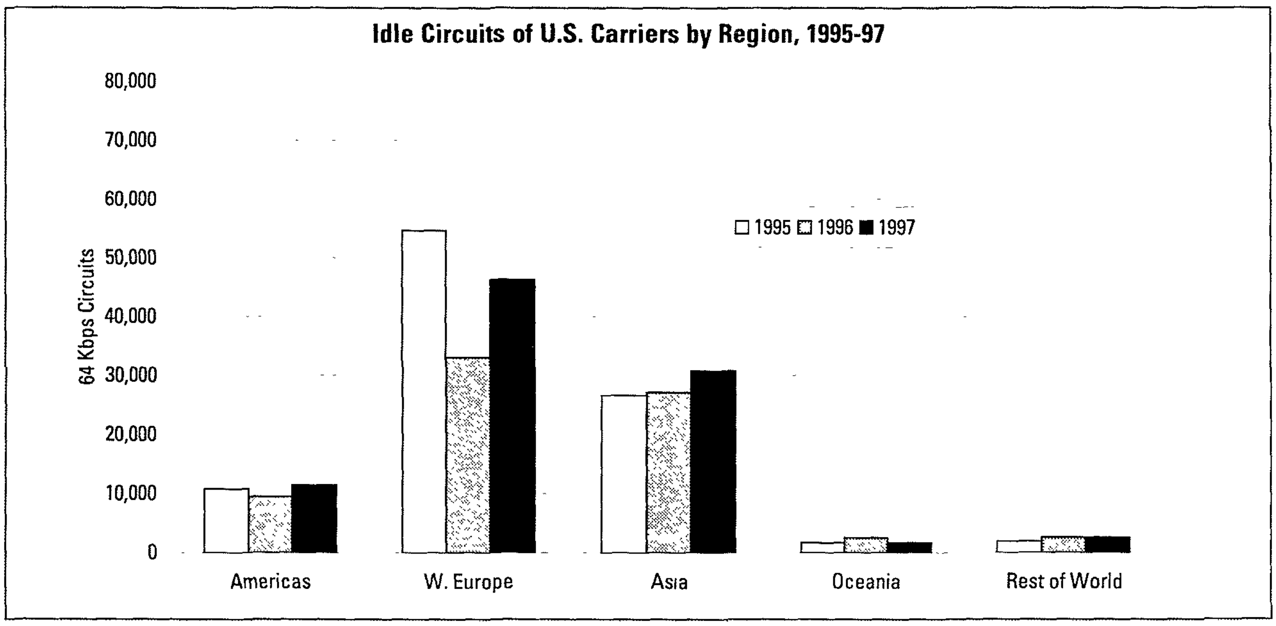
International Private Line Circuit Usage of U.S. Carriers by Region, 1995-97



Source: FCC

Figure 2. Idle Circuits of U.S. Carriers by Region, 1995-1997





Source: FCC

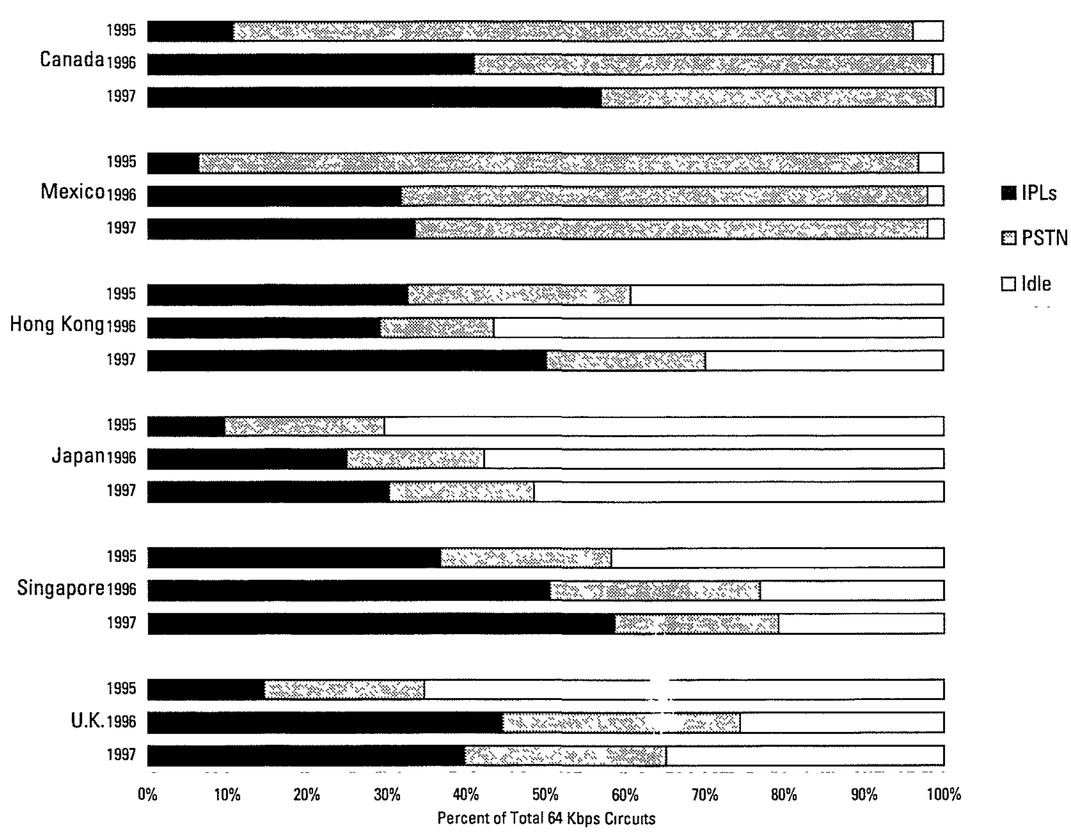
Figure 3. International Circuit Usage for Selected Routes, 1995-1997

U.S. Carrier 64 Kbps Circuit Usage

		For Private Lines	For Public Switched Network	Total Circuits In Use	Idle Circuits	Total Available
Canada	1995	5,543	44,172	49,715	1,936	51,651
	1996	29,698	41,793	71,491	917	72,408
	1997	68,383	50,343	118,726	1,178	119,904
Mexico	1995	1,653	23,416	25,069	800	25,869
	1996	13,312	27,784	41,096	840	41,936
	1997	19,155	36,935	56,090	1,148	57,238
Hong Kong	1995	860	742	1,602	1,036	2,638
	1996	1,921	961	2,882	3,722	6,604
	1997	3,058	1,221	4,279	1,825	6,104
Japan	1995	2,241	4,619	6,860	16,259	23,119
	1996	7,682	5,354	13,036	17,696	30,732
	1997	10,087	6,149	16,236	17,178	33,414
Singapore	1995	521	306	827	593	1,420
	1996	1,114	582	1,696	508	2,204
	1997	1,617	570	2,187	571	2,758
U.K.	1995	6,048	8,317	14,365	27,001	41,366
	1996	18,959	12,648	31,607	10,844	42,451
	1997	23,008	14,662	37,670	20,118	57,788

Note: Data based on year-end FCC circuit status reports filed by AT&T, MCI, Sprint, and WorldCom for circuits originating in continental U.S. only. "Idle" circuits are circuits owned by a carrier at year end but not in use. Satellite capacity utilization is generally not reflected in this data because U.S. carriers do not acquire international satellite capacity in advance. The FCC estimates that 25-30 percent of total submarine cable capacity landed in the U.S. is controlled by foreign carriers and thus not reported here. Also, up to 100 percent of used capacity goes unreported because it is reserved for restoration purposes only.

Circuit Usage and Idle Capacity, 1995-1997



Source: FCC

A Primer on Bits

Figure 1. Measuring Bytes Bit by Bit

Below are the standard metric prefixes used in the SI (Système International) conventions for scientific measurement. With units of time (e.g., gigabits per second) or things that come in powers of 10, they retain their usual meanings of multiplication by powers of $1,000 = 10^3$. When used with bytes (e.g., gigabytes of data storage) or other things that naturally come in powers of 2, they usually denote multiplication by powers of $1,024 = 2^{10}$.

	Base 10				Base 2		
1 Kilobit/s	$= 1{,}000^1 = 10^3$	=	1,000	1 Kilobyte	$= 1{,}024^1 = 2^{10}$	=	1,024
1 Megabit/s	$= 1{,}000^2 = 10^6$	=	1,000,000	1 Megabyte	$= 1{,}024^2 = 2^{20}$	=	1,048,576
1 Gigabit/s	$= 1{,}000^3 = 10^9$	=	1,000,000,000	1 Gigabyte	$= 1{,}024^3 = 2^{30}$	=	1,073,741,824
1 Terabit/s	$= 1{,}000^4 = 10^{12}$	=	1,000,000,000,000	1 Terabyte	$= 1{,}024^4 = 2^{40}$	=	1,099,511,627,776
1 Petabit/s	$= 1{,}000^5 = 10^{15}$	=	1,000,000,000,000,000	1 Petabyte	$= 1{,}024^5 = 2^{50}$	=	1,125,899,906,842,624
1 Exabit/s	$= 1{,}000^6 = 10^{18}$	=	1,000,000,000,000,000,000	1 Exabyte	$= 1{,}024^6 = 2^{60}$	=	1,152,921,504,606,846,976
1 Zettabit/s	$= 1{,}000^7 = 10^{21}$	=	1,000,000,000,000,000,000,000	1 Zettabyte	$= 1{,}024^7 = 2^{70}$	=	1,180,591,620,717,411,303,424
1 Yottabit/s	$= 1{,}000^8 = 10^{24}$	=	1,000,000,000,000,000,000,000,000	1 Yottabyte	$= 1{,}024^8 = 2^{80}$	=	1,208,925,819,614,629,174,706,176

Figure 2. Measuring Telecommunications Bandwidth—DS-0 to OC-192

Carrier Technology	Data Rate(Mbps)	Description	64 Kbps Circuits*
DS-0	0.064	Base rate in the Digital Signal (DS) level hierarchy	1
T-1 (DS-1)	1.544	Primary level of the American T-carrier multiplexing system; capacity is the same as a DS 1 carrier	24
T-2 (DS-2)	6.312	Four times the capacity of T-1	96
T-3 (DS-3)	44.736	28 times the capacity of T-1	672
T-4 (DS-4)	274.176	168 times the capacity of T-1	4,032
E-1	2.048	Primary level of the European E-carrier multiplexing system	30
E-2	8.448	Carries four multiplexed E-1 signals	120
E-3	34.368	Carries four E-2 signals	480
E-4	139.264	Carries four E-3 signals	1,920
E-5	565.148	Carries four E-4 signals	7,680
OC-1/STS-1	51.840	Basic signaling rate of SONET hierarchy	810
OC-3/STM-1	155.520	Exactly three times the capacity of OC-1**	2,430
OC-12/STM-4	622.080	12 times the capacity of OC-1	9,720
OC-24	1,244.160	24 times the capacity of OC-1	19,440
OC-48/STM-16	2,488.320	48 times the capacity of OC-1	38,880
OC-192/STM-64	9,953.280	192 times the capacity of OC-1	155,520

Key

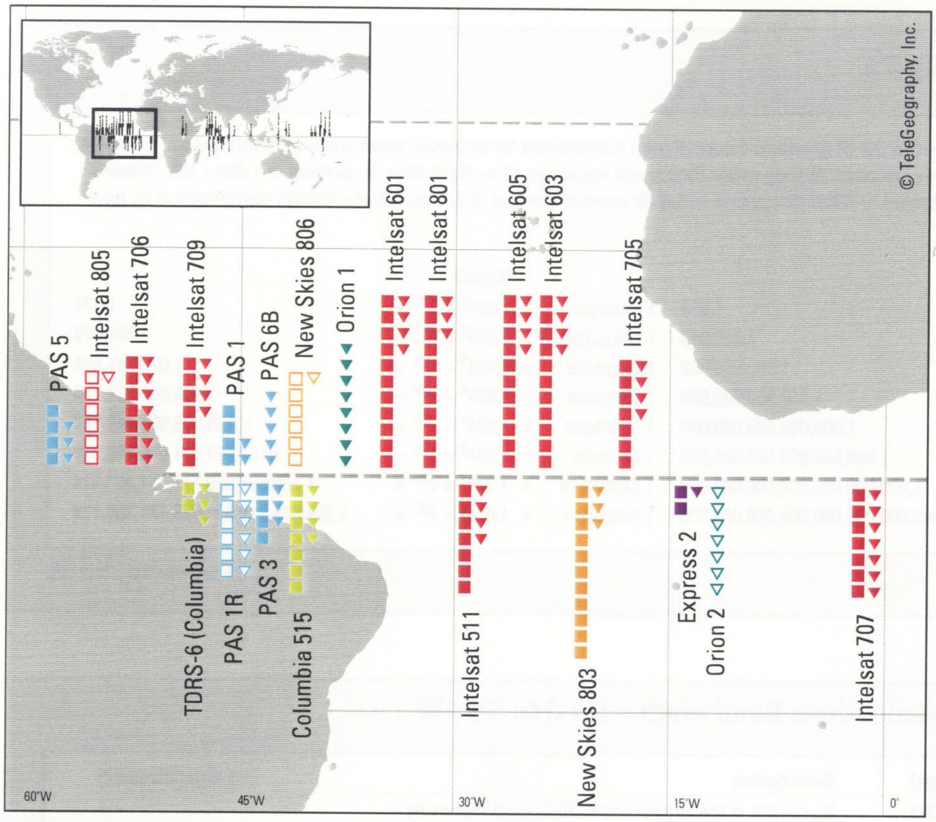
"T"	T-carrier system in U S., Canada, and Japan with 1.544 Mbps as the primary level (24 voice channels x 64 Kbps per channel).
"DS"	Digital Signal that travels on the T-carrier or E-carrier
"E"	Used in countries other than U.S., Canada, and Japan The hierarchy was established by the CEPT (Conférence Européenne des Postes et Télécommunications) with 2.048 Mbps as the primary level ([30 voice channels + 2 channels for overhead] x 64 Kbps per channel).
"OC"	Optical Carrier interface designed to work with STS-*n* (Synchronous Transport Signal) signaling rate in a SONET (Synchronous Optical Network)
"STM"	Synchronous Transport Module refers to a large carrier (base signal 155.52 Mbps) in a SONET
"STS"	Synchronous Transport Signal is the electrical counterpart to the Optical Carrier (OC).

* The number of 64 Kbps is presented for comparative purposes only. The actual number of simultaneous conversations possible over a given carrier may vary depending on the encoding scheme used.

** In the "E" and "T" hierarchies, each higher level is set to be "almost but not exactly" a multiple of the bit rate for the previous order (plesiochronous). To eliminate problems associated with plesiochronous multiplexing, SONET, a synchronous hierarchy, was defined in the United States in 1986. As a result, the "OC" and "STM" carriers are exact bit-rate multiples of their primary levels, OC-1 and STM-1, respectively.

Source: TeleGeography, Inc.; Alcatel; *Newton's Telecom Dictionary*

International Communications Satellites

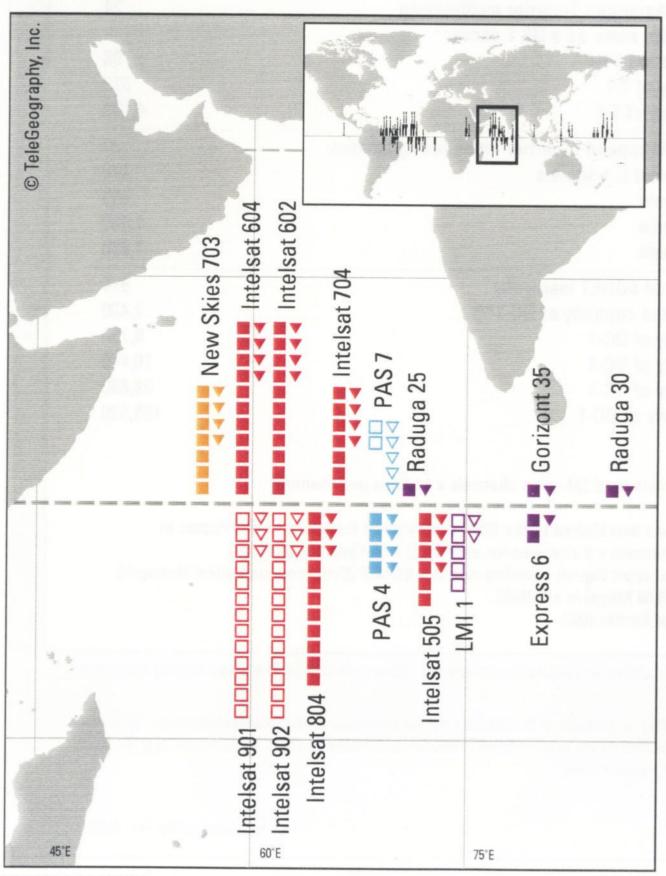


Key

- ■ Six 36-MHz transponder equivalents for the C-band (4/6 GHz)
- ▼ Six 36-MHz transponder equivalents for the Ku-band (11-12/14 GHz)
- □ ▽ Outline denotes satellites under construction as of August 1998

The maps on this page show 36 of the approximately 180 commercial geosationary satellites scheduled to begin operation by January 2001. These satellites use C- and Ku-band transponders to carry voice, data, and video. On some satellites (such as Panamsat's), a majority of capacity is used for video transmission services. A 36 MHz C-band transponder can generally carry about 2,000 calls, but requires a large dish for TV reception. Smaller Ku-band dishes are increasingly the technology of choice for direct broadcast satellite reception. Intersputnik satellites carry only one (Gorizont and Raduga) or two (Express) Ku-band transponders at 36 MHz, therefore the actual Ku-band capacity for these satellites is somewhat less than suggested on the maps.

Source: TeleGeography, Inc., *International Satellite Directory 1998*, Euroconsult



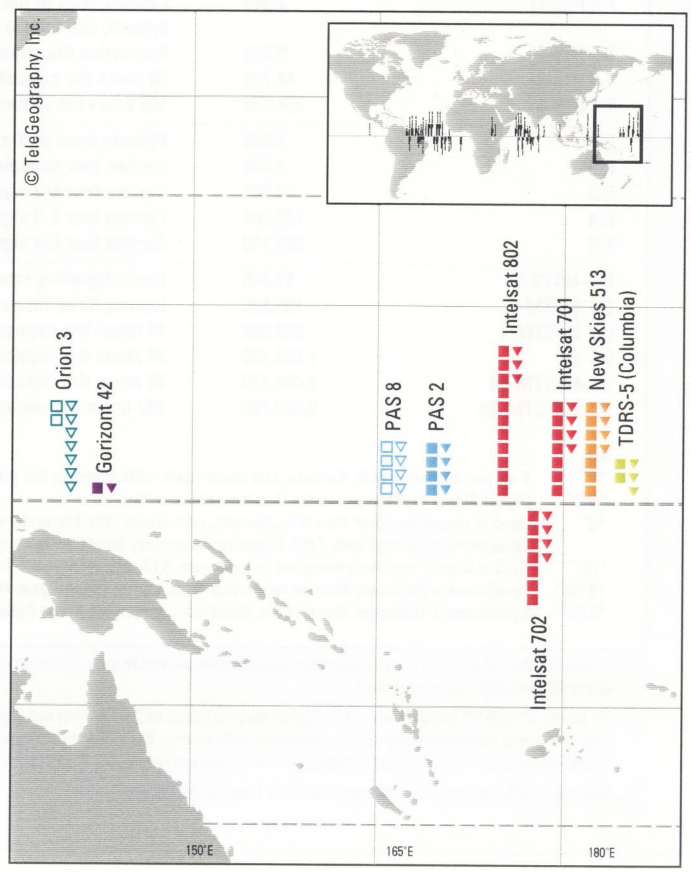
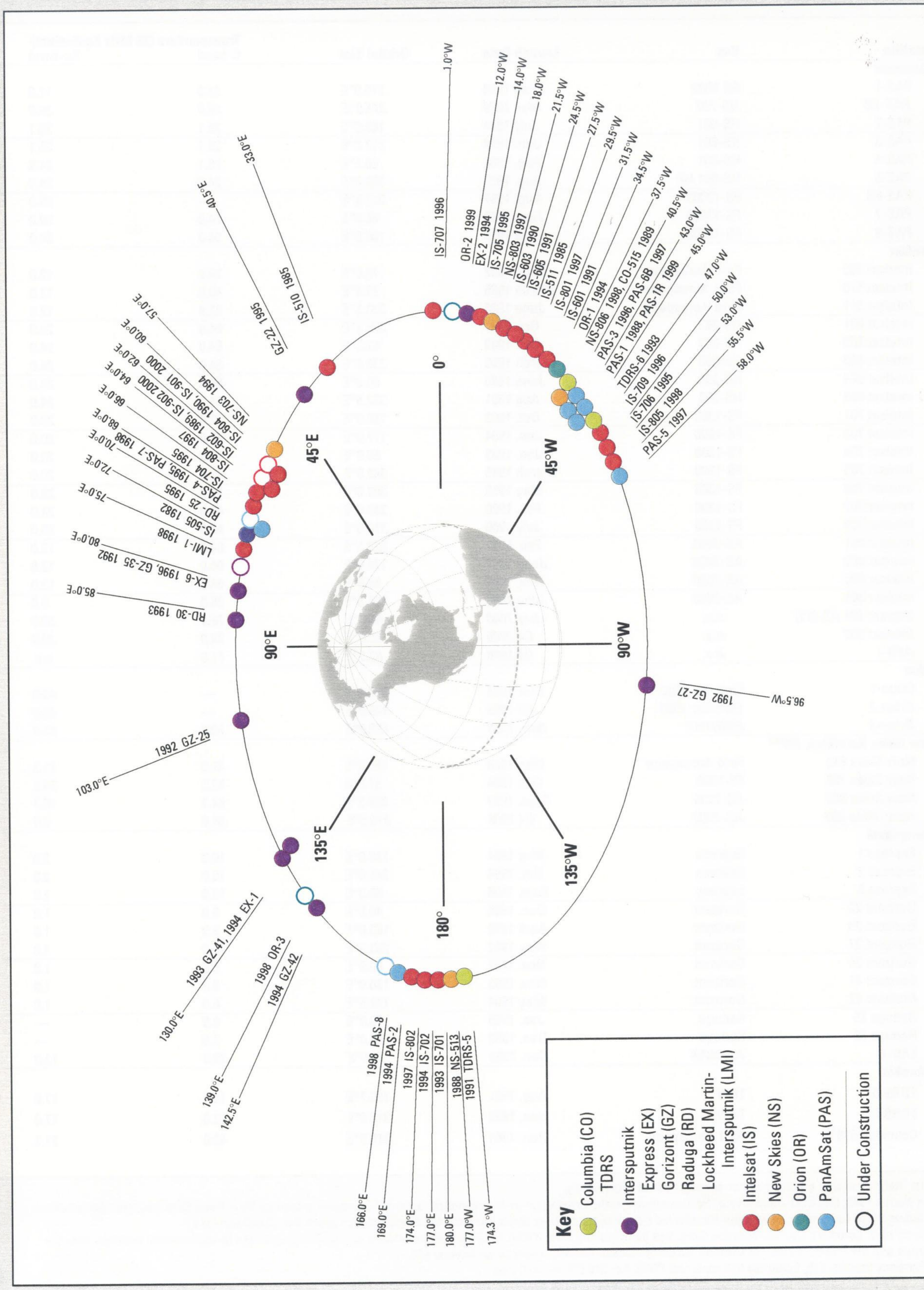


Figure 1. Orbital Map of Major Geostationary Satellites



Notes: The year next to the satellite name denotes launch date. Satellite orbits not to scale. Geostationary Earth Orbit (GEO) satellites orbit 35,785 km above the equator.
Source: Design adapted from *"Global Marketplace 98,"* Merrill Lynch

Figure 2. Major International Telecommunications Satellites in Geostationary Orbit

Satellite	Bus	Launch Date	Orbital Slot	Transponders (36 MHz Equivalent) C-band	Ku-band
Panamsat					
PAS-1	GE 3000	June 1988	315.0°E	24.0	12.0
PAS-1R	*HS-702*	*May 1999*	*315.0°E*	*36.0*	*36.0*
PAS-2	HS-601	July 1994	169.0°E	25.1	25.1
PAS-3	HS-601	Jan. 1996	317.0°E	25.1	25.1
PAS-4	HS-601	Aug. 1995	68.5°E	25.1	24.6
PAS-5	HS-601 HP	Aug. 1997	302.0°E	24.0	24.0
PAS-6B	FS-13003	Aug. 1997	317.0°E	—	36.0
PAS-7	FS-13003	June 1998	68.5°E	14.0	30.0
PAS-8	FS-13003	June 1998	166.0°E	24.0	24.0
Intelsat					
Intelsat 505	Ford Aerospace	Sept. 1982	72.0°E	34.0	12.0
Intelsat 510	Ford Aerospace	March 1985	33.0°E	40.0	12.0
Intelsat 511	Ford Aerospace	June 1985	330.5°E	42.0	12.0
Intelsat 601	HS-393	Oct. 1991	325.5°E	64.0	24.0
Intelsat 602	HS-393	Oct. 1989	62.0°E	64.0	24.0
Intelsat 603	HS-393	March 1990	335.5°E	64.0	24.0
Intelsat 604	HS-393	June 1990	60.0°E	64.0	24.0
Intelsat 605	HS-393	Aug 1991	332.5°E	64.0	24.0
Intelsat 701	FS-1300	Oct. 1993	180.0°E	42.0	20.0
Intelsat 702	FS-1300	Jun. 1994	177.0°E	42.0	20.0
Intelsat 704	FS-1300	Jan. 1995	66.0°E	42.0	20.0
Intelsat 705	FS-1300	March 1995	342.0°E	42.0	20.0
Intelsat 706	FS-1300	May 1995	307.0°E	42.0	28.0
Intelsat 707	FS-1300	Feb. 1996	359.0°E	42.0	28.0
Intelsat 709	FS-1300	July 1996	310.0°E	42.0	20.0
Intelsat 801	AS-7000	Feb. 1997	328.5°E	64.0	12.0
Intelsat 802	AS-7000	June 1997	174.0°E	64.0	12.0
Intelsat 804	AS-7000	Nov. 1997	64.0°E	64.0	12.0
Intelsat 805	AS-7000	June 1998	304.5°E	36.0	6.0
Intelsat 901 (IS-IX1)	*n.a.*	*July 2000*	*60.0°E*	*76.0*	*20.0*
Intelsat 902	*n.a.*	*Q4 2000*	*62.0°E*	*76.0*	*20.0*
APR-1	*n.a.*	*Q4 1998*	*83.0°E*	*11.0*	*n.a.*
Orion					
Orion-1	Eurostar 2000	Nov. 1994	322.5°E	—	48.0
Orion-2	*Eurostar 2000*	*Q2 1999*	*348.0°E*	—	*45.0*
Orion-3	*HS601HP*	*Nov. 1998*	*139.0°E*	*10.0*	*44.0*
New Skies Satellites, NV*					
New Skies 513	Ford Aerospace	May 1988	183.0°E	42.0	21.3
New Skies 703	FS-1300	Oct. 1994	57.0°E	42.3	24.5
New Skies 803	AS-7000	Sept. 1997	338.5°E	64.2	16.7
New Skies 806	*AS-7000*	*Q4 1998*	*319.5°E*	*36.0*	*6.0*
Intersputnik					
Express 1	Express	May 1994	130.0°E	10.0	2.0
Express 2	Express	Oct. 1994	346.0°E	10.0	2.0
Express 6	Express	Sept. 1996	80.0°E	10.0	2.0
Gorizont 22	Gorizont	Dec. 1995	40.5°E	6.0	1.0
Gorizont 25	Gorizont	April 1992	103.0°E	6.0	1.0
Gorizont 27	Gorizont	Nov. 1992	263.5°E	10.0	2.0
Gorizont 35	Gorizont	Nov. 1992	80.0°E	6.0	1.0
Gorizont 41	Gorizont	Nov. 1993	130.0°E	6.0	1.0
Gorizont 42	Gorizont	May 1994	142.5°E	6.0	1.0
Raduga 25	Raduga	Jan. 1995	70.0°E	6.0	—
Raduga 30	Raduga	Dec. 1993	85.0°E	3.0	—
LMI-1	*A2100AX*	*Dec. 1998*	*75.0°E*	*28.0*	*12.0*
Columbia					
TDRS-5†	TRW	Aug. 1991	185.7°E	12.0	17.0
TDRS-6†	TRW	Jan. 1993	313.0°E	12.0	17.0
Columbia 515††	Ford Aerospace	Jan. 1989	319.5°E	42.0	21.4

Note: Italics indicate a system under construction at this printing.

* In March 1998, Intelsat's Assembly of Parties approved the creation of an independent "spin-off" company known as New Skies Satellites, NV. Six satellites, including those listed here, have been transferred from Intelsat to New Skies primarily for direct broadcast satellite (DBS) services.

† Since 1992, Columbia Communications Corp. has been leasing from NASA 12 C-band transponders on two TDRS satellites for commercial services over the Atlantic and the Pacific zones. In addition, Columbia leases Atlantic capacity on Intelsat 605.

†† Formerly Intelsat 515, Columbia 515 replaced TDRS 4 at 319.5°E in April 1998.

Sources: TeleGeography, Inc.; *International Satellite Directory 1998*; Merrill Lynch

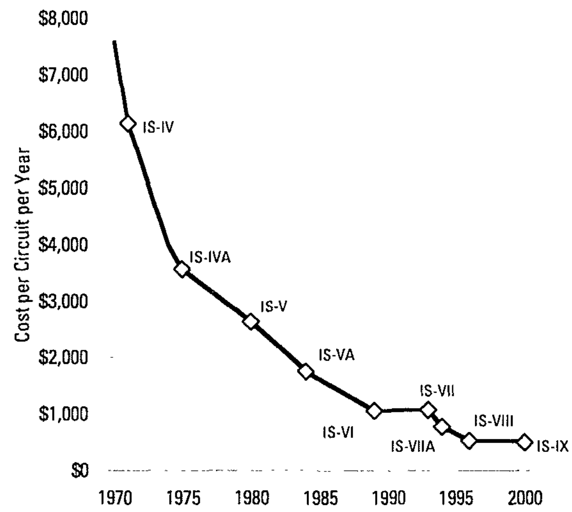
Figure 3. International Satellite Capacity and Cost

Historical Trans-Oceanic Satellite Voice Paths, 1988-1998

	Trans-Atlantic	Trans-Pacific
1988	78,000	39,000
1989	93,000	39,000
1990	283,000	39,000
1991	283,000	27,000
1992	496,000	27,000
1993	620,800	83,300
1994	620,800	234,000
1995	710,800	234,000
1996	710,800	234,000
1997	935,800	424,500
1998	1,048,300	469,500

Note: Data prior to 1993 include Intelsat satellites only. After 1989, deployment of Digital Code Multiplication Equipment (DCME) made 5:1 compression possible where only 2:1 had been used previously. Capacity estimates exclude one Intelsat satellite in each region held in reserve.

Intelsat Cost per Circuit per Year, 1970-2000



Source: TeleGeography, Inc. and Euroconsult (Tel. +33 1 43 38 06 00, Fax +33 1 43 38 12 40)

The New Global Mobile Satellite Services

Traffic Routing, Settlements and Demand

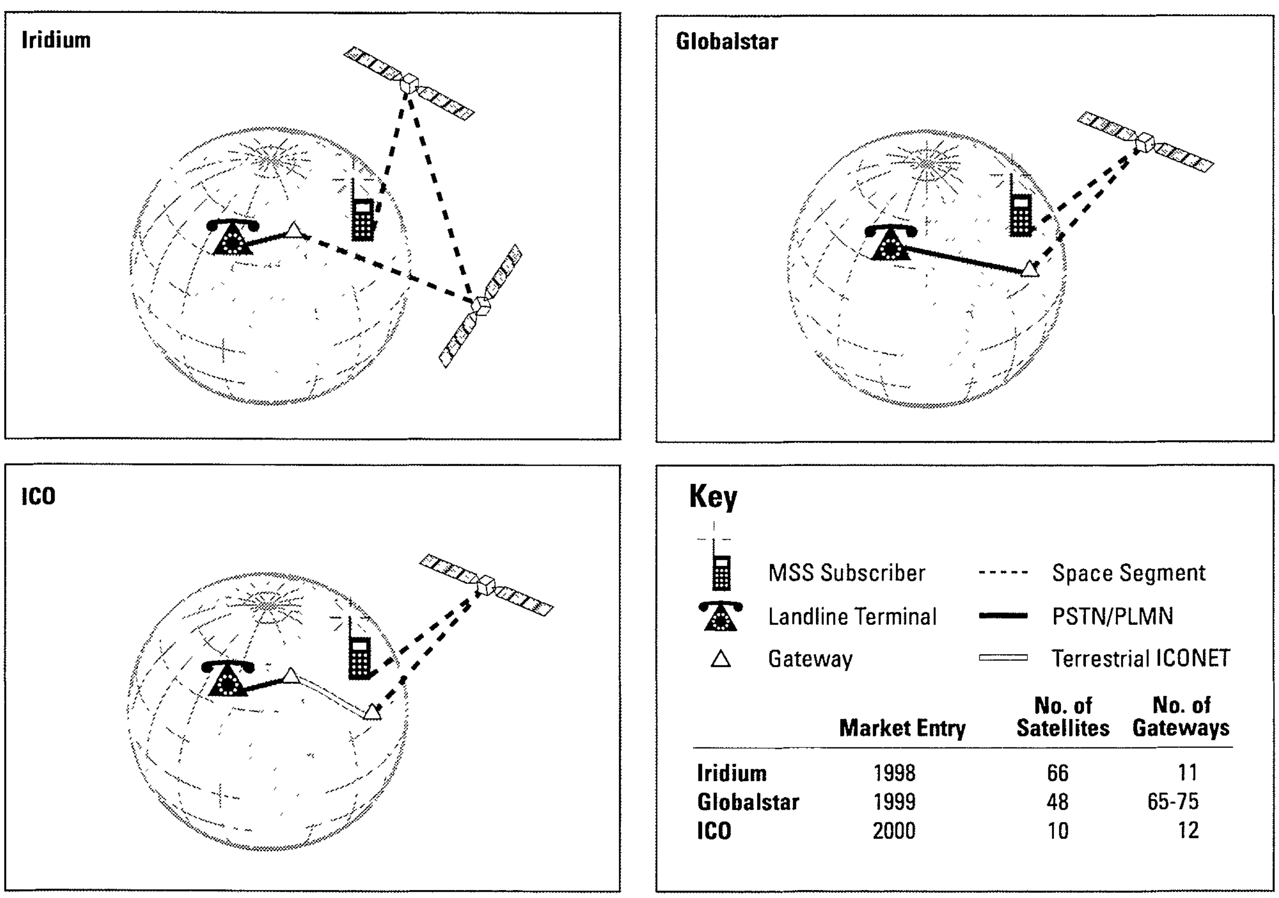
Until recently, using a "sat phone" meant carrying around a briefcase-sized unit full of equipment and enduring a half-second lag in conversation. And only Inmarsat had global coverage, with TMI Communications and American Mobile Satellite Communications (AMSC) limited to service in North America. The next generation of global mobile satellite service (MSS) ventures hope to change all that. Iridium will begin full commercial service in November 1998, offering telephone calls from cellular-sized handsets to or from almost anywhere on the planet. In addition to Iridium, Globalstar and ICO are expected to be the early leaders in the field and together will operate 124 satellites in low and medium earth orbits. The various orbital configurations and satellite specifications have been well covered in the media, but the critical ground segment deserves a closer look from the international carrier's perspective:

- How will these MSS ventures deliver international calls?
- How will they interconnect with the terrestrial wireline and wireless networks?
- What will carriers pay each other for handing off traffic?

To explore these questions, it is helpful to distinguish the basic architectures and call routing strategies to be employed by the three major MSS players (see Figure 1).

Figure 1. Network Architecture for Global MSS

Diagrams show a sample call completed between a handheld MSS subscriber in central Asia and a PSTN number in Paris.



	Market Entry	No. of Satellites	No. of Gateways
Iridium	1998	66	11
Globalstar	1999	48	65-75
ICO	2000	10	12

Note: Diagrams show the different network architectures of each system; actual gateway locations, terrestrial routing, and cellular coverage may vary.

Figure 2. Cheaper by the Minute

	Est. Usage (min/sub/mo)	Est. Capacity (billions of min/year)	Pre-Operational Costs ($ Millions)	Cost per min @ 1B min/year	Cost per min @ 3B min/year
Iridium	50	1.5	$4,361	$1.65	$0.62*
Globalstar	100	6.0	$2,539	$0.82	$0.40
ICO	100	3.0	$4,652	$0.64	$0.28

Note: System traffic of one billion minutes would require more than 830,000 subscribers using 100 minutes per month. All fixed costs are amortized over the life of each system's satellites: Iridium, 7 years; Globalstar, 7.5 years; ICO, 12 years. Source: Merrill Lynch & Co., Dresdner Kleinwort Benson.

*This figure is presented for comparative purposes only.

Iridium

Iridium relies upon a fleet of 66 low earth orbit (LEO) satellites. Inter-satellite links route a subscriber's call to the gateway nearest the called party, from which the call is routed via the Public Switched Telephone Network (PSTN) or the Public Land Mobile Telephone Network (PLMN) to its destination.

By transmitting calls from one satellite to another, Iridium needs fewer gateways on the ground and bypasses terrestrial telephone networks for much of the call route. The Iridium space segment charge ($1.00 - $1.75 per minute) covers the international charges to the gateway; the gateway operator is then responsible for entering into interconnection arrangements with such national or international carriers as it requires to terminate traffic. Settlement charges may apply, but typically only from the gateway country (not the originating country) to the termination country.

Globalstar

Globalstar plans to begin service in 1999 and will use LEO satellites to relay signals from its subscribers directly to the terrestrial gateway closest to the point of call termination. All Globalstar traffic will enter the PSTN or PLMN from the local gateway, which will be independently owned and operated. Gateway operators will be compensated by Globalstar and, in turn, will pay to terminate calls. The system is, in effect, wireless access to the PSTN. This network architecture requires that there be at least one gateway in view of each satellite at all times. Globalstar has, however, opted to install more gateways than the architecture requires in an effort to reduce the distance from the gateway to the call recipient and lower the cost of terminating the call.

ICO

ICO will field its middle earth orbit (MEO) system in 2000. Because of the higher orbit and consequently broader footprint of its satellites, ICO will require fewer gateways than Globalstar. However, where both Globalstar and Iridium hand off their traffic to independent gateway operators, losing control—and associated revenue—arising from the ground segment, ICO will own its gateways. ICO is also investing in its own terrestrial network, called ICONET. The company, thereby, hopes to limit interconnection payments to third parties. An ICO satellite will route subscriber traffic to the gateway that offers ICO the lowest-cost terrestrial route. For example, a call made by an ICO user in North Africa to a PSTN number in a neighboring country may be routed through Europe, where long distance operators offer ICO cheaper rates than the host African country.

PSTN/PLMN Interconnection Challenges

Despite efforts to distinguish their services, the target markets for these global mobile ventures are essentially the same: cellular extension services, basic mobile, aeronautical/maritime specialty services, and fixed site communications. For each of these markets, maintaining a seamless link between the space

Figure 3. First Generation MSS Operators

	Market Entry	Est. 8/98 Voice Units*	Usage (min/sub/mo)
Inmarsat	1991	17,000	90
AMSC	1995	11,000	<100
TMI	1996	1,550	80

* Voice units exclude maritime systems.

It is tempting to look to first-generation Geostationary Earth Orbit (GEO) MSS providers like Inmarsat, AMSC and TMI to estimate the demand for the services of the global mobile new entrants. However, significant differences in their target customers and applications could make the comparison misleading. Service of AMSC and TMI is limited to North America and the Caribbean, and over 98 percent of subscribers use the services purely for domestic purposes. Mobile data users also far outstrip the base of voice terminals, especially for AMSC. Inmarsat does provide global service but it has primarily targeted MSS users who need fixed or semi-fixed communications in remote areas like hinterland logging sites or offshore oil platforms. In contrast, smaller handheld telephones will allow new MSS carriers to target large numbers of mainstream subscribers for cellular extension and basic mobile services. Thus, despite the very small subscriber base of existing MSS operators, supporters of Iridium et al remain surprisingly bullish.

segment and terrestrial networks (wireless or wireline) is critical and requires that operators develop a globally dispersed set of alliances with carriers and manufacturers. Such alliances will prove vital not only for access to the PSTN/PLMN, but for marketing and securing regulatory authorizations.

There are challenges inherent in these relationships, however. MSS operators generally insist that their traffic will not cannibalize existing carrier revenue streams and will complement rather than bypass the lucrative international settlement streams which now benefit poorer countries with low teledensity—the very countries, of course, which are viewed as prime targets for new offerings. Even Iridium, whose satellites will capture additional revenues by switching subscribers' international traffic via inter-satellite links, contends that this is traffic that would otherwise have been absent from the terrestrial networks.

Potential for conflict exists, though, over the extent to which the traditional accounting rate regime will be applied to MSS traffic as it is commingled with conventional international message telephone services (IMTS) traffic. The Federal Communications Commission (FCC) has exempted MSS traffic from its International Settlements Policy, which requires the equal division of accounting rates, equal treatment of all U.S. carriers, and proportionate return of inbound U.S. traffic. This allows for private line routings on high-volume routes, bypassing conventional accounting rate settlements. But few other governments have yet resolved how global MSS traffic will be settled. In any case, most operators expect that despite their global footprint, more than half of their traffic will be domestic, which will dampen the impact on international settlements whatever they turn out to be. And gateway traffic delivered by Globalstar will generally be treated the same as any other international traffic stream (see Figure 4 for projected MSS international traffic).

Trans-border roaming presents another potential conflict affecting MSS international traffic. The promise of MSS lies in the ultimate flexibility to reach anyone from anywhere. The cellular model, however, suggests that some nations may refuse to allow the use of transceivers licensed in another country. To avoid the problem, the International Telecommunication Union (ITU) has sponsored a memorandum on free circulation of handsets, which many countries have accepted.

By pursuing partnerships with cellular providers, global mobile operators hope to take advantage of their access to an exploding pool of target customers—the number of worldwide cellular subscribers has grown to over 200 million and is projected to reach 450 million by 2000 and exceed one billion by 2006. In addition, operators hope to benefit from cellular's established billing and customer service resources. These obvious strategic benefits are mitigated by the nature of the cellular/MSS relationship. All three major operators have proposed dual- or tri-mode handheld transceivers, which will automatically check if the user is within their partner's cellular coverage or roaming area and use the less expensive cellular option if available. Any call that an MSS subscriber makes will only be carried on the space segment if the call originates outside the partner's cellular network or roaming area. Therefore the cellular operator has an incentive to build out its network as far as possible to retain as much traffic—and revenue—as possible.

How much will it cost?

The current mobile satellite services supported by Inmarsat charge $3-5 per minute for airtime. Retail prices for the national satellite telephone service offered by AMSC and TMI are priced at about $1.50 per minute. The next generation of

Figure 4. Market Forecasts for Second-Generation Global MSS, 1998-2002

	MSS Subscribers (millions)				
Mobile Satellite Service Operator	**1998**	**1999**	**2000**	**2001**	**2002**
Iridium	50	600	1,200	1,800	2,500
Globalstar	—	600	1,510	2,223	3,057
ACeS	—	110	283	403	578
ICO	—	—	588	1,241	2,006
Ellipso	—	—	442	715	1,147
Inmarsat and Regional GEOs	187	268	491	806	1,654
Total Subscribers	**237**	**1,578**	**4,514**	**7,188**	**10,942**
Est. MSS Annual Revenue ($m) (CAGR 46.6%)	1,134	3,398	7,123	9,735	13,324
Est. MSS Annual Usage (billions of min)	0.1	0.3	1.4	3.0	4.7
Total International Traffic (billions of min) (CAGR 13%)	92.4	104.5	118.0	133.4	150.7
MSS as % of Total International Traffic	0.03%	0.09%	0.37%	0.70%	0.97%

Note: MSS traffic is assumed to be 30 percent international. Subscribers include voice and data customers.
Source: Subscriber and revenue data adapted from Merrill Lynch; total international minutes: TeleGeography, Inc.

MSS will try to price service below $3.00 per minute to generate the rapid growth necessary to cover their higher fixed costs.

Iridium has announced that subscriber rates will be based on the average of the caller's alternatives in that area—such as hotel rates and payphones—plus an Iridium "mobility premium" of 25 to 30 percent; calls will total anywhere between $2 and $7 per minute. As noted earlier, Iridium retains traffic on its inter-satellite network for much of the call route. The company plans to maximize this competitive advantage over its early competitors by targeting subscribers who make high volumes of international calls.

It is estimated that Globalstar and ICO will charge about $0.85-$1.50 per minute excluding international long distance charges. It is ICO, however, which may provide the lowest overall price to customers. ICO's space segment cost is marginally higher than that of Globalstar but ICO should be able to achieve substantial cost savings by taking advantage of competing interconnect rates at different gateways on the ICONET. According to a Dresdner Kleinwort Benson report, this savings could amount to as much as 50 percent relative to the full PSTN rate assumed for Globalstar.

Demand for Global Mobile

MSS operators have identified the importance of quickly loading their capacity given the limited lifetimes of their satellites and the "use it or lose it" nature of their minutes for sale. To do this, they have chosen to rely heavily on their own investor base for partnerships that will provide easy access to existing mobile telephone customers. MSS operators must balance the push for early revenues from high prices in "captive" environments with the need to build market share for next generation systems which will be priced competitively with terrestrial cellular.

Second generation satellites with increased broadband capacity capable of supporting mobile data applications are planned for 2003. Operators with existing narrowband voice services may have an advantage in marketing the new broadband capabilities of their next generation satellites over those who do not. In addition, the next generation satellites will offer operators the opportunity to broaden their target customer base by accommodating the bandwidth-intensive Internet applications of an increasingly mobile workforce.

For Further Reading

Rob Frieden, "That Pesky Last Mile." *Telecommunications Policy*, Vol. 22 No. 2, March 1998.

Merrill Lynch, Pierece, Fenner, & Smith Inc., *Global Satellite Marketplace 98*, April 1998.

Dresdner Kleinwort Benson, *Mobile Satellite Services*, March 1998.

For more information, visit the providers' web sites:

AMSC (http://www.AmMobile.com)
Globalstar (http://www.globalstar.com)
ICO (http://www.ico.com)
Inmarsat (http://www.inmarsat.org)
Iridium (http://www.iridium.com)
TMI (http://www.tmi.ca)

The Internet

The Global Internet: A Primer

by Kenneth Neil Cukier, CommunicationsWeek International

I. Introduction

In October 1997, when the elite of France's high-tech industries held a special meeting at the *Senat* to discuss "the information society," the chief executive of France Télécom (FT), Michel Bon, downplayed the importance of the Internet. He argued that the country's proprietary videotext system, Minitel, remained a success. But four months later, FT began transitioning Minitel content providers to the Web and by Spring 1998, the carrier was touting its Internet telephony research. Then, in September 1998, Deutsche Telekom and FT announced a joint billion dollar network based on Internet Protocol (IP). It was followed in October by a joint venture with IBM to develop new screen-based telephones for Internet access.

Everyone knows that the Internet will change the business of carrying telecom traffic around the world. And several other major carriers, such as AT&T, MCI WorldCom, Cable & Wireless (C&W), and Sprint, have announced plans to make IP friendly networks the core of their 21st century business. These carriers, some a century old, are reacting to upstarts with space-age names, such as Qwest and Level 3, who believe that Internet technology provides a low cost means of building a global communications network. And build they will, eyeing data communications—not voice—as the majority of their traffic and source of future revenue (see "International Circuit Usage by U.S. Carriers" on page 98).

Yet to most international carriers, the economics of the Internet remain uncertain, more threat than promise. The mechanics of the Internet also seem to be in constant flux—who owns what and where? That makes deciding what to build and what to buy, who to connect with and on what terms, more like gambling than network planning. The failure to gamble on these decisions, however, just could cost carriers their business.

This essay attempts to provide carriers with some of the information required to make their business decisions less like a roulette game. It maps the Internet's current reach, sketches how it is changing, and where future opportunities—and dangers—lie. Like the Net itself, it scraps national borders and instead takes a global view.

It provides possible answers to such questions as: What is driving demand for Internet bandwidth? What are the major costs for carriers building IP networks? And, how will new Internet services affect the Net's physical topography and traffic flows?

It also challenges a number of assumptions. For example, new technologies—e.g., Internet telephony—rather than being a major bandwidth driver may instead have only a marginal effect. And caching technologies, seen by some as the band-

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width savior of Internet service providers (ISPs) outside the U.S., may only bring ephemeral savings.

When all is said and done, this essay remains a primer. The Internet's only certainty is constant change. We start with the basic architecture.

II. How Is the Internet Structured?

The answer today is fairly obvious: the Internet is U.S.-centric. Viewed from afar, the Internet's basic transmission facilities form a big star centered in the U.S. with spokes of light reaching around the world—some broad like the beams of a search light, others laser thin.

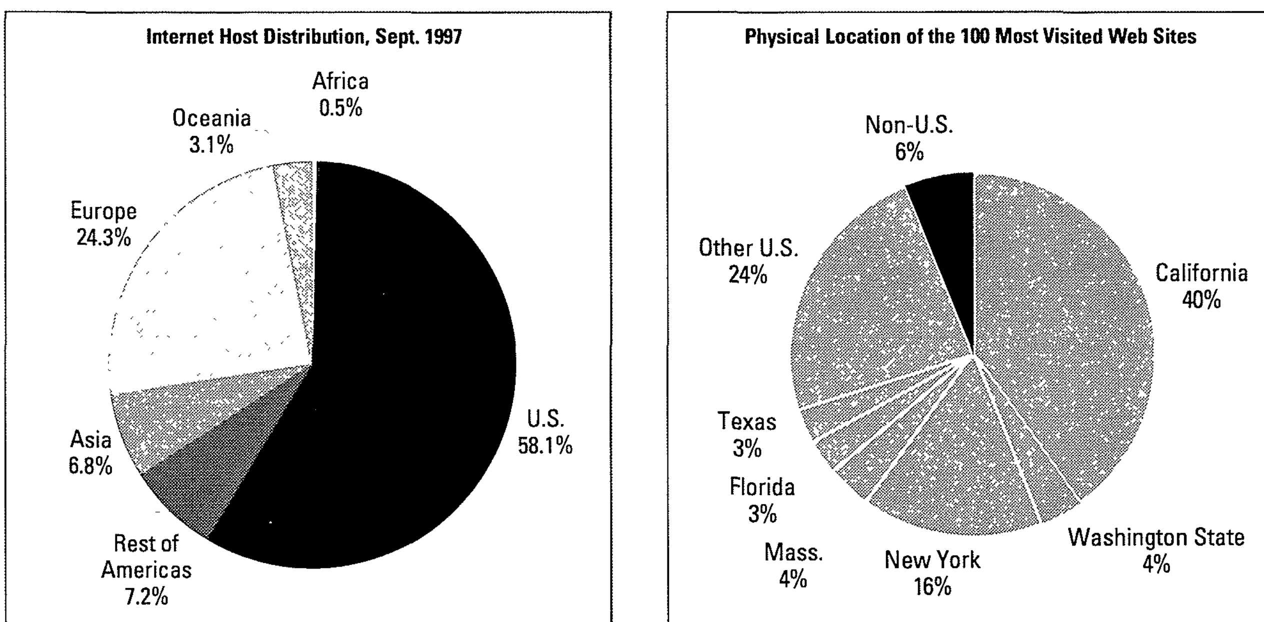
There are many reasons for the architecture, including the U.S. head-start in building infrastructure, the location of Internet content, the artificially high cost of cross-border capacity outside the U.S., and customer demand for Internet services. Yet, this topology is in many ways unplanned, a reflection of the Internet's U.S. origins and its embryonic commercial structure, rather than engineering efficiency. But whether built by accident or design, the Internet's architecture matters greatly. It affects the way traffic is routed, how today's infrastructure is utilized, and the scale and location of the bandwidth required tomorrow.

Let us look at history first. When the Internet began, it was a national U.S. network (see Figure 2). Later, data networking research institutions outside the U.S. enthusiastically plugged in, leasing international circuits at their own cost to do so. In fact, non-U.S. networks paid for both ends of the circuit, a precedent that still remains and has since escalated to a diplomatic controversy (see Figure 15). At the time, European and Asian network operators didn't complain about paying the full cost because the U.S. backbone was "the Internet." And the data flow was almost entirely one-way—from the U.S. to overseas locations. American users would only rarely seek to connect to non-U.S. networks.

Traffic patterns are now beginning to change. More U.S. Internet users are seeking off-shore content and intra-regional European and Asian traffic is growing, as are facilities there. Yet the Internet's old architecture remains in place, largely because half of Internet users, as well as 58 percent of hosts, are still based in the U.S. and the U.S. is the source of the world's most popular Internet content (see Figure 1).

Traffic balances also tell the story. A little over half of Internet traffic in Europe goes to the U.S., according to two ISPs, Amsterdam-based EUnet and Stockholm's Telia. In Asia, the figure is 70 percent, according to both Telstra in Australia and Inet Inc. in Korea. That provides a powerful incentive for non-U.S. ISPs to continue buying the international bandwidth to get to the U.S. while at the same time seeking ways to cut associated costs. While users pay for this bandwidth indirectly as

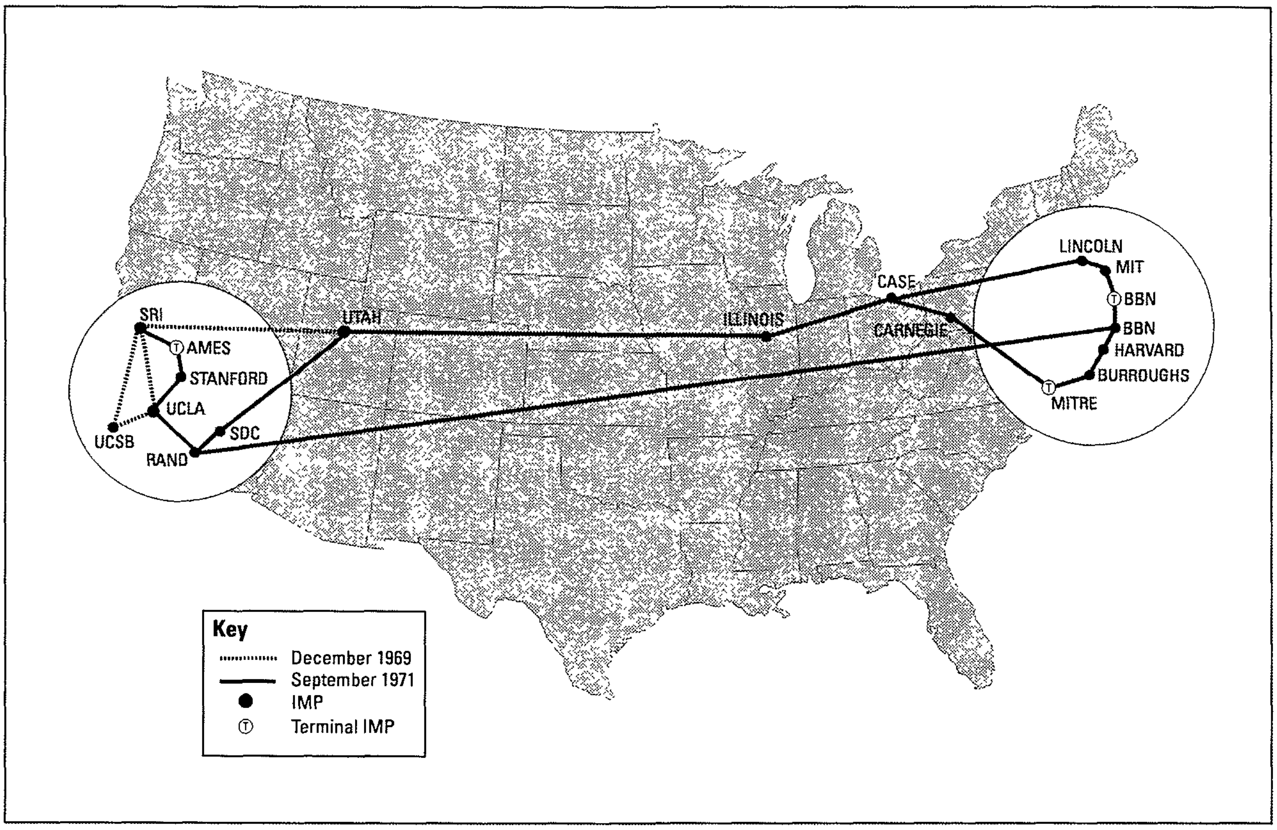
Figure 1. Geographic Distribution of Internet Hosts and Content



Note: Data for host distribution chart distributes the generic Top Level Domain (gTLD) registrations between countries according to registrations in September 1997. Data for top sites chart is based primarily on proxy server logs from strategic locations on the Internet backbone, as well as on monitoring usage pattern of over 100,000 users (60% U.S., 40% non-U.S.).

Source: Host chart adapted by the International Telecommunication Union from data originating with Network Wizards (www.nw.com), the OECD, and RIPE (www.ripe.net). Top sites chart adapted from Web21 (www.web21.com) data. © TeleGeography, Inc. 1998

Figure 2. The Internet in 1971—Across the U.S. at 56 Kbps



Note: The map above reflects data reported in BBN's "Quarterly Technical Reports" delivered to ARPA under contract between 1969 and 1971. An Interface Message Processor, or IMP, was a node computer designed to handle the message-sending tasks for several host computers connected in a local network.

Source: Adapted from maps drawn by Alex McKenzie, in Peter Salus' *Casting the Net*, Addison-Wesley Publishing Company, 1995.

Map design by TeleGeography, Inc. © 1998

part of the monthly subscription fee or leased line cost, it is the service provider who pays up-front.

The status quo is also supported by a second economic rationale: ISPs need to interconnect with one another to furnish connectivity everywhere. It would be impractical for a German ISP to have direct links with every provider in Europe, as well as the Middle East and Latin America. Networks outside the U.S. thus tend to make the U.S. their central switching office (see Figures 4-7). It's more economical to lease a single line to the U.S. rather than multiple smaller-capacity lines to other foreign points to connect with other networks.

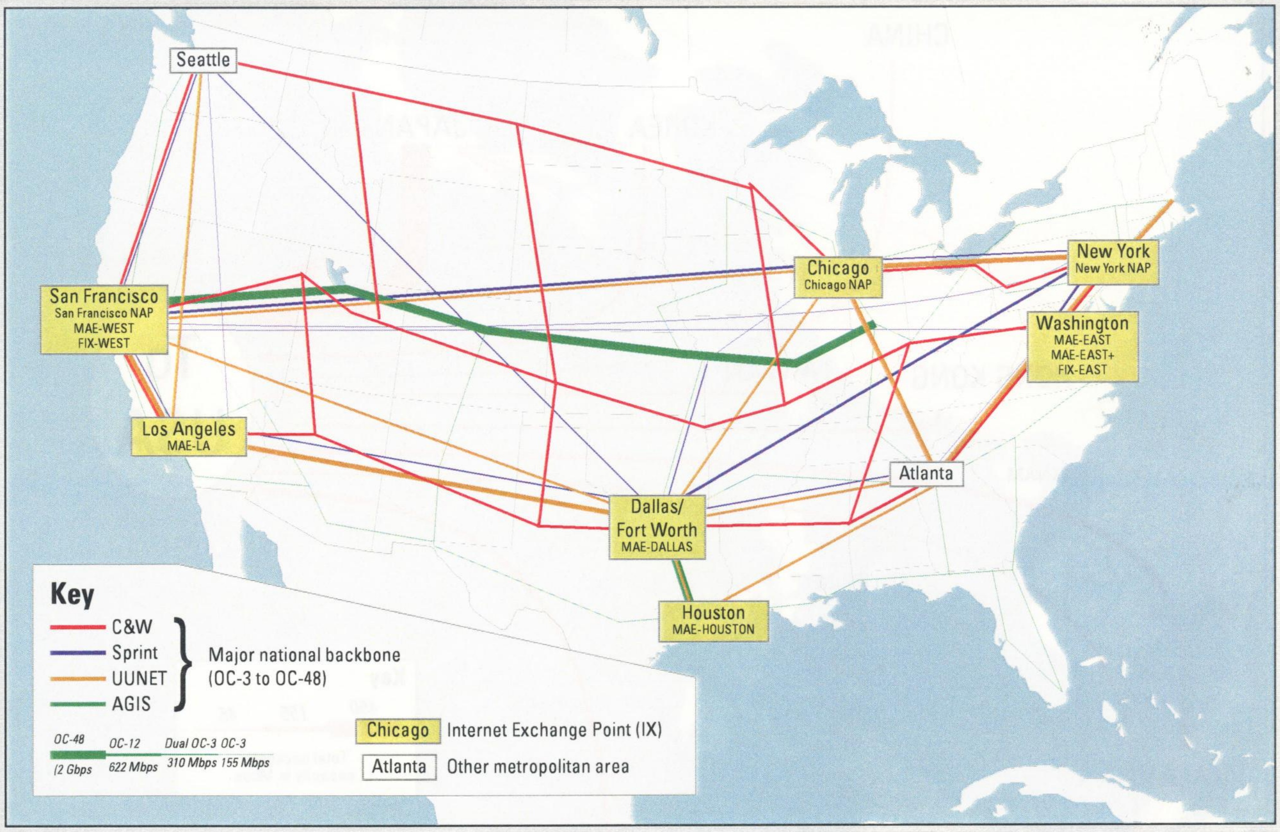
The central role of U.S. networks in switching the world's Internet traffic can be highlighted by drawing a series of "traceroutes," a networking tracking procedure to identify the end-to-end path taken by any given Internet packet. In a recent experiment, packets from Hong Kong to Japan transited Silicon Valley in California, and London to Rome traffic was routed via New York (see Figure 8).

This may seem illogical. Shouldn't traffic between nearby countries be sent by a more direct path? Perhaps. But making sense of Internet traffic patterns is a bit like mastering quantum physics—the longer the route the shorter the time it may take to arrive.

There is a major engineering reason, nonetheless, to explain the Internet's current architecture. It has to do with the way the addressing system works. Each computer on the Internet is assigned a unique address or domain name, and to send or receive any information to or from that address, a query is often first sent to the Internet's electronic directory system or root name servers. Of the 13 root name servers, only three are deployed outside the U.S.—in Tokyo, London, and Stockholm (see Figure 10). If a foreign Internet service provider does not have a direct connection to any of these three cities, chances are that it will send an address query to the U.S. to access the vital domain name system (DNS) data needed to route the user's traffic. It's a serious problem.

One request for Web access generates two DNS transactions; one from the customer (to find the server), and one from the server (the reverse look up). Each request may generate a stream of packets. Measured at one California-based exchange

Figure 3. Major U.S. Internet Backbones in 1998—155 Mbps to 2 Gbps



This map shows portions of the Internet backbones of the four leading American backbone providers. According to *Boardwatch Magazine*, these four companies account for at least two-thirds of the backbone connections in the country.

Many backbone providers are reluctant to release detailed maps or diagrams of their networks, so it is impossible to show the precise routes or capacities here. Nevetheless, it is clear that a handful of metropolitan areas: New York/Philadelphia; Washington, DC; Atlanta; Chicago; Dallas/Fort Worth; Los Angeles; San Francisco/San Jose; and Seattle—remain the critical nodes, enjoying the fastest connections and switching the most traffic, including international traffic.

Source: *Boardwatch Magazine Directory of Internet Service Providers* (www.boardwatch.com) and company reports.

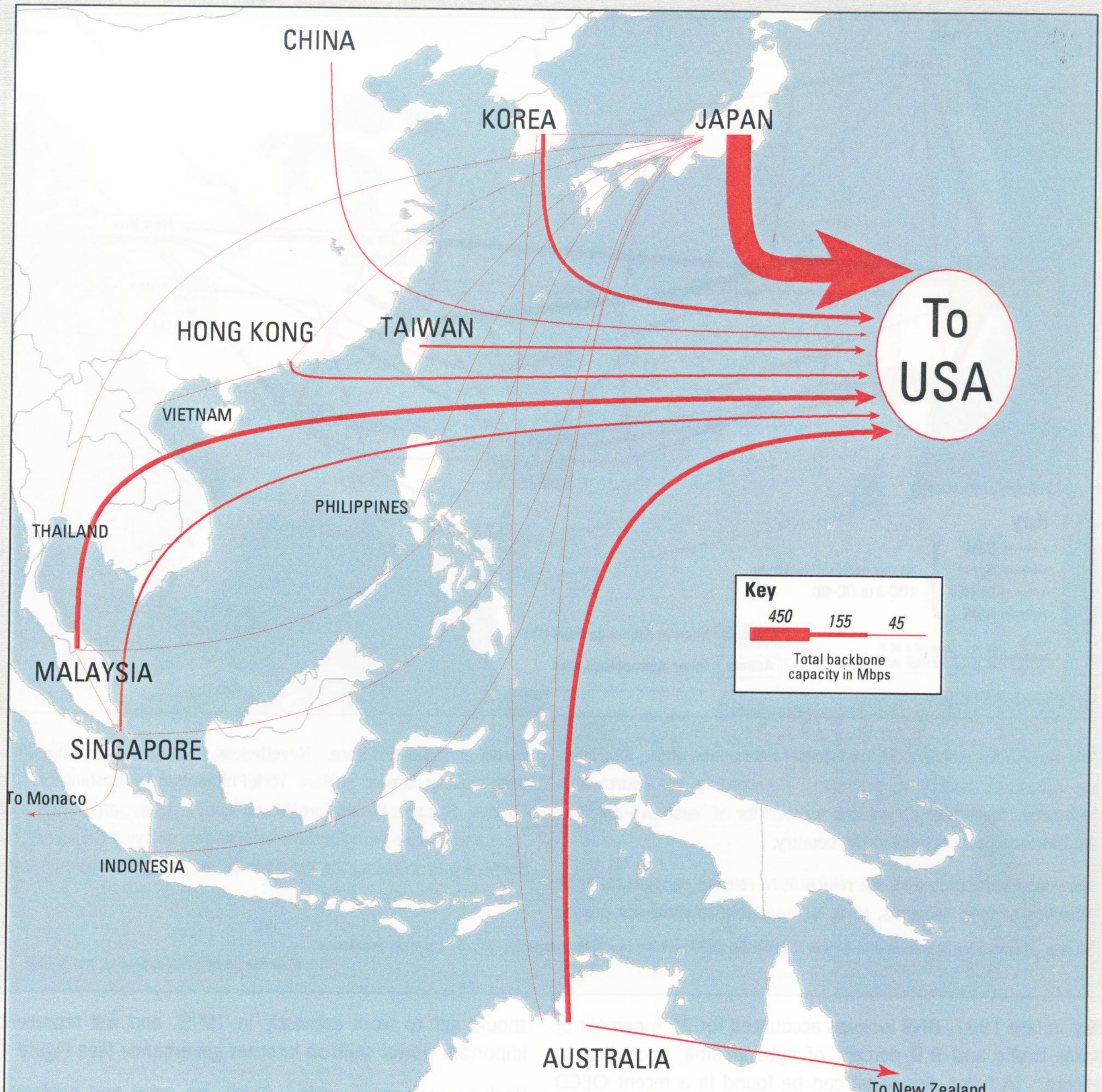
Map design by TeleGeography, Inc. © 1998

point in late 1997, DNS lookups accounted for 24.4 percent of packet traffic and 9.9 percent of byte volume, according to Bellcore. (A fuller discussion can be found in a recent OECD paper, "Internet Traffic Exchange: Developments and Policy.") While the statistic sounds suspiciously high, and may not be representative of the global Internet, most observers agree that DNS traffic is a significant proportion of traffic. Hence, according to some engineers, the current U.S.-dominated root server deployment is not only a symptom of the network's centricity, but also partially a cause.

Will it change? Probably. The coordination of root servers, as well as domain names, IP addresses, and protocol development will soon be overseen by a new nonprofit organization with a board of directors reflecting U.S. and non-U.S. interests. It should get to work earnestly in 1999, and will represent an important power shift on Internet governance (see Figure 11).

Back to economics again. There are price and performance incentives to hub traffic via the U.S. The lack of telecom competition in Europe and Asia has historically meant that users in those regions paid more for telecom circuits than in the U.S. We've heard this before. But the magnitude of the problem is startling: A 300 kilometer circuit at two megabits per second (Mbps) in Europe costs up to four times more than the equivalent capacity in the U.S. Try and go across a border with the same speed line and the price differential is 17 times higher. This price gap is also growing. In June 1998, the Brussels-based European Internet Service Providers Association (EuroISPA) held a conference for European Commission (EC) officials to underscore the high costs for European long distance

Figure 4. Asian Internet Backbone Connectivity



Trans-Pacific Backbone Capacity (Mbps)

Japan	830	Australia	90	Taiwan	90
Malaysia	180	Hong Kong	90	China	45
Korea	135	Singapore	90	TOTAL	1,550

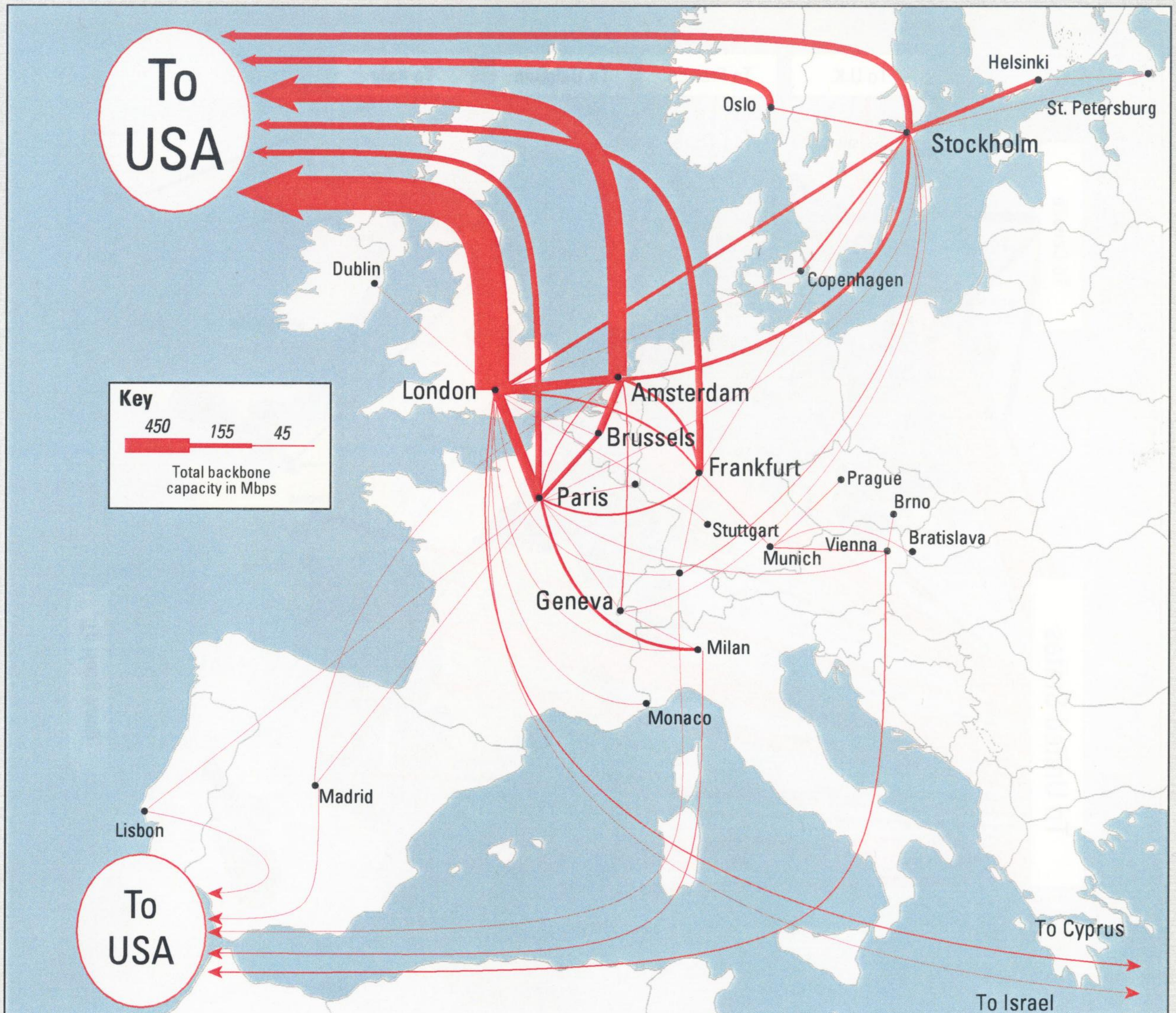
Note: Table and map reflect Sept. 98 survey of Asian ISPs with backbone connections above 10 Mbps.
Source: Barry Raveendran Greene, Singapore; intra-Asian links from company data; OECD.

Map design by TeleGeography, Inc. © 1998

circuits and thus the pressure to transit Internet traffic via the U.S. A circuit from suburbs outside of Washington, D.C., where many U.S. Internet backbones meet, to Paris or London or Stockholm, costs approximately $30,000 a month per megabit of capacity, said EuroISPA. By comparison, a direct line from any of these European cities to another cost roughly $35,000. By the next month, the presentation was out of date, as some London-based members of EuroISPA were quoted trans-Atlantic prices of $6,500 per megabit.

Part of the reason for this is the power which Europe's incumbent operators have over the supply of telecom infrastructure,

Figure 5. European Internet Backbone Connectivity



Trans-Atlantic Backbone Capacity (Mbps)

	9/98	12/98 proj.		9/98	12/98 proj.		9/98	12/98 proj.
United Kingdom	1,063	1,514	Italy	34	68	Norway	4	8
Sweden	576	776	Russia (not shown)	34	45	Other*	100	150
Netherlands	250	600	Spain	16	45	TOTAL	2,457	3,740
France/Monaco	200	245	Poland (not shown)	16	34			
Germany	140	215	Switzerland	12	24			
Austria	38	49	Portugal	8	12			

*Other countries include: Finland, Belgium, Hungary, Croatia, Israel, S. Africa, Macedonia, Yugoslavia, Slovenia, Romania, and Cyprus.

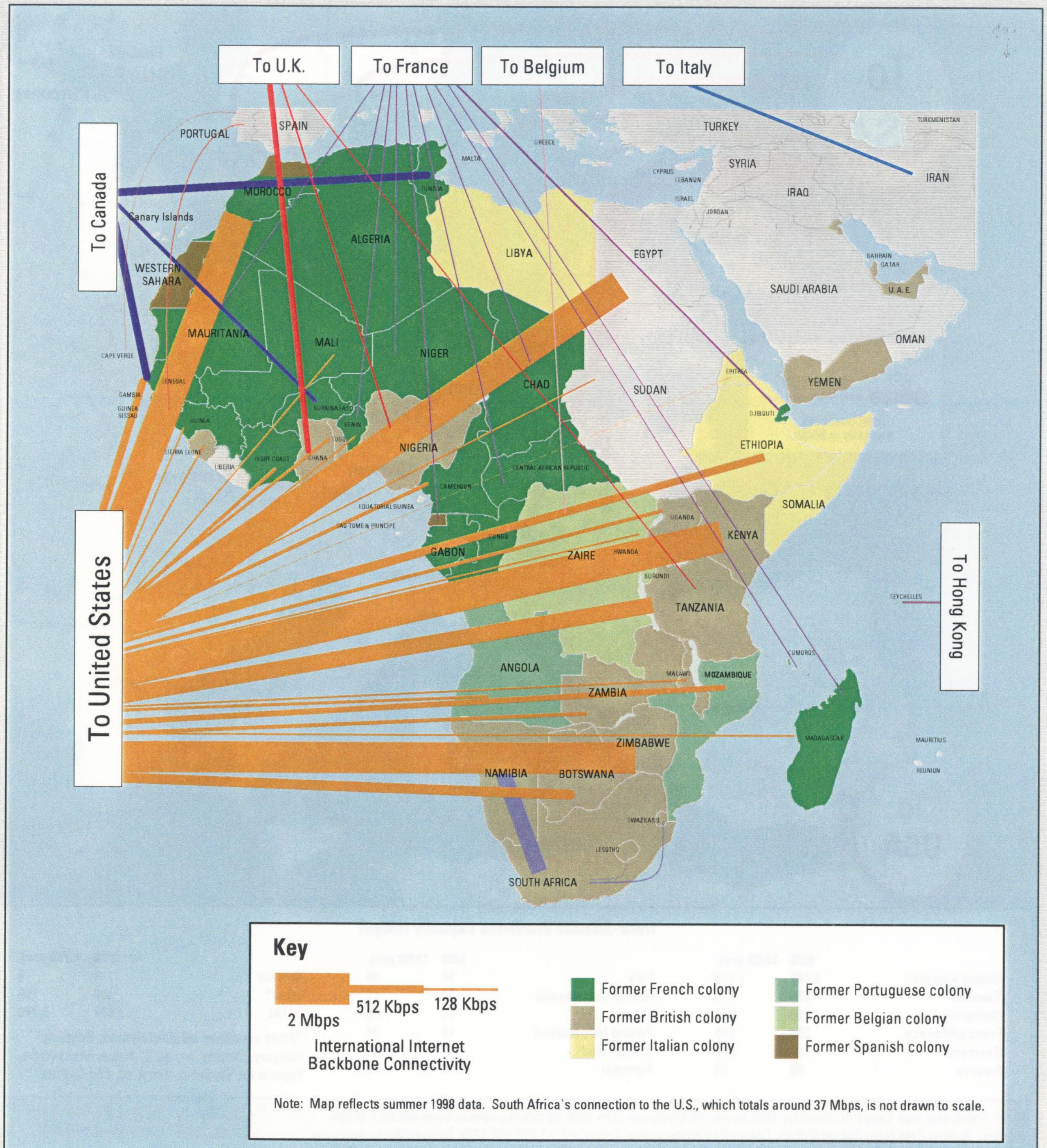
Note: Table and map based on Summer 1998 survey of European ISPs with backbone connections above 2 Mbps.
Source: Europe data from Robert Cohen, Cohen Communications Group, tel: +1 212 986 7720, bcohen@mail.bway.net.
Israel figures from Sharon Chan, California State University.

Map design by TeleGeography, Inc. © 1998

although this is slowly decreasing as alternative operators gain momentum. As well, new trans-Atlantic capacity has come on-line more quickly than cross-border European capacity. And more capacity usually means better performance.

Just as the celebrated book *The Death of Distance*, by Frances Cairncross, made the point for telecom prices, Internet performance is frequently distance-insensitive too. In Asia, it is not uncommon for Internet traffic to be quicker if it's routed via California rather than over a direct link. In Singapore, for example, the round trip time to Phnom Penh is 1,100 milliseconds but to Los Angeles a scant 400 milliseconds (see Figure 13). Where bandwidth is available and the line speed is constant, such as in the United States, distance again becomes a factor (although minor). For example, statistics from C&W's

Figure 6. African Internet Backbone Connectivity



Source: Mike Jensen (http://demiurge.wn.apc.org/africa/index.html)

Map design by TeleGeography, Inc. © 1998

real-time Traffic Report show cross-country delay rates of around 70 milliseconds, roughly three times longer than cases where traffic travels within the same U.S. region (see Figure 14).

There is a self-sustaining, some say insidious, industry dynamic at play here. Historically, the global Internet was built atop excess bandwidth available on existing international cables owned by major telecom carriers. Most carriers planned to fill these cables over ten years or so given that voice traffic growth averaged but 13 percent to 15 percent annually. Hence, in the short run, leasing capacity for new Internet services seemed like found money. Yet, because U.S. carriers picked up or landed over 25 percent of the world's traffic, they tended to build new cable capacity faster than other carriers. They therefore had more available capacity to sell to or from the U.S. and at better rates. This, of course, led more and more off-shore ISPs to acquire capacity to the U.S. for Internet services. This in turn led to yet more U.S. carrier cables and still better prices.

And that, in somewhat simplified fashion, is how the star topology of the Internet was born and why it still glows so brightly.

III. Who Pays For It?

"The answer is either really long or really short depending on what you're trying to say," says Scott Bradner, a leading Internet expert at Harvard University. The Internet does not have a set economic model, so there's no standard way network providers are remunerated for the resources they expend. End of story.

The longer answer is more complicated, precisely because the Internet's provisioning model is not static. In contrast to the public switched telephone network (PSTN), a typical Internet transmission may involve five or ten different networks rather than two or three. And the connectionless transmission technology on which the Internet is based also means that the role of each of these networks cannot easily be predicted in advance. Smaller networks increasingly must pay larger networks by the speed of the leased line for connectivity. The larger networks exchange traffic without charge under a peering, sender-keep-all basis (see Figure 15). They seek to recoup their network costs primarily from users and their downstream ISP customers—not from other networks, as in the telephony world. To understand why the Internet's schemes for funding international networks are so different from the traffic-based settlement arrangements over the PSTN, a brief digression on technology is useful.

The Connectionless Network

Traditional phone networks, built for voice communications, switch or assign a dedicated end-to-end circuit for every call. That is bandwidth intensive and also reliable: every user gets their own circuit. Minute-by-minute and circuit-by-circuit payment methods consequently developed to compensate network providers.

The Internet involves a radical departure: It is based on packet-switching. There is no dedicated connection. Any communication is converted to a digital format, broken up into chunks of data called packets, given an address, and sent out into the network. What's most significant is that the path the packets take is never specified—the network itself determines the route and speed. The packets only know their destination address and how to be reassembled at the end of their trip.

To some, it sounded like a crazy idea when it was first proposed in the 1960s by Donald Davies and Paul Baran and later refined in the early 1970s by pioneers like Robert Kahn and Vint Cerf, but it worked. (For an engaging history of the period, see Peter Salus' book, *Casting The Net.*) Since the early principles of Transmission Control Protocol/Internet Protocol (TCP/IP) were advanced by Kahn and Cerf, packet delivery has not changed much. Routers along the way still store and forward packets. After forwarding, if the first router doesn't receive acknowledgment that the packet has arrived safely at the next hop, it resends the packet. The protocol self-adjusts to achieve the best possible service; routers send packets as fast as they can with the least error rate. And in socialistic fashion, all packets are treated equally, on a best-effort basis.

It wasn't—and still isn't—very reliable. If there's a lot of congestion on a single route, packets may be continued on page 122

Figure 7. Backbone Connectivity for Latin America and the Middle East

Latin America

Country	Connection Via	Bandwidth
Argentina	U.S.	70 Mbps
Belize	U.S.	125 Kbps
Brazil	U.S.	106 Mbps
	Argentina	128 Kbps
	Uruguay	128 Kbps
Caribbean	U.S.	1.5-2 Mbps
Colombia	U.S.	12 Mbps
Costa Rica	U.S.	4 Mbps
Chile	U.S.	22 Mbps
Dominican Republic	U.S.	45 Mbps
Ecuador	U.S.	2 Mbps
Guatemala	U.S.	4 Mbps
Guadeloupe	U.S.	1.5 Mbps
Honduras	U.S.	64 Kbps
Nicaragua	U.S.	64 Kbps
Panama	U.S.	20 Mbps
Paraguay	U.S.	10 Mbps
Peru	U.S.	12 Mbps
Puerto Rico	U.S.	125 Mbps
Venezuela	U.S.	20 Mbps

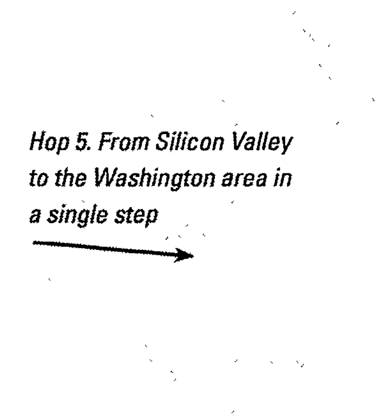
Middle East

Country	Connection Via	Bandwidth
Egypt	U.S.	3.5 Mbps
	France	1.5 Mbps
Iran (Tehran)	Austria	2 Mbps
Israel	U.S.	26 Mbps
	U.K.	2 Mbps
Jordan	n.a.	512 Kbps
Kuwait	Philippines	8 Mbps
Lebanon	U.S.	500 Kbps
	Italy	500 Kbps
Libya	n.a.	2 Mbps
Morocco	U.S.	500 Kbps
	Italy	2 Mbps
	France	500 Kbps
Turkey	U.S.	70 Mbps
United Arab Emirates	U.S.	45 Mbps

Note: Data generally current to September 1998.
Source: TeleGeography research, DTT Consulting, Spotbeam Communications, The Mosaic Group, and Sharon Chan.

Figure 8. Internet Traceroute Maps, July 1998

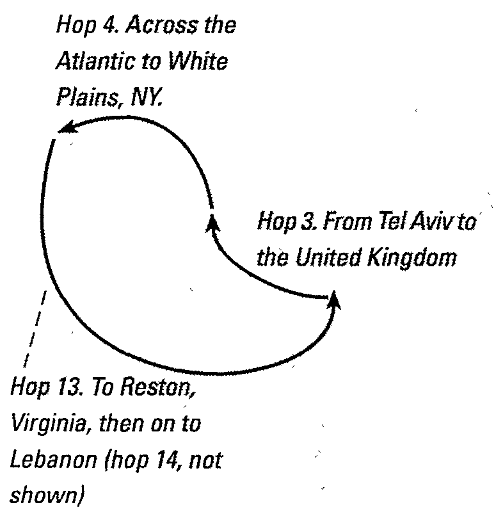
From California to Washington, DC, direct




```
To rs7 loc gov (140 147 248 7)  1-30 hops, 38 byte packets

 1  gate-96 main sjc above net (207 126 96 189) 0 917/2 72/5 30 (1 10) ms
 2  paix-main-oc3 pao above net (207 126 96 122) 1 97/4 64/9 2 (2 65) ms
 3  paix dra net (198 32 176 40) 2 24/4 16/8 99 (1 85) ms
 4  SantaClara1-s6-0 dra net (150 147 74 18) 3 34/5 18/7 54 (1 13) ms
 5  MaeEasta25.dra.net (150 147 25 17) 67 7/77 7/93 0 (9 21) ms
 6  LibOfCongress-T3 dra net (150 147 46 34) 73 4/83 3/95 6 (8 83) ms
```

From Israel to Lebanon via New York and Virginia




```
To zeina aub edu lb (193 188 128 14), 30 hops max, 40 byte packets

 1  server-cisco tlv ibm net il (192 115 72 161)  2 ms  2 ms  1 ms
 2  fe7507 tlv ibm net il (192 116 177 1)  3 ms  3 ms  3 ms
 3  port1br1.pt.uk.ibm.net (152 158 16 1)  86 ms  76 ms  81 ms
 4  165.87.220.34 (165 87 220 34)  166 ms  172 ms  164 ms
 5  165 87 28 113 (165 87 28 113)  162 ms  166 ms  172 ms
 6  165 87 230 81 (165 87 230 81)  198 ms  198 ms  207 ms
 7  165 87 29 36 (165 87 29 36)  208 ms  181 ms  189 ms
 8  165 87 97 225 (165 87 97 225)  186 ms  183 ms  195 ms
 9  sl-bb11-rly-0-1 sprintlink net (144 232 0 33)  180 ms  199 ms  202 ms
10  sl-bb10-pen-7-0 sprintlink net (144 232 8 154)  182 ms  185 ms  190 ms
11  sl-bb1-pen-8-0-0 sprintlink net (144 232 5 10)  206 ms  190 ms  230 ms
12  gip-penn-4-fddi0-0 gip net (204 59 136 200)  188 ms  190 ms  197 ms
13  204.59.194.18 (204 59 194 18)  543 ms *  432 ms
```

Source: Keynote Systems, Inc

Map design by TeleGeography, Inc. © 1998

Traceroute software, originally written by Van Jacobson of Lawrence Berkeley National Laboratory, charts the path of a data packet between two points on the Internet. Launch the packet into the Net, and at every hop—a router, gateway, or an exchange point—the software records its location and the time it took to get there.

In the first example shown here, the traffic takes the most direct path. After its trans-continental journey from the West Coast of the U.S., the traffic is passed onto another network in Virginia, at the MAE-East exchange point.

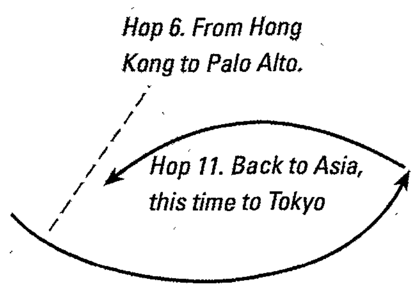
However, in the second example, when a user in Israel tries to send e-mail to Lebanon, the traffic first passes though the U.K., then goes to New York, down to Virginia, and finally back across the Atlantic to Lebanon. This is most likely because IBM and Sprint, the respective carriers, agreed to interconnect at a U.S. exchange point, but not in the Middle East, where no international interexchange points exist.

A similar situation occurs in Asia. In the third example, traffic between Hong Kong and Japan transits California. Hong Kong Telecom sends the traffic to Palo Alto, California where the carrier

continued on page 121

Figure 8. Internet Traceroute Maps , July 1998 (continued)

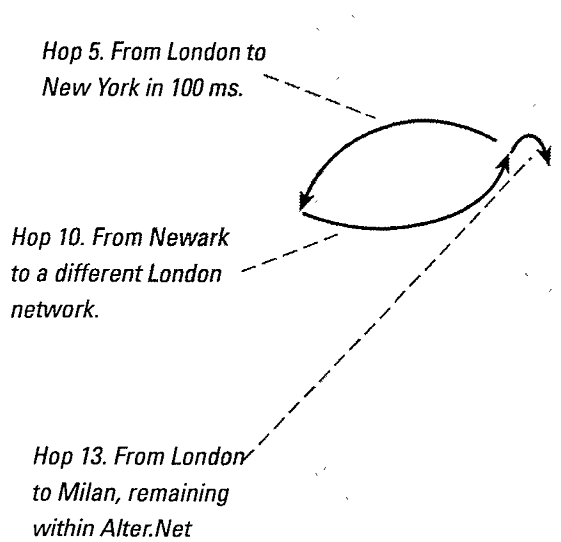
From Hong Kong to Japan via Silicon Valley, California




```
To jpsun231 oracle co jp (202 211 136 41), 30 hops max, 40 byte packets

 1 web-hk-rtr (203 223 0 1) 1 267 ms 0 814 ms 0 725 ms
 2 s4-7a tmh08 hkt net (202 84 224 153) 102 671 ms 285 039 ms 475 136 ms
 3 a3-0 yck06 hkt net (205 252 130 82) 297 266 ms 337 731 ms 265 526 ms
 4 f5-0 hk-T3 hkt net (205 252 130 207) 297 282 ms 313 282 ms 305 571 ms
 5 hssi8-0-0 paix-T3 hkt net (202 84 128 254) 479 666 ms 234 939 ms 213 439 ms
 6 915.Hssi5-0.GW1.PA01.ALTER.NET (157 130 193 133) 188.524 ms 188 033 ms
 7 119 ATM3-0 XR1 SCL1 ALTER NET (146 188 144 78) 188 976 ms 306 485 ms 189 928 ms
 8 195 ATM9-0-0 GW3 SF01 ALTER NET (146 188 145 237)190 519 ms191 704 ms 190 722 ms
 9 att-sfo-gw customer ALTER NET (157 130 193 62) 191 716 ms 312 471 ms 374 858 ms
10 205 174 74 250 (205 174 74 250) 395 630 ms 294 089 ms 322 915 ms
11 hsd-gate0-fddi3-2.Tokyo.InterSpin.NET (165 76 0 7)547 064 ms 304 172 ms 392 646 ms
12 202 211 136 98 (202 211 136 98) 533 020 ms 624 000 ms 589 522 ms
13 jpsun231 oracle co jp (202 211 136 41) 681 701 ms 714 300 ms 764 475 ms
```

From London to the Vatican via New York




```
To www vatican va (194 91 153 247), 30 hops max, 40 byte packets

 1 ensign-1 frontier-networks co uk (195 200 1 1) 3 ms 3 ms 3 ms
 2 central-1 frontier-networks co uk (195 200 12 3) 6 ms 4 ms 7 ms
 3 bgp-1i frontier-networks co uk (195 200 12 13) 7 ms 17 ms 7 ms
 4 atm-1 frontier-networks co uk (195 200 12 37) 7 ms 7 ms 8 ms
 5 atm0-0-1.nyc1gw1.us.insnet.net (207 181 1 65) 121 ms 112 ms 96 ms
 6 Hssi2-0-0 GW2 NYC4 ALTER NET (157 130 5 229) 117 ms 101 ms 99 ms
 7 132 ATM2-0 XR1 NYC4 ALTER NET (146 188 178 134) 98 ms 101 ms 107 ms
 8 189 ATM3-0-0 XR1 EWR1 ALTER.NET (146 188 178 54) 118 ms 104 ms 123 ms
 9 193 ATM11-0-0 CR2 EWR1 ALTER NET (146 188 176 25) 102 ms 103 ms 98 ms
10 105.ATM1-0-0.BR2.LND1.Alter.Net (137 39 30 77) 200 ms 246 ms 215 ms
11 432 ATM6-0-0 CR1 LND1 Alter Net (146 188 5 25) 199 ms 198 ms 218 ms
12 267 ATM6-0-0 CR1 LND2 Alter Net (146 188 4 246) 197 ms 201 ms 262 ms
13 215.Hssi6-0.CR1.MLN2.Alter.Net (146 188 3 34) 278 ms 234 ms 234 ms
14 Fddi0-0 GW1 MLN2 Alter Net (146 188 31 35) 237 ms 239 ms 235 ms
15 ITnet-gw customer ALTER NET (146 188 32 50) 235 ms 242 ms 241 ms
16 Ethernet0 r5 mi01 IT net (151 1 64 250) 239 ms 273 ms 248 ms
17 fi01-milano IT net (151 1 254 61) 290 ms 248 ms 273 ms
18 roma-fi01 IT net (151 1 254 41) 258 ms 312 ms 257 ms
19 * roma3 IT net (151 1 3 252) 265 ms 288 ms
20 vatican-gw IT net (151 1 203 26) 318 ms 271 ms 326 ms
21 dns1 vatican va (194 91 153 5) 265 ms 292 ms 298 ms
22 dns1 vatican va (194 91 153 5) 265 ms !H 264 ms !H 278 ms !H
```

Source: Keynote Systems, Inc.

Map design by TeleGeography, Inc © 1998

interconnects with UUNet. As the upstream ISP, UUNet exchanges the traffic with the recipient's upstream ISP, and the traffic is then sent back to Asia.

In the last example, a user on one network in London connecting to the ISP hosting the Vatican Web site in Rome has a diabolical ordeal. Since the two downstream networks do not interconnect with one another, the traffic is handled by the upstream ISPs. The first network hauls the traffic to New York, where it is picked up by UUNet and, ironically, carried back to London! From there, UUNet routes it to Milan, where the Vatican's ISP faithfully accepts the traffic.

To be sure, not all traffic between these locations follow the same routes: It depends on the peering relationships of different ISPs. Also, on a single network, the path itself dynamically changes to account for network conditions, such as congestion. Nevertheless, the traceroutes shown here, all recorded in July 1998, are illustrative of the general U.S.-centric pattern of the Internet's traffic flow.

To learn more about traceroutes, visit http://www.cybergeography.com/atlas/routes.html. Or, to run traceroutes from many different locations, see *Boardwatch* magazine's compilation of traceroute servers at http://boardwatch.internet.com/traceroute.html.

dropped; not such a good thing for time-sensitive traffic. But the original designers cleverly built in robustness. To be certain traffic took the most efficient path, routers would dynamically update information about congestion on the network, querying devices at every subsequent hop. So if a backhoe dug up a cable—or an atom bomb wiped out a city—the router would detect a problem and choose a different path. With network information distributed, the Internet could route around any central point of failure.

Once the basic architecture and design principles were in place in 1985, the U.S. National Science Foundation (NSF) began funding data networking pioneers at 13 supercomputing centers across the U.S. A nationwide circuit for the traffic was commissioned. The academic institutions had to strike deals with local telecom providers to lease local and regional circuits. More institutions sought to be connected to the NSFNET backbone, which basically was synonymous with the Internet.

Things moved quickly. In 1992, after the Internet had proved its commercial viability, the U.S. government wanted out, and the backbone transmission network of the NSFNET was privatized. It also began to accept commercial traffic. As well, in 1994, the NSF commissioned four network access points (NAPs), essentially traffic exchange points for ISPs; they were located in northern New Jersey, outside Washington, D.C., Chicago, and San Francisco, and were all run by different telecom operators. Thus, in a remarkably short period of time, all the basic ingredients of today's global Internet emerged.

Of course, an application from outside the traditional Internet community would dramatically shake things up. The World Wide Web, developed by Tim Berners-Lee and popularized around 1993, was soon followed by the Mosaic browser, forerunner to Netscape. The exponential growth the Internet had seen until then—users and host counts generally doubled annually—hit massive proportions and backbone traffic surged. Curiously, what remained constant was different components of the Net's architecture, albeit on a far more monumental scale.

What You Pay Depends On What You Do

Back to the economics. As we have seen, although traffic is routed over the Internet on a virtual pathway, without fixed routes or network connections, the physical networks which make up the Internet—typically leased circuits from telephone companies—do interconnect. And networks do exchange traffic. Indeed, the economics of traffic exchange are key to understanding who pays for what on the Internet.

That said, however, the Internet industry has matured to such a point that one can now make important distinctions among different categories of network service providers or ISPs. Doing so provides, in part, the answer to how global infrastructure providers, such as telcos, are and will be compensated.

The generic term "Internet service provider" has become meaningless. It does not distinguish, for instance, between backbone ISPs that have global infrastructure (such as MCI WorldCom's UUNet and Sprint), or local ISPs that lease infrastructure in a specific geographic region and require global connectivity, such as EasyNet in Europe (www.easynet.co.uk) and Tokyo Internet in Japan (www.TokyoNet.ad.jp), or Concentric Network Corp. (www.concentric.net) and EarthLink (www.earthlink.net) in the U.S. Nor does it take into account whether the service provider's customers are individual users, who tend to request content, or content providers who pay to export data.

Better, then, to break down the industry into four classes: (1) backbone ISPs; (2) downstream ISPs; (3) online service

Figure 9. The World's Top ISPs

Carrier/ISP	Market Share of U.S. backbone	U.S. Backbone Speed	Number of POPs	Total Quarterly Revenue	Comment
MCI WorldCom (UUNet, ANS, CNS)	22.53%	622 Mbps	Over 1,000	$4.96 billion (2Q98)	Building national networks in Europe; boosting Asian presence.
Sprint	21.19%	155 Mbps	320	$3.97 billion (2Q98)	Global One alliance building pan-European backbone.
GTE (BBN)	5.32%	155 Mbps	375	$6.28 billion (2Q98)	No owned international infrastructure.
Cable & Wireless	28.43%	155 Mbps	493	$3.12 billion (1Q98)	Building European network; leases capacity from MCI WorldCom for U.S. backbone.
AGIS	3.57%	155 Mbps	Over 200	n.a.	No owned international infrastructure.
PSINet	1.84%	622 Mbps	Over 400	$44.5 million (1Q98)	Bought major ISPs throughout Europe and Asia 1997-1998.
Qwest (EUnet)	n.a.	622 Mbps	Over 400	$393.7 million (2Q98)	EUnet in over 42 countries.

Note: Market share measured by percentage of downstream ISPs served by backbones. Backbone speeds represent fastest nationwide link per single fiber route. Cable & Wireless data includes Internet infrastructure bought from MCI in September 1998.

Source: *Boardwatch Magazine's Directory of Internet Service Providers*, Winter 1998 - Spring 1999.

providers such as AOL (www.aol.com) and Japan's NiftyServe (www.niftyserve.or.jp); and (4) firms that specialize in web site hosting, such as Exodus (www.exodus.net). The cost structure and the money flow is determined by the category to which one belongs. Taken together, the worldwide market for Internet access is now big business: it was at $25 billion in 1997 and is predicted to top $100 billion by 2000, according to Zona Research Inc. (www.zonaresearch.com).

Web Hosting Companies

Web server "farms" emerged from the ISP industry itself but are now somewhat separate since companies have made web hosting into a niche business and are growing rapidly. The important fact is that their traffic flow is mostly uni-directional. The few bits of data that trickle in when a user requests a web page are overwhelmed by the flood of outgoing audio, video, images, and text. As a result, backbone ISPs demand that Web hosting companies, which typically do not maintain a national

Figure 10. The U.S. Controls the Internet's Directory System

The Internet's address books—the electronic directories and numbering systems—are based in the U.S. and supported by government contracts.

Amid growing dissent, since 1996 the Internet community has debated ways to change this, chiefly by creating an international, bottom-up, private sector body. It would take over the functions the Internet Assigned Numbers Authority (IANA) at the University of Southern California (USC, which was headed by Jon Postel until his death in October 1998.

No plan has yet achieved a consensus. But, the U.S. government and the European Commission, among others, have said they support this private sector initiative.

For the U.S., handing off the real estate IANA controls to a private, international entity might be compared to the land grants of the 1800s, only the land value—the cyberspace of tomorrow—is probably infinitely greater.

In addition to setting policy decisions on the number of top level domains, (e.g., .com, .org, .edu) the new entity will also allocate the Internet Protocol (IP) numbers needed for routing. These are a scarce and valuable resource.

As well, the new entity will assume IANA's oversight of the world's 13 root name servers. These computers hold the authoritative routing data for the domain name system, and in many cases the data for popular names (.com, .edu, etc.) too. Without round-the-clock access to these databases, much of the traffic on the Internet would never find its way.

The transfer of IANA's power has become hotly political. Many nations have come to recognize that IANA represents a central control point in the digital economy, and so seek positions of influence in the new entity. Likewise, large net-savvy companies understand that access to IP numbers affects the magnitude and type of services they can offer downstream. See Figure 11 for further details on the Internet's new governors.

Root Server Administrators

ID	Organization	Status	Location
A	InterNIC (Network Solutions Inc.)	Private company	Herndon, Virginia
B	Information Sciences Institute (USC)	Academic	Marina del Rey, California
C	PSINet, Inc.	Private company	Troy, New York
D	University of Maryland Computer Science Center	Academic	College Park, Maryland
E	NASA Ames Research Center	Government	Moffett Field, California
F	Internet Software Consortium	Private company	Palo Alto, California
G	Department of Defense Network Information Center	Military	Vienna, Virginia *
H	Army Resource Laboratory	Military	Aberdeen, Maryland *
I	Royal Institute of Technology (NORDUnet)	Academic	Stockholm, Sweden
J	Information Sciences Institute (USC)	Academic	Marina del Rey, California
K	European Network Coordination Center (RIPE NCC)	Non-profit consortium	London, UK
L	Information Sciences Institute (USC)	Academic	Marina del Rey, California
M	University of Keio (WIDE project)	Academic	Keio, Japan

Note: The world's 13 root servers, known by the letters A to M, coordinate the domain name system data that links alphanumeric names to the IP number addresses used for routing.

* Servers maintained by the U.S. military move among undisclosed locations.

Source: http://nic.ddn.mil/DNS/root-server.html, Internet Assigned Numbers Authority, and root server administrators.

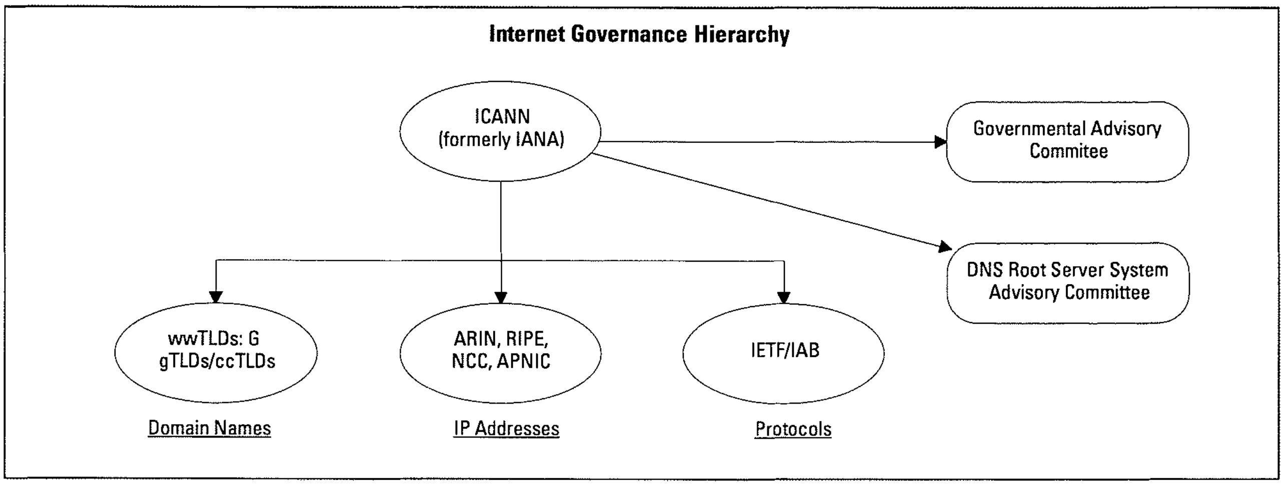
network, purchase connectivity from a backbone or downstream ISP whose customers seek the content.

But there's a problem: The web hosting firm claims that backbone ISPs are already compensated by their end customers, and thus to seek a payment from the content provider would mean a double payment. The backbone ISP counters that it is forced to haul the content provider's traffic on its own network to reach its customers—and it wouldn't need so much infrastructure if the server farm had its own national network. Backbone ISPs thus only agree to accept a server farm's traffic at a price. In August 1998, a peering dispute erupted between GTE Internetworking and Exodus over this very issue, and both firms' customers came close to losing direct connection to one another.

Downstream ISPs

A similar logic is used for downstream ISPs and online service providers, and the price of Internet connectivity varies by location and amount of data. For example, a downstream ISP in Cambridge, Massachusetts can lease a 45 Mbps circuit for $2,500 per month. But that only pays for the facilities required to meet the gateway of an upstream backbone ISP. The price to connect with the backbone, which lets the downstream ISP's

Figure 11. The Internet's New Governors



A new structure to replace the Internet's unelected governors is slowly emerging. The Internet Corporation for Assigned Names and Numbers (ICANN)—if the name sticks—will serve as the umbrella organization for three supporting organizations overseeing domain names, IP addresses and protocols. All three groups are expected to retain considerable autonomy.

The Domain Name Supporting Organization is made up of registrars for both generic top level domains (TLDs) like .com, and country-code TLDs like .jp for Japan. The Address Supporting Organization groups the three regional IP address registries, and will include others as they form. The Protocol Supporting Organization will be represented by the Internet Engineering Task Force (IETF), probably via the Internet Architecture Board (IAB).

Two so-called Advisory Committees exist. One provides a means for national governments to be represented in ICANN's operations, while the other is intended to treat issues of domain name system root server deployment (see Figure 10, "The U.S. Controls the Internet's Directory System").

Who's Who in Internet Governance:

ICANN—Internet Corporation for Assigned Names and Numbers. Non-profit corporation that acts as the Internet's central coordinating body, formerly known as the Internet Assigned Numbers Authority (www.iana.org). Interim funding may be provided by the IBM-led consortium of major suppliers known as the Global Internet Project (www.gip.org).

wwTLD—World Wide Alliance for Top Level Domains. The umbrella organization to unify top level domain name registrars, including national country codes, current registrars of current and possibly future generic TLDs (www.wwtld.org).

ARIN—American Registry for Internet Numbers. Allocates IP addresses for the Americas and the Caribbean (www.arin.net).

RIPE NCC—Reseaux Internet Protocol Européens Network Coordination Center. Allocates IP addresses in Europe, Africa, and the Middle East (www.ripe.net).

APNIC—Asia-Pacific Network Information Center. Allocates IP addresses in the Asia-Pacific region (www.apnic.net).

IETF—Internet Engineering Task Force. The Internet's technical standards setting body (www.ietf.org).

IAB—Internet Architecture Board. Oversight body of the IETF (www.iab.org).

customers reach other destinations on the Internet—can be as high as $30,000 per month.

While the connection fee may seem a crippling cost for U.S.-based ISPs, service providers outside the U.S. must also pay for the cost of an international private line if they wish to connect directly with the Internet at its core. Such a connection does not come cheaply—trans-Pacific circuits, for example, may cost between $700,000 and $1 million a year for a 45 Mbps line.

However, most downstream ISPs and large corporate users that purchase Internet connectivity do not pay based on their actual usage, bit by bit, but based on a usage profile, broken down into different tiers. It would be too expensive and the tools are too embryonic today to meter every data flow and charge for it. According to Internet engineers, the cost of measuring exact usage could put a debilitating premium on Internet service. Such a dilemma is beginning to occur in the U.S. long distance telephone business. With coast-to-coast U.S. rates of $0.10 a minute or less, up to 40 percent of the rate for long distance telephony may reflect the costs of monitoring and monthly billing.

So on the Internet, the backbone ISP's network measures the overall traffic pattern by glancing at the router, octets in and octets out (octets being the 8-bit unit of traffic measurement for packet networks)—and charging the downstream ISP accordingly. This allows a customer to lease a line with much more capacity than is ever used, pay a sum closer to the actual usage, and be assured that should traffic spike, the line can meet the demand for an additional fee. The only drawback with

Figure 12. Power Shifts in Internet Governance: 1982-1998

1982 - The U.S. Department of Defense Advanced Research Projects Agency (DARPA) begins funding Jon Postel at the Information Sciences Institute at the University of California to coordinate the allocation of Internet Protocol addresses and assign networking parameters. The term IANA, Internet Assigned Numbers Authority, emerges informally in 1988 to describe the task.

1984 - The Domain Name System (DNS) is created to translate IP numbers into user-friendly names, ending in .mil, .gov, .edu, .org and .com.

1990 - New Top Level Domains (TLDs) are created for countries, based on the two-letter country abbreviations of the International Organization for Standards (www.iso.int).

1992 - The U.S. National Science Foundation (www.nsf.gov) begins a cooperative agreement with Network Solutions Inc. (NSI, www.netsol.com) to act as a register of domain names and serve as the InterNIC, the Internet Network Information Center (www.internic.net), which allocates IP numbers.

1996 - Jon Postel, head of IANA, proposes a policy to institute new TLDs on a first-come, first-served basis, in response to Internet entrepreneurs who begin selling self-minted TLDs like ".web". These new TLDs are only routable on a minuscule number of networks (i.e., www.alternic.com).

1997 - The International Ad Hoc Committee (www.iahc.org), comprised of representatives of IANA, the Internet Architecture Board (www.iab.org), the U.S. Federal Networking Council (www.fnc.gov), the International Trademark Association (www.inta.org), the World Intellectual Property Organization (www.wipo.int), and the International Telecommunication Union (www.itu.int), releases a proposal for a new governing system for the DNS and an initial seven new TLDs. In May, 80 companies from around the world sign a Memorandum of Understanding that is deposited at the ITU (www.gtld-mou.org), which creates a Council of Registrars (CORE) and a Policy Oversight Committee (POC).

1997 - The U.S. Department of Commerce, after a series of interagency task force meetings overseen by the White House, begins soliciting public comments on the issue of DNS reform.

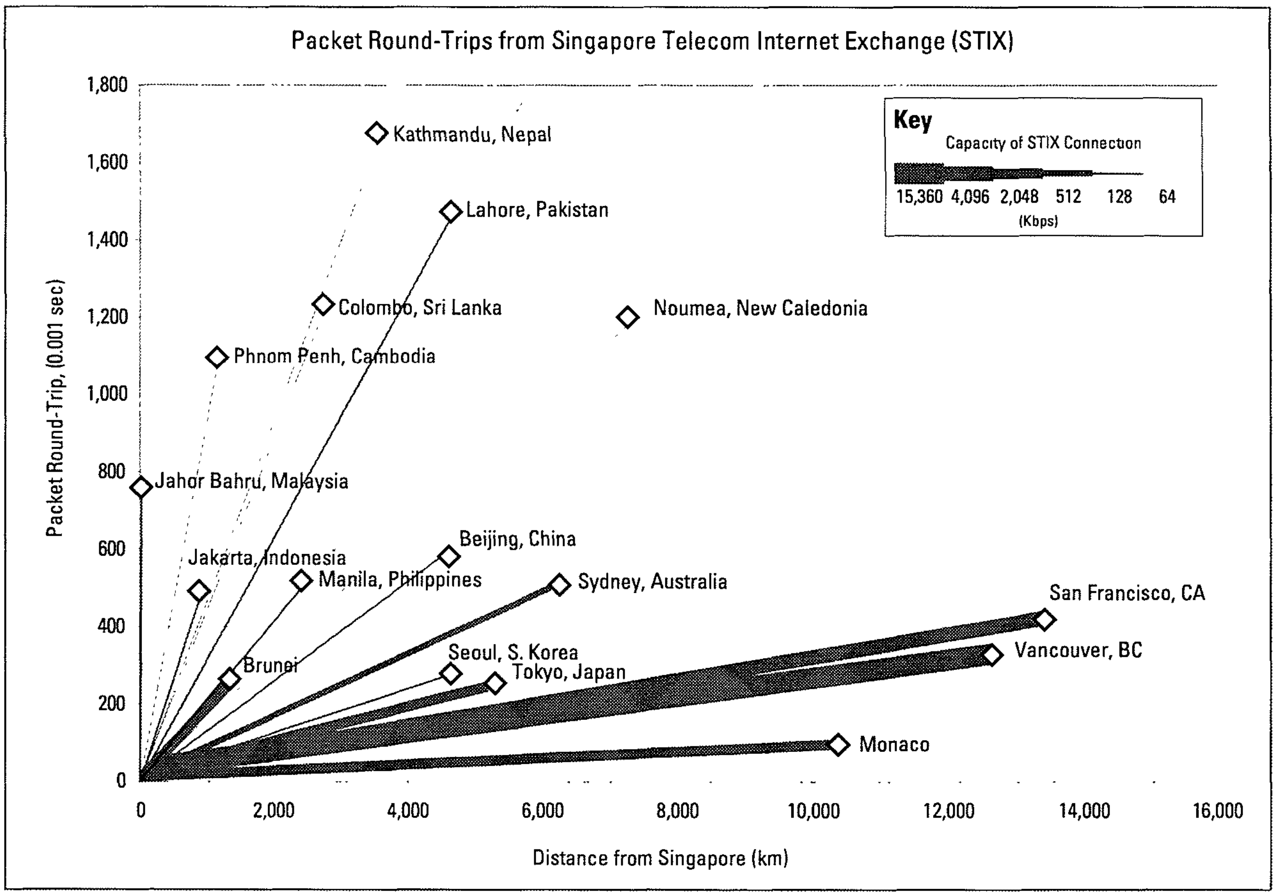
1998 - The Department of Commerce issues a "green paper" in January to solicit public comments on a proposed policy to manage the DNS and IP number allocation, as well as oversee root server administration and protocol development. A final "white paper" is issued in June, calling on industry to create the new entity (see http://www.ntia.doc.gov/ntiahome/domainname).

June 1998 - The International Forum on the White Paper (www.ifwp.org) forms under the guidance of Boston University law professor Tamar Frankle and is steered by around 30 non-profit organizations specializing in technology. It hosts public meetings in Reston, Virginia, Geneva, Singapore, and Buenos Aires to achieve consensus on the structure of a new body to govern the Internet's numbering resources.

September 1998 - A month before his death,Jon Postel of IANA, on behalf of the Internet community, develops a proposal for a successor body, called the Internet Corporation for Assigned Names and Numbers (ICANN), along with nine candidates for an interim board of directors. The plan is immediately attacked by a few IFWP participants when submitted to the U.S. Department of Commerce.

October 1998 - The Department of Commerce and Network Solutions Inc. extend NSI's cooperative agreement to register .com, .net and .org until 30 September 2000. NSI agrees to transition to a shared registration system, allowing other companies to register names under those TLDs, by June 1, 1999. NSI agrees to strike a contractual agreement with IANA's successor for the management of the central "A" root server.

Figure 13. On the Net, Bandwidth Determines Distance



Note: Packet round-trip times are averages taken from the Singapore Telecom Internet Exchange (STIX) web site, http://www.stix.net, in late November to early December 1997 at different times of day.

Source: Adapted from *Internet Traffic Exchange*, OECD 1998.

this approach is that it sets up an incentive for the upstream ISP to overbook capacity, under the hopeful (and reasonable) assumption that all customers do not generate peak loads at once.

At MindSpring Enterprises Inc. (www.mindspring.net), chief executive Charles Brewer says 30 percent of company costs derive from connectivity fees and 13 percent from customer service expenses. He expects a complete reversal over the next five years, as bandwidth becomes a commodity and the ISP must differentiate itself more by the services it offers.

Online Service Providers

An online service provider, such as AOL, earns revenues not by reselling network transmission service but, by offering proprietary content and specialized commerce, selling ads, and providing users with the ease-of-use which comes from special software interfaces and customer hot-lines. They are typically the customers of the backbone ISPs, which also manage the network points of presence (PoPs) accessed by dial up retail users. AOL, for example, has outsourced nearly all of its network transmission needs to the MCI WorldCom subsidiary UUNet, though it maintains a multi-vendor strategy to ensure redundancy. Even AT&T, when it launched its WorldNet residential Internet service in 1995, relied mainly on BBN's network, since acquired by GTE.

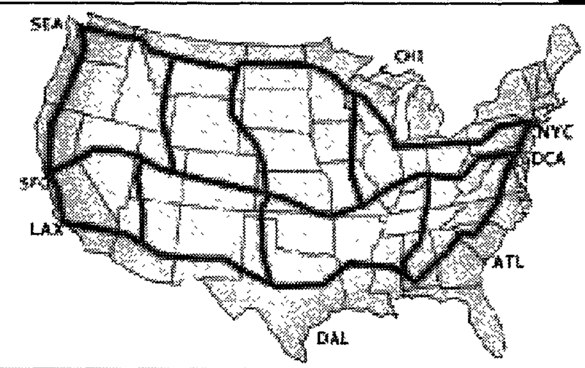
The online service provider is either paid a flat monthly rate by customers for unlimited service, or charges additional fees after a set usage is exceeded. The real payoff is in the eyeballs and the mouse-clicks—selling specialty content, advertising space and taking a share of e-commerce revenue. The cost of data networking is apparently the highest cost, around 50 percent of revenue. Significantly, however, marketing, customer support and subscriber acquisition represent close to 35 percent of revenue.

Backbone ISPs

All networks are beholden to the backbone ISPs—be they web hosting facilities, downstream ISPs, or online service providers—either to furnish Internet connectivity or to manage the actual network infrastructure.

Figure 14. Distance and Delay on the Cable & Wireless Backbone

BREAKING TRAFFIC REPORT



Delay:
Delay measures the time it takes a packet to travel from one node to another and back again. The Cable & Wireless Internet backbone averages better than 95 milliseconds cross-country roundtrip.

Delay (ms)	ATL	DAL	CHI	SFO	LAX	NYC	SEA
Atlanta		19	27	73	61	24	78
Dallas	21		46	40	31	54	73
Chicago	27	43		62	74	25	67
San Francisco	60	39	63		11	70	17
Los Angeles	63	33	75	11		86	25
New York	25	53	22	69	83		73
Seattle	79	73	68	16	25	74	
Hosting Center	39	48	29	74	78	9	80

LEGEND:
greater than 120 milliseconds
95 to 120 milliseconds
less than 95 milliseconds
* All numbers are "round trip."

As of 9/19/98 6:23:48 PM Eastern. Statistics are delayed 10 minutes.

When the anomaly of bad network infrastructure (such as in Asia) does not exist, distance becomes a factor for traffic delay. This is demonstrated by Cable & Wireless' U.S. Internet backbone. The roundtrip time of a packet roughly correlates with the distance it must travel.

Source: Cable & Wireless, Inc., http://traffic.mci.com

Internationally, the same dynamic applies. Local downstream ISPs in Asia, Europe and elsewhere need the larger, upstream networks, often the incumbent telecom provider, for Internet connectivity. And big Internet sharks outside the U.S. find themselves but tiny sardines when they arrive on U.S. shores with their leased circuit dedicated to IP traffic. They must strike an interconnection agreement with one or more of the Internet backbone networks, just like a regional U.S. ISP.

Some off-shore backbone ISPs have begun to acquire their own national U.S. networks to obtain free peering. Most have not. Japan's NTT hopes to aggregate its traffic with the large U.S.-based backbone ISP Verio, in which it took a ten percent stake, and Qwest was keen to piggyback onto EUnet International's peering agreements when the U.S. telecom upstart bought the pan-European ISP in March 1998. But it is unclear whether other backbone ISPs will allow either move. No one is certain what is actually going on: backbone interconnection deals are shrouded under "non-disclosure agreements," and only limited bits of information are available (e.g., from a stock prospectus when a company, such as Verio, goes public).

The emergence of backbone ISPs to provide connectivity to the Internet—indeed to determine what actually constitutes Internet connectivity—is a relatively recent phenomenon. Not surprisingly, there's controversy surrounding their role in the Internet food chain.

When the Internet first evolved, ISPs were generally the same size and swapped traffic freely. Early Net applications, like file transfer protocol, led to more or less symmetrical traffic among ISPs. In contrast, the Web creates a split between the end users, who import data, and content companies, who are data exporters. That's new. In the early days, the ganglia of network interconnections were so complex—since everyone accepted any other network's traffic—that the only way Internet engineers could map the Internet's topology and traffic flow was simply to draw a cloud. Today, however, the enormous size differences among ISPs coupled with the terrific infrastructural investment, and major traffic imbalances due to the emergence of Web hosting firms, has meant the practice of settlement-free peering is waning. The two noticeable exceptions are that local ISPs peer with their siblings at local exchange

Figure 15. A Primer on Peering

Peering is to the Internet what interconnection is to the telecoms world—the way in which different networks exchange their customers' traffic. Without interconnecting, a customer of one ISP can't reach the customer of another.

Over the past two years, a handful of the biggest Internet service providers have refused to interconnect for free with other ISPs. Instead, they demand smaller ISPs pay a fee to compensate for the bandwidth resources larger ISPs must expend to carry the smaller providers' traffic. Smaller ISPs claim this is discriminatory. And regulators reluctantly admit that unless the conflict is settled, they may intervene to assure a competitive market and protect the public interest. The Federal Communications Commission (FCC), for example, in the fall of 1998 solicited public comment on the issue (see www.fcc.gov/ccb/706).

When the Internet first developed, networks were generally the same size and the traffic flow roughly equal—hence all were "peers." It thus made economic sense to swap traffic freely. Even if there was a slight imbalance, it was less expensive to set up a free deal than to meter and to charge because both parties benefitted by being able to reach more users.

But as the Net became commercial, the size of networks began to differ enormously. As a result, large networks such as UUNet and Sprint began to change the rules.

Both small and large ISPs have a point. Large ISPs are not fairly compensated, even if the amount of traffic exchanged is equal, because the larger ISP is inherently forced to carry traffic a longer way over its network than the smaller ISP. This is because most ISPs use "shortest exit routing," whereby traffic is handed off at the earliest possible network juncture. A larger network has more network interconnection points, and so is constantly in the unenviable position of having to accept others' traffic and to carry it farther.

On the other hand, large ISPs do not publicly state their peering criteria, and insist that all arrangements be shrouded under nondisclosure agreements. The lack of transparency and objective criteria may put smaller ISPs at a disadvantage. Small ISPs or start-up companies today have little control of their costs, nor can they gauge the direction of market costs unless fair and nondiscriminatory peering criteria exist.

Internationally, interconnection takes on a different hue. ISPs outside the U.S. are not considered peers by major U.S. ISPs. In addition, foreign ISPs must pay the full cost for transoceanic circuits required to connect to U.S. backbones. In contrast, domestic U.S. ISPs which are treated as peers typically share the cost of the circuits used to join their networks, since they have essentially parellel ystems.

Off-shore ISPs thus claim they effectively subsidize U.S. Internet users. Due to "shortest exit routing," the foreign ISP carries the traffic to the U.S. and carries it back to the in-house region. In the U.S., the long-haul cost is shared by different ISPs, since one is able to carry traffic from one exchange point to another before handing it off to the second ISP.

Discrimination Against Foreign ISPs?

The discrimination alleged by off-shore ISPs has sparked intergovernmental controversy. The Asia Pacific Economic Council in May 1998 agreed to study the matter, over the objections of AT&T. The International Telecommunications Union (ITU) Study Group 3 is also examining the issue. And an Organization for Economic Cooperating and Development (OECD) report in May 1998 stated "the question of cost allocation is a valid one if the current arrangements are not equitable in terms of use made of infrastructure relative to financial contribution."

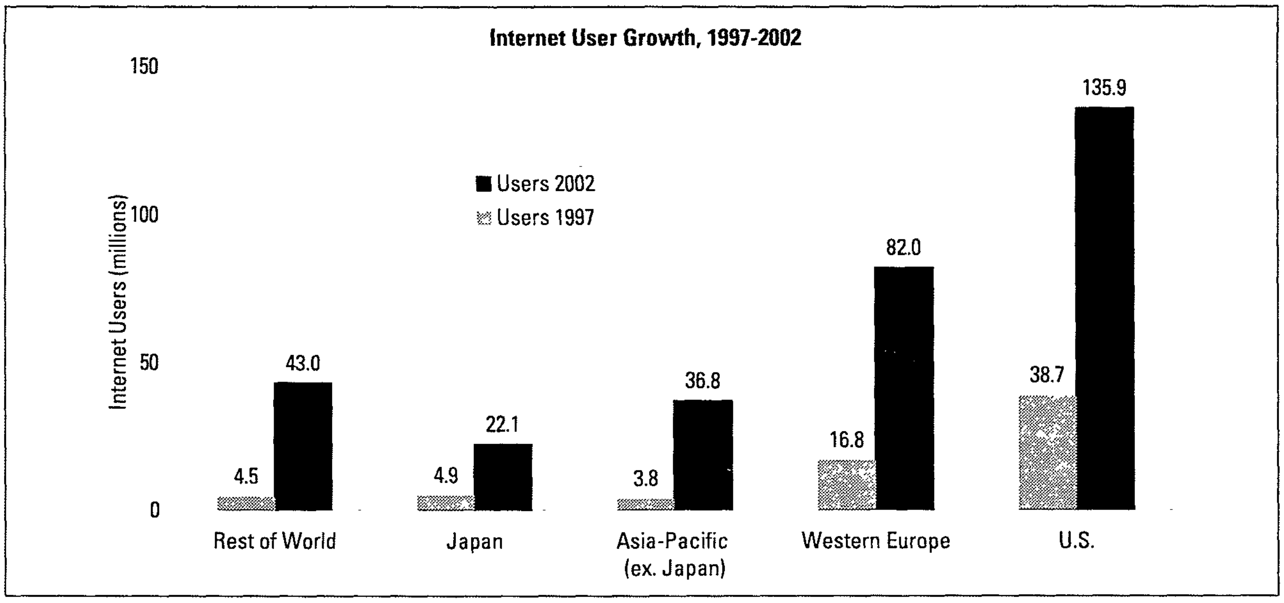
At an OECD Internet workshop in Osaka, Japan in June 1998, John Hibbard, Vice President of international carrier business at Australian carrier Telstra, presented the views of non-U.S.-based ISPs: "U.S. demand has increased such that in the case of Telstra, approximately 70 percent of the usage of the link is driven by Australian users and 30 percent by U.S. users. Yet Telstra, at the Australian end of the link, pays 100 percent of the cost.... Our action plan is to promote global awareness, try to negotiate better solutions with U.S. operators and if that fails, resort to other tactics.... One avenue is to involve the World Trade Organization (WTO) because what is happening will stunt the Internet, and hence restrict the potential for electronic commerce."

The U.S. private sector, meanwhile, cleverly seeks to capitalize on these disputes. Some companies, like InterNAP and Savvis, are trying to develop a model for metering and billing for interconnection traffic, to move the matter from barter to contract. That would bring a degree of certainty to the marketplace.

And new Net developments, like quality of service assurances, may make much of the controversy moot. To honor service level guarantees between networks, ISPs will need common metrics to meter premium-priced traffic and to charge a settlement fee for handling it. Until then, however, regulators are keeping a close eye on the Internet's commercial structure, especially after the WorldCom-MCI merger (see Figure 17).

Moral for the industry—be fair, or be regulated.

Figure 16. Regional Internet Growth



Source: International Data Corp. Design by TeleGeography, Inc. © 1998

points, and the very biggest backbone ISPs continue to peer among themselves.

The point—scale matters. Unless your network is very big and very fast and upgraded continuously, you are a customer of somebody else, and therefore will not be able to control your fixed costs. Which is one reason why regulators, who otherwise loathe to interfere with the Internet's dramatic growth, have stepped in to try and keep the backbone market competitive (see Figure 19). But many of the hard questions, such as the regulatory status of backbone networks—basic telecom facility or enhanced ("private") data pipe—remain unresolved.

IV. How Fast Is the Internet Growing and Why?

Thus far we've seen that although it is global in reach, the Internet has a U.S.-centric infrastructure, and that there are strong economic and technical reasons why this remains so. We've also seen that the business of providing Internet facilities and services is becoming quite heterogeneous; there are distinct network tiers with all but the largest ISPs—the backbone ISPs—being customers of the others. This structure affects the economics of the global Internet in terms of the flow of money between downstream and upstream network owners and the incentive to invest in new transmission and switching facilities. Simply put, one ISP's expenses are another's revenues.

Now, we turn to the question of Internet demand, which is central to the Internet's future structure. Where there is growth, and where not, will determine tomorrow's revenues and expenses for the ISP industry.

Scaling The Net

With overall demand for transmission capacity growing at 200 to 300 percent plus per year, the crux of nearly all Internet problems today is scaling—how to take a protocol and infrastructure designed to link a handful of computing centers together to exchange non-real-time data, and make it work internationally, and even carry voice traffic.

Keeping this challenge in mind we look at the following four drivers of demand: (1) the growth of users and what they do online today; (2) tomorrow's applications and devices; (3) the effect of local access technologies on international bandwidth consumption; and (4) new technologies that, against the prevailing wisdom, may not increase demand very much.

Follow the Data

We start with a reprise of some basic statistics. Since its inception, the Internet has doubled annually by many measures. As a rule of thumb, computers linked to the Internet or hosts have increased by 100 percent per year, as have domain names and users. For a more detailed review of the current numbers, see Figures 16 and 18.

What about Internet backbones? In terms of traffic, the growth rate appears to vary from 200 to 1,000 percent a year, depending on the network. And some ISPs have provisioned for even greater growth. To get a better idea of the magnitude of bandwidth growth, consider the Internet's evolution.

In 1986, the NSFNET backbone ran at 56 Kbps—the rate of many user's modems today (recall Figure 2). In 1988 it was upgraded to 1.54 Mbps or T-1. In 1991, it was upgraded again, to 45 Mbps or T-3. At this point, the commercial sec-

Figure 17. Lessons of the MCI-WorldCom Merger

On September 14, 1998, the $37 billion MCI-WorldCom merger cleared its final regulatory hurdle. The U.S. Federal Communications Commission (FCC) approved the deal subject to the prior divestiture of MCI's Internet business, as European and U.S. antitrust regulators had proposed (the FCC order can be found at www.fcc.gov). MCI promptly agreed and the new MCI WorldCom began business the next day.

After 11 months of negotiations, regulators had extracted their pound of flesh—MCI Internet—but the terms of the divestiture and the competition inquiry which preceded raised more questions than were answered.

The buyer of MCI's Internet assets, Cable & Wireless plc (C&W), paid $1.75 billion for MCI's Internet customers (corporate and retail), network ports, routers and peering agreements—but not MCI's backbone transmission circuits. C&W agreed to lease the capacity it needed to support its new Internet business from the seller. To some observers, that made the divestiture a Pyrrhic victory for competition given the original regulatory concerns regarding undue concentration in the market for Internet backbone services.

On the other hand, officials from the European Commission (EC), who were the most adamant about divestiture, privately said that the scope of the divestiture may still have been too broad. And, informally, at least one U.S. antitrust official agreed.

Yet whether the outcome was correct, what regulators learned during the review—the first time competition and telecom watchdogs seriously examined the Net—will have future implications.

Regulators focused on three broad issues raised by the combination of the MCI and WorldCom networks: the supply of raw trans-Atlantic circuit capacity; the combined companies' Internet market share as measured by the percentage of backbone traffic; and the structure of peering arrangements.

Most worrisome to regulators was the amount of traffic the companies carried. An essential distinction, however, is that "market share" isn't really about backbone traffic—that's just a proxy for the real concern—the number of routes an ISP services. These downstream routes represent a network's customers where traffic either originates or terminates.

The more routes you have, the better the chances are that you can terminate your customer's traffic without having to hand it off to a rival ISP. That provides better control over the quality of service and costs. But if you get very large, it means that a greater number of other networks are more beholden to you to carry their customers' traffic, than you are to them.

Regulators understood the merger could upset the existing balance of power among backbone networks. As recently as 1996, it was known as the Group of Five—UUNet, BBN, Sprint, MCI, and ANS. The deal would have added MCI to WorldCom's ownership of UUNet and ANS, reducing the cartel-like club to three. So EC regulators laid down conditions for the merger—and by doing so, advantaged a home-town favorite, U.K.-based C&W.

There are three immediate legacies of the investigation. The first is that it has set the stage for, but not yet settled, ground rules for peering arrangements. The FCC ducked the issue as apparently did the EC and the U.S. Department of Justice (DOJ) (i.e., the post-merger company can still peer on its own terms). But any other large Internet merger can expect the issue to be front and center.

Second, the investigation was distinctive because it used antitrust law, rather than telecom policy principles, to address competitive concerns in communications.

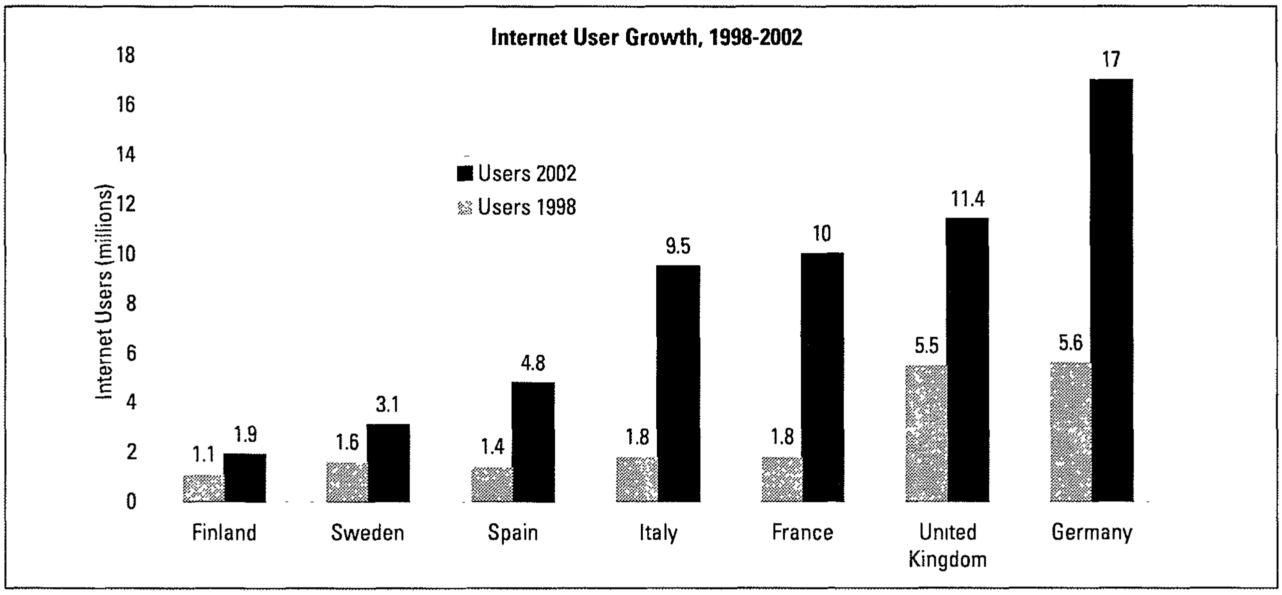
Third, there was significant cooperation between the EC's merger task force and the DOJ throughout the two agencies' separate investigations. When the deal was announced in October 1997, few observers thought that the companies would be subject to much scrutiny in Europe, where WorldCom had relatively few assets and MCI even less. Nevertheless, subsequent events make it clear that even minimal assets in foreign jurisdictions, especially the EU, may subject a deal to local approval requirements.

In this case, the broad reach of the EC's competition guidelines eventually allowed European regulators to take the lead, not the DOJ. Indeed, that may have been intentional, allowing the DOJ to avoid a politically sensitive case. No U.S. agency wants to risk political censure as the first bureaucrats that tried to regulate Internet capacity or prices.

Finally, the MCI-WorldCom deal may be but the opening salvo in the larger conflict over the regulatory status of Internet backbones. If the backbones are treated as telecommunications infrastructure, that is, as common carrier facilities, then companies supplying "Internet carriage" probably will be required to provide fair and non-discriminatory terms to ISPs seeking interconnection. If not, they may be able to pick and to choose with whom they connect and on what terms, as do large data networks today, because they are considered "enhanced" service providers.

Enhanced services are still subject to antitrust laws. But, as the MCI-WorldCom docket showed, when it comes to the messy details of peering and network access, antitrust authorities seem as willing as telecom officials to let the industry sort them out for itself.

Figure 18. Internet Growth in Western Europe



Source: IDATE, *The World Atlas of the Internet*, http://www.idate.fr Design by TeleGeography, Inc. © 1998

tor took over as the key bandwidth vendor. BBN, the company that created and first operated the forerunner to the Internet, the ARPANET, had an Internet backbone running at T-1 speeds of between one and three Mbps in 1993. In 1996 its backbone ran at between 150 and 200 Mbps or OC-3. In early 1998, the company deployed OC-12 lines at 622 Mbps rates. By late 1998, certain routes on the backbone were being upgraded to OC-48 lines, moving traffic at 2.5 Gbps. BBN anticipates having OC-192 lines installed by late 1999 which can handle around 10 Gbps.

The international Internet, outside the U.S., has trailed the magnitude yet matched the rate of U.S. growth. Significantly, the number of international private lines (IPLs) used by U.S. carriers jumped from 26,000 in 1995 to over 155,000 in 1997 (see "International Circuit Usage by U.S. Carriers" on page 98). The great majority of this growth appears to be due to capacity acquired by ISPs or corporate intranets.

DANTE, the pan-European research network, had a two Mbps backbone in 1996, upgraded to 34 Mbps in 1997, then 155 Mbs by 1998. Carriers state similar growth rates. France Telecom's data networking division, Transpac, reports that traffic on its 155 Mbps backbone increases at a rate of 15 percent a month, which translates to 400 percent per year, and the network will be upgraded to 622 Mbps by 1999.

Pan-Pacific links have grown equally fast. There were four 34 Mbps lines from Asia to the U.S. in the first half of 1996 and ten such links a year later. Asia started 1998 with 13 links of 45 Mbps connecting the region to the U.S., and by the second half of the year the number grew to 35 Internet links of 45 Mbps. Within Asia, however, the dedicated Internet bandwidth growth lagged due to high infrastructure costs and national rivalries to become a regional "hub." Instead, the four major Asian backbones—Singapore's SingNet, Japan's A-Bone, Australian carrier Telstra's Big Pond and Hong Kong's Net Plus—still mostly swap traffic in California.

The amount of traffic passed through these telecom pipes also generally doubles each year, barring the one-off explosion of Internet traffic, which occurred as soon as the web and the Mosaic browser caught the imagination of mainstream computer users. (By one count, web traffic in 1993 grew by 341,634 percent, overshadowing the then-killer Internet application called gopher, which that year grew by a mere 997 percent.) As late as 1994, the Web still ranked behind file transfer protocol (FTP) as the most popular Internet application in terms of traffic. Today, around 75 percent of traffic is generated by the Web.

The number of Web sites has exploded. It went from an estimated 130 sites in June 1993, to 2,738 in June 1994. Twelve months later there were 23,500. In June 1996 there were 252,000; by June 1997 there were 1,117,255. At this point, the growth began to slow to the tried-and-true annual Internet doubling. By May 1998 the number was estimated at 2,215,195.

Traffic data showed a similar skyrocketing effect. However, the oft-cited figure that traffic doubles every three months seems misleading—it does not specify on what routes, nor whether the growth is an aberration or a standing trend. Rather, Andrew Odlyzko and K.G. Coffman of AT&T Labs conclude that growth rates are "lower than is often cited [yet] still about 100 percent a year." Public Internet traffic doubled annually from 1990 to 1994. But from 1994 to 1996 it increased by 1,000 percent. AT&T calls it an "anomalous period," noting that traffic returned to 100 percent annual growth in 1997.

Will the growth of the global Internet follow these trends or not? Consider this: Today's bandwidth consumption and Internet growth has been maintained almost exclusively through adding more users, and through current users doing more. Corporate customers, who represent around half of all Internet users, generated 0.4 Mbps of traffic during peak usage in 1996. By 1998, consumption grew to 1.7 Mbps per customer, says The Yankee Group (www.yankeegroup.com). But ever since the Web popularized the Internet, the growth has not been from more bandwidth-intensive services, other than data-heavy graphics. All this bandwidth consumption is happening over e-mail and the Web.

There's a lot of room for more growth in the number of users, today estimated at around 100 million people. Other bandwidth drivers, such as online software distribution, online music purchasing, and Internet "bots" that crawl the Web looking for the best priced product, have scarcely penetrated the mass market. Nonetheless, current drivers of demand like video, music, and networked-based applications likely represent a major portion of tomorrow's Internet uses.

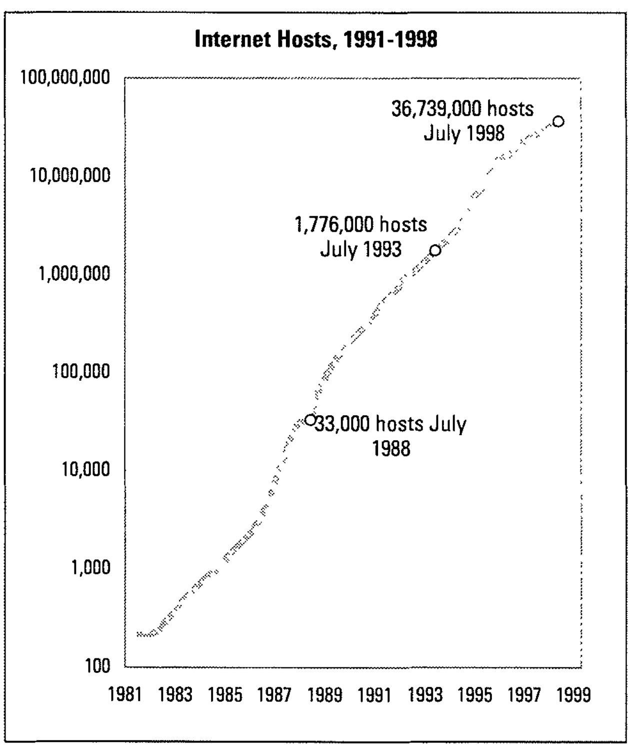
"Silicon Cockroaches"

Mike O'Dell, Chief Scientist at UUNet, wagers that the key driver for bandwidth will come from what he calls "silicon cockroaches"—the always-on devices such as mobile phones, personal digital assistants (PDAs) and yet-to-be-conceived multipurpose devices that will require connectivity. That the Net's appetite for bandwidth depends upon such things as IP telephony and streaming video, are "notions bound up with the immediate interaction of a human," he says. "Those become thinner and thinner assumptions" in the future.

"Things that think want to link," says Nicholas Negroponte, the director of MIT's Media Lab and author of *Being Digital.* Whether they are small, portable devices or a nationwide net of linked vending machines, ubiquitous connections may also make these silicon cockroaches hungry bandwidth hogs. For instance, grandma wants to buy a sweater so she launches a shopping robot to compare prices on thousands of Web sites from Bogota to Bucharest while she naps.

There will also be a symbiosis between wireless and fixed-line networks. For example, a car's radio-fed global positioning system (GPS) will constantly maintain its geographic coordinates so if the driver becomes lost, or is involved in an accident, the speediest assistance can be had. The wireless base-station monitoring progress along the route might be continually passing the information over terrestrial cables to query map data-

Figure 19. Internet Host Growth 1981-1998



Source: Network Wizards Design by TeleGeography, Inc. © 1998

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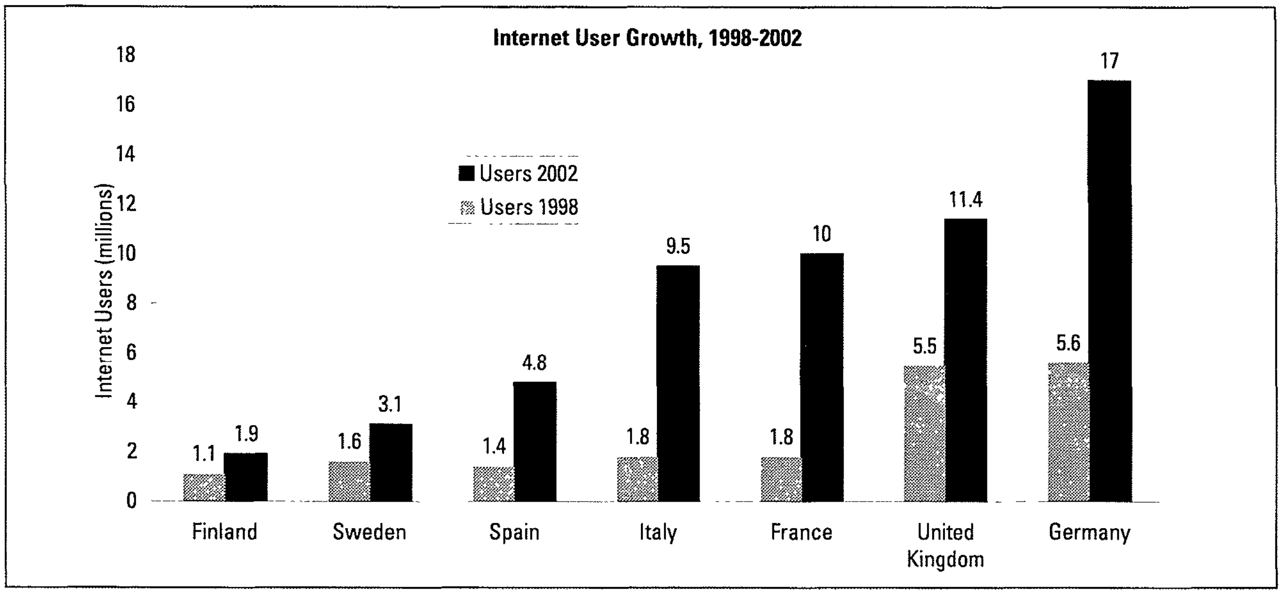

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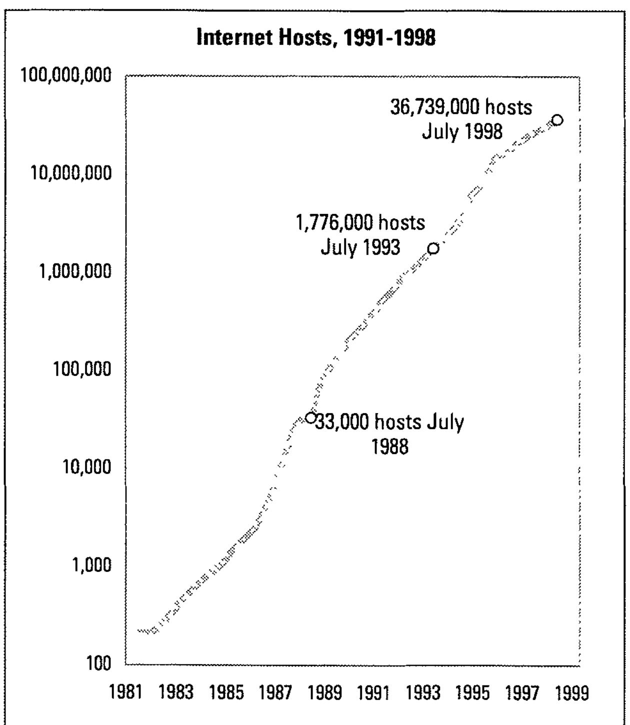

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bases thousands of miles away. The databases might be feeding graphic-intensive maps back to the car. But it will require bandwidth. Today, the Israeli-based company MailPush (www.mailpush.com), backed by BellSouth, offers to contact customers via phone or fax when new e-mail arrives. It does so, by querying customers' mail servers every seven minutes.

Even where people are involved, the demands for bandwidth will increase as new consumer electronic devices are introduced. The Internet's past growth has been bound up with the computer. This probably will not last long. Internet access devices other than PCs, such as TV set-top boxes, web-enabled phones and devices like address books, planners, and videogame consoles are expected to triple annually. By around 2004 or 2005, the number of web-enabled devices sold is expected to exceed PCs. The still bulky Nokia 9000 cell phone is probably a harbinger, with its web browser, keyboard and address book.

Network Applications

Not to be discounted are the applications. Although the Web represents the most traffic, the most commonly used application is e-mail, with 4.5 terabytes a day accounting for over 400 Mbps of bandwidth. E-mail attachments also matter because there is some evidence they are getting longer and thus require more bandwidth. New word processing and graphics programs appear to be the main reason.

Another application that will affect bandwidth demand is electronic commerce. In addition to clicking on more web pages, many purchases will likely use digital certificate technology. A digital certificate is a piece of cryptographic software that attests to the identities of both buyer and seller. The certificates themselves are issued by a certification authority, which would probably be linked with other such authorities higher up in a hierarchy, for cross-certification. As a result, the authentication needed for a single purchase might generate scores of traffic sessions and database queries around the world.

In the future, therefore, entering a web site's URL may entail at least two domain name system lookups, multiple cache queries over a cache network to find a locally-stored version of the web page without having to go to the actual server, and finally an exchange of cross-certified digital certificates—all before the desired web page actually appears in a browser's window.

High Speed Local Access

A faster set of "on ramps" for the Internet will also affect the demand for long-haul bandwidth. Today the "last mile" of the Internet is typically the slowest: 56 Kbps and below. It follows Amdahl's law, that the speed of a system is determined by its slowest component. (Gene Amdahl, was the father of the first mainframe computer, the IBM System/360, and inventor of the parallel processor in 1967.) New local access technologies will not only improve performance for end-users, but in so doing, it

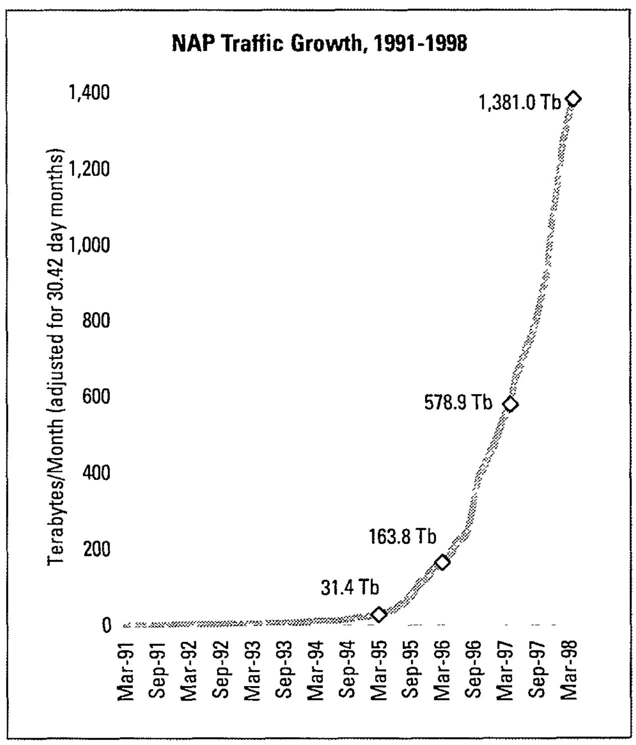
Figure 20. NAP Traffic as a Measuring Stick

George Gilder's monthly newsletter for high tech investors, the *Gilder Technology Report* (GTR), publishes one of the few publicly available estimates on the growth of Internet traffic. Each month Gilder's team collects statistics on the packets that move through selected major U.S. Network Access Points (NAPs) and Metropolitan Area Exchanges (MAEs). Based on these data sets, GTR claims that its estimates account for only 20 percent of the Internet's total traffic.

GTR's traffic estimates build on the model once used to measure traffic on the NSFnet backbone. Like the NSFnet data, it combines the traffic totals for each exchange point. Thus, bits transiting through two or more NAPs/MAEs on a single trip may be duplicated. On the other hand, this data underrepresents total traffic because it does not include traffic (a) within an individual network; (b) between networks with private peering points (up to 60 percent of all traffic); or (c) at other exchanges which are outside the U.S.

The future of GTR's metric looks gloomy. In April 1998, the NAPs stopped reporting traffic and it is unlikely that new data will be generated.

For information on how to subscribe to the GTR, visit www.gildertech.com or call them at +1 413 274 0211.



Source: Gilder Technology Report (www.gildertech.com)

Figure 21. Starr on the Net: Big Crowds, But Not for Long

When the U.S. Congress decided to post the Independent Counsel's report on President Clinton's White House affairs, some pundits predicted an Internet crash. Not so, according to Matrix Information and Directory Services (MIDS, www.mids.org), a company which tracks Internet traffic jams:

While there have been discernable slowdowns at the web sites where the Starr report has been posted, Internet traffic on a nationwide basis has not been significantly impacted by the release of the Independent Counsel's report.

The accompanying graphs were generated from data we collected at our San Francisco beacon on Friday, September 11, 1998, the day the Starr Report was released, and the preceding Friday, September 4. The Starr day graph shows a decided spike at noon Pacific Daylight Time (PDT).

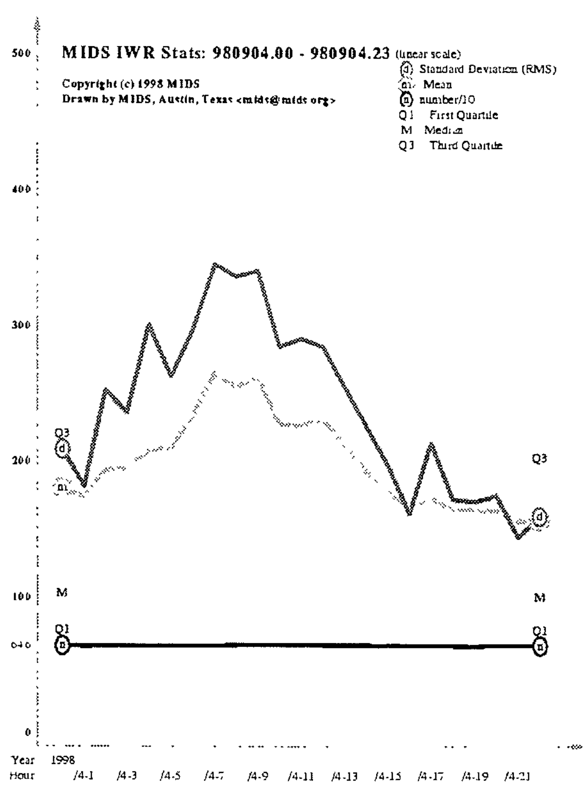
The most interesting lines on the graphs are the two averages. The spike appears in both these averages. The curve labelled "m" (and shown in green in the online versions of the figures) depicts the arithmetic mean, which is the most common kind of average. The curve labelled "M" (and shown as the line between the two light shadings) depicts the median, which is a kind of average favored by Internet performance researchers for this type of data.

These averages are of latency, or round trip time from our beacon to the destination nodes, for ping (ICMP ECHO), as indicated by the left hand scale, which is in milliseconds. The graphs also have a black line labeled "n", which shows the number of responding nodes divided by 10. The nodes pinged for this data were web servers.

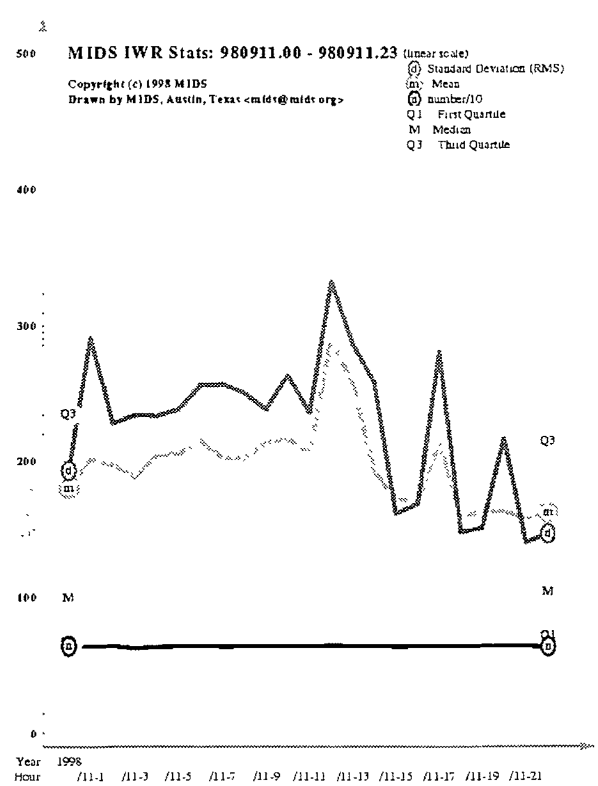
While the "normal" Friday shows a peak in the morning, tapering off in the afternoon and evening, Friday the 11th shows a tremendous peak at noon PDT, which is 3PM EDT. The Starr Report document was "officially" released at 2:30PM EDT. We cannot of course say for sure that this spike in Internet web server latencies was caused by the release of the Starr Report, because for example there could have been some other popular information released at about the same time. We can, however, say that such a spike does not normally occur and the coincidence of timing is unusual enough to be interpreted as correlation. We observed the same spike from other beacons, so it is not an artifact of that particular beacon or its vantage point. The spike indicates a real event in the Internet. Nothing in recent times has caused a spike quite like that: not the Olympics (Nagano and Atlanta); not the beginning or end of the World Cup.

To contact MIDS, send email to jsq@mids.org.

Traffic on a Regular Friday



Traffic on Day of Starr Report's Release



Source: Matrix Information & Directory Services, http://www.mids.org/press/starr.html will greatly influence the demand placed on IP backbones and their global architecture.

Today, access between home and office is fairly evenly split. For residential users, the majority access the Internet with analog modems at speeds between 14.4 and 56 Kbps (see Figure 23). A plethora of new local access technologies is slowly invading the market: cable modem access, DSL (digital subscriber line) and, in Europe, ISDN (integrated services digital network). It is important to note that while backbone speeds have risen by a factor of 13 over the past five years, local access technologies have not been as quick to improve, albeit they have almost doubled annually for the past few years. When the growth of online service providers and Internet access spurted due to the mass appeal of the Web in 1995, modems of 14.4 Kbps were standard fare. In 1996, it doubled to 28.8 Kbps, and by 1998 rates of 56 Kbps became the norm, despite their actual throughput being closer to 33 Kbps.

The Internet industry is now bracing for a discontinuous jump in local access rates: Cable modems offer high-speed access anywhere between 1.5 and, theoretically ten Mbps. DSL offers rates between four and eight Mbps. Another high speed local access technology may be the electric power grid, if Nortel's Digital PowerLine project is successful. The technology, being trialed in Europe and Asia, transmits Internet traffic over electricity lines at speeds exceeding one Mbps.

For users, these technologies offer great promise. A short video clip, for example, that today takes 46 minutes to trickle in over a 28.8 Kbps modem would zoom in over a ten Mbps cable modem in eight seconds flat (see Figure 24).

Impact On IP Backbones

The network architectures of these high speed access technologies affect the design and demands placed on upstream IP backbones. DSL is a telecom technology; it travels across the same twisted pair a regular analog modem uses. That is one reason it is such an attractive service—it requires no new local infrastructure, just a new (but expensive) box of electronics on the customer's premises and at the telco's central office which can then be linked to the Internet. But since it uses the infrastructure plant of the telecom universe, DSL technology is starkly different from the hierarchical architecture of cable networks (and electrical power grids)—and this affects the backbone infrastructure needed to support the local access speeds.

Cable networks resemble "leaf and branch" networks. Unlike the telecom system's point-to-point links, cable networks are trees, which rely on a series of capillaries and customer end points. The challenge of making these networks Internet-ready is formidable. For instance, it is necessary to protect users at

Figure 22. A Signaling Channel for the Internet?

Today's smart telephone networks set up calls with a technology known as Signaling System 7 (SS-7). The system uses two channels for each PSTN call: one for the conversation and a separate, dedicated, channel which transmits data for call set up, addressing, delivery, and metering.

Will an Internet equivalent to the phone network's Signaling System 7 emerge? Some trends suggest it may.

The Internet's addressing system, the domain name system (DNS), consumes bandwidth and congests routers on the transmission infrastructure, as special servers translate the alphanumeric domain names into Internet Protocol (IP) number addresses for routing.

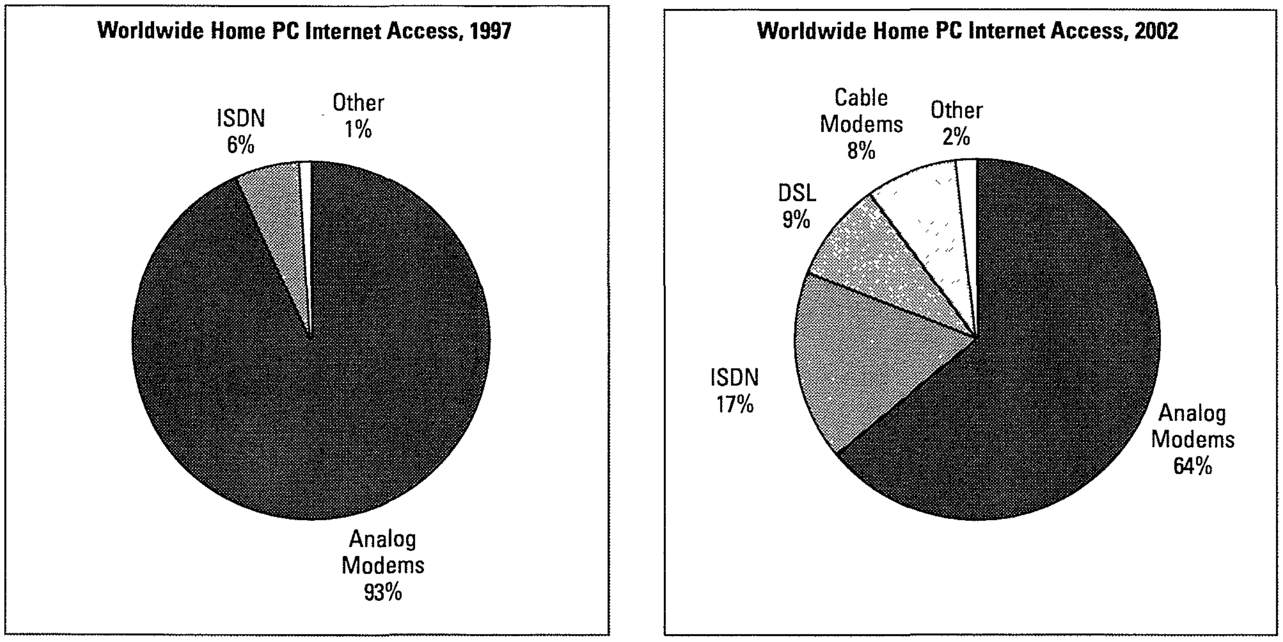
It may be more efficient to route the DNS on a separate channel—especially if plans called "secure DNS" move forward. Spearheaded by Internet gurus Carl Malamud, John Gilmore and the Internet Software Consortium, it applies digital signature encryption technology to ensure that web sites are the rightful party they say they are—a critical step in bringing sound security to the underlying infrastructure.

With a plethora of encryption keys being invisibly passed between user and web site, taking DNS off the transmission network and onto a separate, more reliable channel may make sense. The same logic—and the same channel—applies for digital certificate technology, which may form the bedrock of electronic commerce. It requires continual use of network-based certification authorities to authorize transactions between parties.

There are other reasons to dedicate a channel to network information. Today, the "Squid" system of caching hierarchies commercialized by MirrorImage (www.mirrorimage.net) already acts akin to signaling. If a local cache does not have a copy of a requested web page, the server sends out a query to other peer caches to see if they do. This might entail messages zipping among 20 caches at a time. A new technical model has the top cache server in the hierarchy constantly querying the contents of downstream caches, to act as a sort of index that knows which caches have what pages. Like signaling, all this information is used by the network, not the end user.

Finally, Internet telephony may push the Net to adopt a signaling channel. The Internet Engineering Task Force, a standards body, is at work to meld IP addresses and telephone numbers. And Internet telephony companies have formed an industry working group to create an Internet version of the telephone system's "call data record" (CDR) structure, the first step in defining call parameters, service quality and billing, and in tracking interconnections among operators. Taken together, the Internet just might learn a bit of intelligence from the telecom world.

Figure 23. A Slow On-Ramp: Internet Users and Access Speeds



Source: Adapted from International Data Corp. (www.idcresearch.com), Telecommunications and Networking programs, 1998. Design by TeleGeography, Inc. © 1998

branches farther from the main source of the data from suffering poorer service due to bandwidth-hungry customers on branches slightly ahead.

Importantly, the deployment of these local access technologies may subtly change the distributed architecture of the Internet backbone upstream. In the case of cable and electrical power networks, there will be an engineering imperative to build new exchange points to keep as much of that fast traffic off of the backbones as possible. And caching technology can be easily deployed where trunk meets branch. It was an obvious move then for @Home, the ISP affiliate of cable operator TCI (which AT&T acquired in 1998), to forge an alliance with a cache technology vendor. And to say these types of networks lend themselves well to multicasting Internet content becomes a tautology: cable service and electrical power provision *are* multicasting.

Real-Time Applications

What will people do on the Net when the "last mile" bottleneck is broken? Real-time applications are one possibility. AOL users currently transmit 15 million e-mails on peak days—but 116 million "Instant Messages" are sent. Then there's voice traffic, the first area where real-time traffic flows appeared over Internet infrastructure. Yet voice isn't a big bandwidth consumer, as the next section explains. Instead, think big: think time-sensitive graphics applications and video.

Big bandwidth is required for three-dimensional modeling and "white-boarding"—the ability for many users to work on a document at the same time. Corporate pioneers like Boeing Corp. already use these applications; in fact, the latest Boeing 777 aircraft was mocked up entirely by engineers collaborating digitally worldwide. Moreover, Microsoft's NetMeeting software, which allow for multi-person video and audio conferencing over the Internet, is being trialed by ISPs.

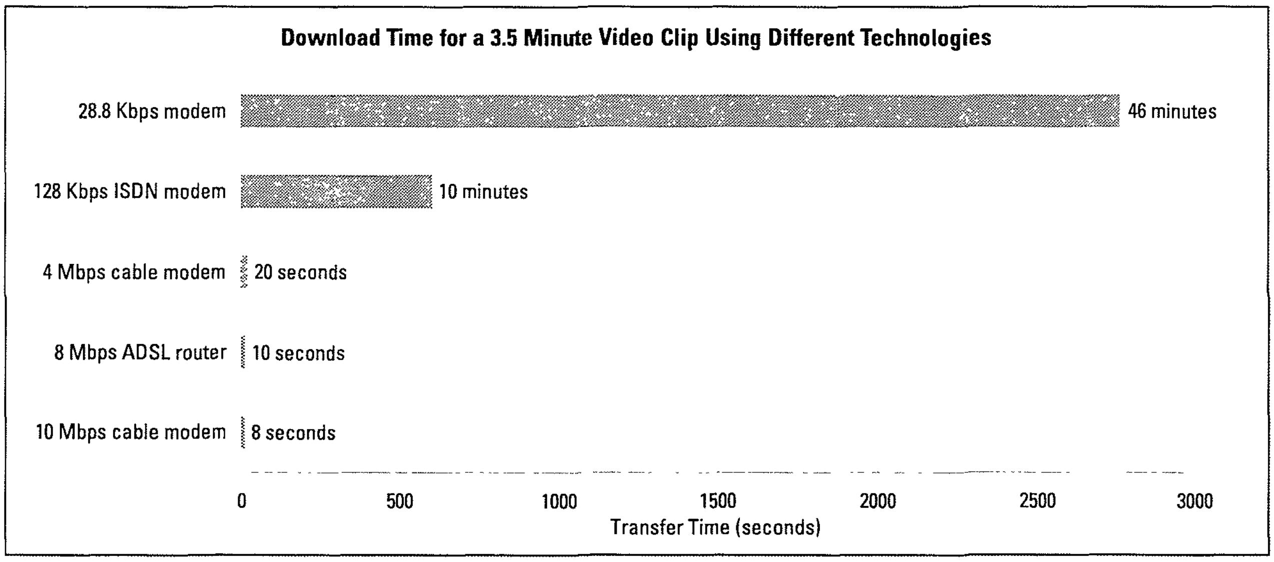
Kesmai Studios (www.kesmai.com), a multi-user Internet-based games company, counted 1.5 million users in the fall of 1998, and doubled its bandwidth usage over the course of the year. But what's most remarkable is that 90 percent of its users access the Internet on analog modems with rates between 28.8 and 56 Kbps. Today, the company engineers its products to take this into account, but expects the real bandwidth adventure to begin when faster local access exists.

Online games may be a niche service for 14-year-olds today, but the technology required for handling multiple point-to-point real-time traffic can be directly cross-applied to broader commercial uses, such as in medicine, education, and business. Today, many working groups of the Internet Engineering Task Force (IETF), the Net's standards setting body, are broadcast over the M-Bone, or "Multimedia Backbone," an experimental virtual network atop the Internet that is engineered to support real-time video traffic. If there's enough bandwidth generally, the entire Internet may support these applications. And as the IETF protocol developers say: "If you build it, they will come."

Bandwidth Conservation Technologies

Before we conclude that faster Internet "on-ramps" and new applications will radically boost traffic and hence the bandwidth demanded of the Internet's spoke-like architecture, some cau-

Figure 24. Why Broadband Matters



Source: FCC and TeleGeography, Inc. © TeleGeography, Inc. 1998

tion is necessary. Fast on-ramps or not, some new services may well reduce the overall demand for global bandwidth.

The Internet is like a living organism. It has feedback mechanisms to protect it if too much stress occurs. In this case, as congestion grows due to the bandwidth consumption of new services, the Internet community tends to discover ways of delivering more efficient routing and transmission.

For example, caching Internet content closer to the user—say, at a local ISP—eliminates the need for some of the bandwidth that otherwise would have been used to access Web content over long-haul routes. And deploying IP multicast technology which aggregates flows, means that each new viewer of streaming media does not add much to the overall long-haul bandwidth consumption, though it certainly will at the last mile. Finally, taking fax and voice traffic off the PSTN may increase Internet bandwidth, but it also frees up capacity on another part of the network (in this case, the PSTN which may share the same long haul transmission facilities). All three services require a closer look.

Internet Caching

Caching is misunderstood, believes Barry Raveendran Greene, a Cisco engineer in Singapore. On the surface it saves bandwidth by locally storing or coding the most frequently requested Web pages rather than satisfying each new request for the same page from a remote web server. One company, MirrorImage Inc. (www.mirrorimage.net), claims to save between 30 to 40 percent on local caches and up to 75 percent of bandwidth consumption when local caches are linked to an upstream cache. David Peterschmidt, CEO of rival cache company Inktomi Corp. (www.inktomi.com), claims one European carrier realizes up to 80 percent bandwidth cost savings. Greene himself admits that Singapore's government-mandated proxy servers, which also act as caches, effectively double the bandwidth of the city-state's three ISPs, which otherwise would be on a trans-Pacific route to the U.S. or Canada.

But those figures are misleading. A cache simply permits the end user to access the page faster. The result: "Users click more," says Greene. And eventually, they click through cached content and into non-cached Web pages. A cache saves on bandwidth costs and makes networks more efficient, but it doesn't reduce the need for bandwidth per se. There is no evidence that carriers are provisioning less bandwidth due to implementing caches. In fact, carriers that have deployed caches, such as Australia's Telstra, follow the industry trend in bandwidth consumption; in Telstra's case, ten percent growth per month, corresponding to 200 percent a year, according to John Hibbard, Telstra's vice president of international carrier business.

To be sure, caching is becoming an essential part of network design for international carriers. Since 1997 it has gone from small scale deployments with individual ISPs to large scale outlays by major carriers. But caching is really about network evolution, not about saving money or bandwidth. In the same way as computing went from mainframes to PCs—changing the architecture of where information is stored based on the cost/performance factors of memory—so too is caching merely adding a storage capability to network design.

And caching proponents are also looking skyward—at satellites. Since more than one ISP may need access to the content, satellites are being called in to beam the content to local proxy servers on an ISP's network. Teleglobe and Intelsat teamed up in late 1998 to trial a such a service for ISPs outside the United States (see Figure 25).

Streaming Media

Streaming media, the term for bringing audio and video onto the Internet by streaming its packet flow, is often predicted to bring the Net to its knees. It may actually lighten the Internet's load. Currently, each request for a web page—including video or audio content—generates its own unique flow of data. Two users in the same office building, for instance, get two separate streams. However, some networks that host sites specializing in real-time media content are able to deploy multicasting technology that cleverly aggregates the flows to the optimal point, before sending it onward to different users. Once multicasting protocols are standardized, the service will operate over numerous backbone networks. One flow instead of hundreds on the long-haul lines saves bandwidth.

Webcasting and streaming video and audio are increasing in popularity. NetRadio (www.netradio.com), which offers 150

Figure 25. Satellites and the Internet

While futuristic broadband satellite systems like Celestri, Skybridge and Teledesic get ready to light up the sky with Internet access, today's birds are beaming bits now.

There are actually some clever advantages to using satellites for the Internet, especially for Internet service providers outside the United States. They provide connectivity in a single direction, and are well-suited for point-to-multipoint uses, like streaming media. Also, satellites offer an inexpensive way to transfer large amounts of regular data, like the current 20 megabits per day of USENET data. Some ISPs in Europe and the U.S. provision them to assure redundancy in case terrestrial links fail. In the future, using satellites for individual Internet connectivity is set to become standard fare (see "The New Global Mobile Satellite Systems" on page 106).

Satellites found their first niche in providing Internet service in regions untouched by international fiber lines, such as the Middle East, Africa and most of South America. For many countries in those regions, satellites are the only means of gaining Internet access.

For most other countries with a choice of infrastructure, a satellite is the last resort since the performance lags far behind terrestrial fiber. When it makes sense, it is often because it permits ISPs to bypass the artificially high prices of the national carrier. Even in deregulated Australia, the ISP Ozemail Ltd. was able to cut costs by 37 percent by using a 45 Mbps satellite connection across the Pacific, skirting Telstra Corp. and Optus Communications Ltd., the country's submarine cable duopoly.

Yet there are many difficulties with using satellites for Internet service. They have much greater delay than fiber, which engineers have to take into account. Also, many satellite systems contain technical limitations to how much bandwidth they can transmit at any time. The barrier for the best birds is 155 Mbps, but most satellites are transmitting under 45 Mbps. Finally, the base TCP/IP protocols have to be jerry-rigged. Internet traffic flows customarily send an acknowledgment that each packet arrived safely at the next hop—but back-channeling all these "acks" over the Earth to get to the previous hop wastes expensive capacity, so it is not done.

That said, satellite use for the Net—estimated at under five percent of total Internet capacity—is more than doubling each year for some powerful commercial reasons. Satellite links, like the Internet itself, are asynchronous. Leasing a trans-oceanic circuit offers a two-way channel, yet the majority of Internet traffic tends to be inbound from the U.S. A typical web surfer trickles out a couple of bits to request content from a Web site, and back at him streams graphics, music and video clips.

Far better—and in some cases cheaper—is to send U.S.-bound traffic over cable, and use satellite for the data-heavy return path. Over the past few years a number of providers around the world, including Brazil's Embratel and UUNet France, have done just that. Interpacket Inc. (www.interpacket.net) of Santa Monica, California has made substantial inroads into Latin America, and the France-based NetSat (www.internetsat.com) has similarly in the Middle East and Africa.

Indeed, by supplying the bandwidth via satellite rather than cable, service providers outside the U.S. are able to turn the tables on U.S.-based ISPs. As it stands today, non-U.S.-based providers must pay for the full cost of circuits into the U.S., unlike the telephony world where the cost is evenly shared.

Thus, purchasing one-directional capacity lets the ISP outside the U.S. maintain good service quality for its own users (who access U.S. content), without providing better connectivity to the growing number of U.S. users who wish to access content in the foreign country without paying for the international link. Satellite technology may thus impact the politics of backbone financing and force U.S. backbones to strike a new commercial deal with off-shore ISPs.

Other innovative Internet satellite uses include content caching, and two companies—SkyCache (www.skycache.net) and MirrorImage (www.mirrorimage.net)—already offer such services, by beaming popular web pages to proxy caches to reduce the need for US-bound bandwidth. Finally, as a broadcast technology, satellites are well-suited for multicasting web content to many destinations in a single flow. That's what Teleglobe had in mind when they began trialing a "push" service in late 1998 to send specified content directly to service providers outside the U.S. The company believes the key driver will be beaming high-demand, data-heavy, real-time web content worldwide.

different music and program channels, counts a monthly global audience of three million listeners. Broadcast.com, with its real-time cybercast events, reported one million new visitors to its web site the day Clinton's heretofore "secret" video testimony hit the Net. Though a small fraction of visitors actually saw the video, that was enough to send the company's stock price skyrocketing.

The numbers of users for the services are growing, too. RealNetworks Inc. (www.realnetworks.com), the most popular streaming media software vendor, said that 3.5 million users downloaded its product in July 1998, double the number from a year earlier. Currently 28 million users have installed the software. The company is aware of the stress web video and audio places on backbones, and has allied with cache companies and ISPs to implement architectures to decrease the long-haul bandwidth consumption.

Engineering backbones to handle this amount of traffic is difficult. UUNet, for example, needed to create a sort of virtual overlay network, a service they call UUCast. But with abundant bandwidth, that may not be needed. And the bandwidth savings from aggregating the same traffic flow to many users will decrease the overall bandwidth consumption the service requires.

Internet and IP Telephony

The migration of fax and voice traffic from the PSTN to the Internet is also unlikely to be a major driver of new bandwidth. That could make the loss of PSTN revenues more painful to incumbent carriers, however, because off-setting increases in bandwidth fees may not materialize.

Research firms love to conjure up statistics about this scenario. London-based Tarifica has predicted that by 2001 incumbent carriers will lose from three to 11 percent of their yearly revenue due to Internet telephony. And there's no doubt that Internet telephony and fax services are growing quickly. A number of new carriers have begun services in 1998, such as RSL, PSINet and ICG Netcom, as well as incumbent carriers like Telnor, Telia, Deutsche Telekom and even AT&T, in Asia. Actual usage, however, appears limited and does not seem to support the most fearful forecasts. Instead, industry executives are now downplaying whether Internet telephony actually costs less than circuit-switching, and are promulgating all the benefits computer-telephony integration will bring (see Figure 26).

Importantly, there is a difference—sometimes not understood—between Internet and IP telephony. The former uses the public Internet's infrastructure, mixing the voice calls with unpredictable web traffic and routing it all over ISP exchange points to swap it with other providers. On the other hand, IP telephony simply uses Internet Protocol as the means to packetize the voice traffic, often for use over a corporate user's regular leased lines. In the case of PC-to-phone calls, popularized by VocalTec (www.vocaltec.com), users dial in to their ISP and the traffic is then transmitted over the public Internet.

But the majority of firms in the market seek to keep the calls on their own network for as long as possible, to lower costs and ensure better quality. As a result, the traffic may never actually be on the public Internet per se, as it often makes sense to dedicate a circuit optimized for voice over IP. And nascent federations of IP telephony companies are extending their coverage by striking interconnection agreements among themselves, creating a de facto parallel network. But either on the public Internet or not, in terms of bandwidth consumption the end result is the same—operators and users need to provision bandwidth for IP calls, rather than use the PSTN.

Figure 26. Internet Telephony: Build Once, Run Anything?

Packets, schmackets. In the short term, Internet telephony—phone calls and faxes—is cheaper on some routes because it runs over international private lines that avoid the accounting rate regime.

But it is only marginally more efficient, technically speaking. Where the circuit-switched PSTN transmits long distance calls using compression algorithms of 32 kilobits per second, IP telephony can compress data over a connectionless network at eight Kbps. Yet it often results in poorer sound quality.

Scrap the accounting rate, and wait for advances in circuit-switched technology to compress voice more efficiently, and the cost difference soon disappears. Mike O'Dell, the chief scientist at UUNet decries IP telephony's cost advantages as: "one of the great myths of all time."

But the best engineering and business minds proclaim IP telephony will be a winner since it will enable new communications applications that meld voice and data.

That's the logic behind the new networks of Qwest Communications Inc. and Level 3 Communications Corp., which are building massive, pure-IP networks. One early application of this convergence is MCI WorldCom's Vault service, which lets users click on web-enabled call centers.

"IP Telephony is not always cheaper," admits Jeff Pulver, an IP telephony consultant. "The investment that needs to happen [is] so that the service providers have the infrastructure to support the wide range of future IP-based services. IP voice will be just one."

Yet there may be cost advantages, nevertheless. Juha Heinänen, Telecom Finland's chief IP network architect, believes "the real savings of voice over the Internet is not cheaper phone calls—the savings come from the infrastructure: You don't need to build more than one [network]."

Figure 27. The ITU and the Internet

The International Telecommunication Union (ITU), long considered irrelevant in the brave new world of the Internet, has made a concerted effort to catch up. It presented its prestigious silver medal to Vint Cerf, the co-inventor of Internet Protocol, in November 1995, followed by one in July 1998 to Jon Postel, an Internet old-timer who headed the Internet Assigned Numbers Authority. In September 1998, it announced that all new standards work would be immediately reassessed to see how it might dovetail with protocol developments at the Net's standards body, the Internet Engineering Task Force. That comes despite the ITU's refusing to recognize IETF specifications for years because it is not a government-sanctioned standards group.

At the ITU's quadrennial plenipotentiary conference in Minneapolis in October 1998, U.S. Vice President Al Gore called on governments and industry to boost Internet penetration, especially in the developing world, to promote democracy and electronic commerce:

Today, I want to pose five great challenges. Together, they make up a Digital Declaration of Interdependence.

First, we must improve access to technology so everyone on the planet is within walking distance of voice and data telecommunications services within the next decade. Second, we must overcome our language barriers and develop technology with real-time digital translation so anyone on the planet can talk to anyone else. Third, we must create a Global Knowledge Network of people who are working to improve the delivery of education, health care, agricultural resources and sustainable development—and to ensure public safety. Fourth, we must use communications technology to ensure the free-flow of ideas and support democracy and free speech. Fifth, we must use communication technology to expand economic opportunity to all families and communities around the globe.

The full text of Vice President Gore's speech can be found on the ITU's web site at http://www.itu.int/newsroom/press/PP98/Documents/Statement_Gore.html.

And what about the impact on total bandwidth? The lower price of Internet telephony and fax will boost consumption, which in turn increases the need for bandwidth dedicated to IP. But the result may be that a carrier simply leases an extra circuit to a firm offering Internet telephony. More traffic is likely to be squeezed onto that circuit than before when it was allocated to PSTN traffic. The result could be a net decrease in total bandwidth required. What happens in practice thus will bear close watching because, in theory, IP telephony seems unlikely to be a significant factor in changing the bandwidth provided by global telecom carriers.

Rather, IP telephony is more likely to have its largest impact in driving down prices, the mainstay of traditional carriers' revenues. IP telephony avoids the accounting rate on international calls and faxes since it moves over private lines; in the U.S. long distance market, it bypasses local access fees. Executives at pre-paid calling card companies say privately that on many routes, the calls already are routed via Internet gateways.

In some cases, IP telephony just makes technological sense. Faxes are better suited to the Internet's store-and-forward data networking architecture than to a dedicated circuit engineered for real-time transmission.

Yet, very few companies use the public Internet's infrastructure today because there is essentially no way to control quality of service, especially if the traffic travels between different networks. Common standards for IP telephone services could change that (see Figure 27). In the interim, three models are emerging. One is to offer IP telephony as an end-to-end service on a single provider's network. That costs a lot of money to build, and only the operators with the largest global footprint can manage it. But that's also the best way to control costs, since no interconnection is required. It was no coincidence, then, that PSInet (www.psinet.com) began offering corporate users an IP telephony service at the same time as it announced the purchase of numerous Asian ISPs, after having bought out a fleet of ISPs in Europe over the course of the preceding 12 months.

Another model is for "federations" of ISPs, interested in being IP telephony operators, to emerge. This formula is championed by GRIC Communications Inc. (www.gric.com). The company began as an "ISP roaming" service that allowed users of different service providers to use infrastructure in areas where their own network lacked coverage. It now brings disparate providers together under a single roof. GRIC licenses the technology, and oversees a settlement between the different ISPs whose network are used—all the while taking a small commission for its efforts.

Finally, true IP telephony clearinghouses may spring up, such as ITXC Corp., the Internet Telephony Exchange Carrier run by former AT&T executive Tom Evslin (www.itxc.com). Unlike GRIC, it is less an alliance and more of an independent service. It hopes to serve as the third-party broker among all the different IP telephony operators.

In the first model, the traffic stays on a single provider's IP network. The other models have traffic swapped between numerous providers—in GRIC's case, over their regular public Internet infrastructure, and in ITXC's case, most likely over separate IP networks dedicated to Internet telephony traffic.

Figure 28. Future Scenarios

Three Possible Future Scenarios

1. Complete network convergence:
   - A single network that melds voice and data emerges.
   - Rising bandwidth demand due to new applications keeps backbone prices up.
   - Long distance voice calls are (nearly) free.
   - New regional infrastructure reduces US-centric Internet.

2. Heterogeneous networks:
   - Two networks co-exist, one optimized for voice, one for data.
   - Capacity exceeds demand, with drastic fall in backbone prices.
   - Cheap trans-oceanic bandwidth discourages regional infrastructure; US-centric Internet continues.
   - Service-oriented firms exploit cheap bandwidth, stealing carriers' retail business.

3. Neither and Both:
   - Separate networks continue due to cost of convergence.
   - Pace of global Internet adoption slows, mirroring take up of telephony.
   - Excess bandwidth drops prices; capacity lit up incrementally to keep prices higher.
   - The trend towards convergence remains just a trend, as multimedia services stay primarily on broadcast and cable TV networks.

Regional Exchange Points

The demand for international bandwidth will also be affected by the deployment of more private and regional Internet exchanges. Here, too, there are strong conservation incentives. As we have seen, international ISPs are switching traffic via the U.S. based on a marketplace anomaly—the high cost of telecom capacity in their region due to the historic lack of competition. As that changes, infrastructure prices should fall, making it advantageous to keep more local traffic local. But for that to happen, more local exchange points will be needed.

In the U.S., a number of companies have made private exchange points the mainstay of their business model. InterNAP (www.internap.com) and Savvis (www.savvis.com) are perhaps the most prominent. In Savvis' case, the ISP operates nine private NAPs so as to terminate around 90 percent of their Internet traffic directly. By providing customers with "the shortest, fastest, and 'cleanest' route to almost any location on the Web," Savvis believes content providers and downstream ISPs will sign on.

The companies deploying private NAPs pay to peer with the larger backbone networks—indeed, they rely on the backbones for transit to reach other networks and customers downstream in the rare cases where they lack a direct connection. Both companies seek out the most efficient routes for traffic flows, which results in more efficient bandwidth consumption on their domestic backbones. If the model were applied internationally, trans-oceanic bandwidth would be reduced as carriers that send intra-regional traffic across an ocean to exchange it, would instead keep it local.

The percentage of traffic in Asia and Europe that stays local is already changing. As the number of Internet users outside the U.S. grows (see Figure 16), so too will new Internet content companies and electronic commerce firms that attract their traffic. And with that, the number of exchange points that bypass the U.S. will grow. Over the past 18 months, a national NAP has been built in almost every European country. But these are generally used for national traffic. In Asia, exchange points don't really exist: traffic is routed at the national location of each regional backbone initiative—be it Singapore, Japan, Hong Kong or Australia. However, as we've already seen, in almost all cases the different backbones themselves do not exchange traffic inside the region but haul it to the U.S.

V. Conclusions: What Happens Next?

The Economist magazine once called the Internet the "accidental superhighway." Keep that in mind in thinking about where it will go from here. No one really knows.

The Internet is both the catalyst and embodiment of a new world—one that little resembles the present one. Consider the 1998 World Cup soccer tournament. The event, which attracted the highest number of television viewers ever, took place in France. But of the four computers hosting the Cup's web site, only one was located in Paris. The others were on the east coast, west coast, and middle of the United States, mirroring the topology of the Internet rather than the geography of the event. In a world of materialism and industry, geography matters; transporting raw materials, goods and people from place to place is central for businesses. But in a digital economy, information is the main product of value, and connectivity is what matters.

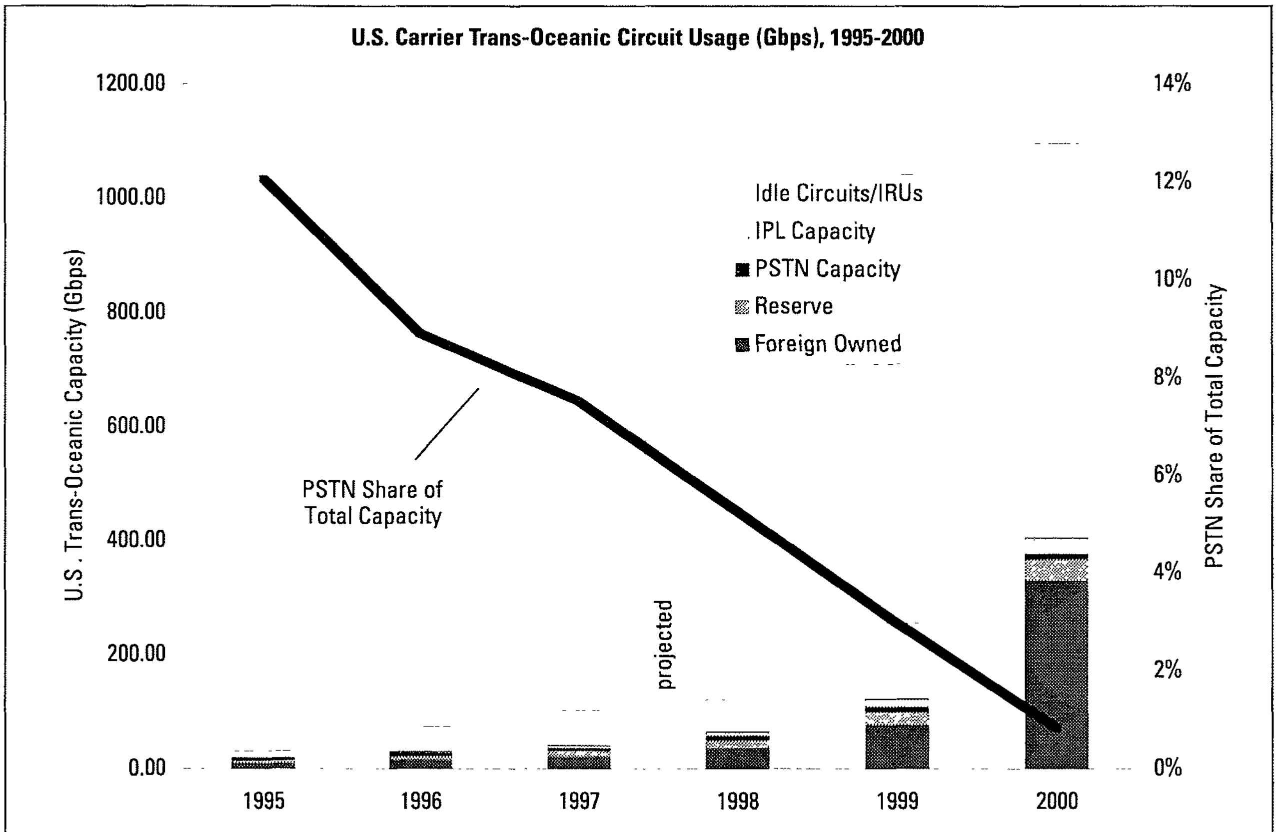
We've seen that here. The largest IP backbone providers are at the top of the Internet food chain, benefiting from downstream ISPs who are their customers. But being on top has a cost—the backbone carriers are forced to make continual massive investments in infrastructure to keep up with demand. In an era of bandwidth scarcity, that sounds like a terrific business model. Yet if bandwidth becomes plentiful (see Figure 29), these same ISPs may find themselves on the losing end as connectivity becomes a commodity.

But, let us consider a less extreme case. How might the future differ if long haul bandwidth is less plentiful because of large new demands, say from IP entertainment services? What of the Internet's future then? There are at least three possible scenarios (see Figure 28).

The first is almost complete network convergence, which many "next-gen" carriers are hoping for. In this world, voice is a small fraction of traffic. So it is subsumed into a single network, called the Internet, that has enough capacity to carry any real-time applications. New types of communication, melding voice and data, emerge. These new applications treat bandwidth as abundant so they never seek to compress or optimize it, resulting in a continual demand for bandwidth that keeps prices high. However, the price of voice calls plummets to its provisioning cost of near zero. The fast pace of both demand and new capacity continues making the commercial environment more predictable.

The economies of scale derived from a single network, and the lower cost of entry for new network construction due to new technologies, also encourage new regional infrastructure. That fosters more direct connections between countries, dramatically decreasing the U.S.-centricity of the Internet. The radical jump in demand between 1994 and 1998; the growth of capacity from 1999 to 2003; and the phenomenon of U.S. hubbing for Internet traffic, all come to be seen as historical aberrations.

Figure 29. Voice's Shrinking Role



Note: Data based on TeleGeography submarine cable research and FCC circuit status reports filed by U.S. carriers (see "U.S. Carrier Circuit Usage" in the International Facilities section of this report). "Reserve" capacity assumes that 100 percent of used capacity is also held in reserve for restoration. "Foreign-owned" capacity includes circuits owned by foreign carriers, which the FCC estimates at 25 to 30 percent of total capacity. "Idle Circuits/IRUs" includes circuits owned by carriers at year end but not in use as well as unsold capacity on submarine cables. Satellite capacity utilization is generally not reflected by this data because U.S. carriers do not acquire international satellite capacity in advance.

In the second scenario, networks are heterogeneous: voice is a small fraction of traffic, yet its different technical characteristics makes a separate network tenable. The huge increase in available capacity is not matched by a corresponding rise in demand, leading to a bandwidth glut, with a drastic fall in prices. And since the cheapest bandwidth is trans-oceanic, the U.S.-centric nature of the Internet continues, which reinforces the economic disincentive to build out regional Internet infrastructure.

In this world, companies that focus on services above the transport layer, many of them small and innovative, can profit from cheap connectivity at the expense of the carriers who built it, and who focus mainly on transmission.

The final scenario is a combination of both, yet it is distinct. The cost and technical means of transitioning the network costs more and takes longer than the optimists predict. This leads to a mixed network and application environment for the next decade. And just as over half the world has never made a telephone call, so too does the pace of Internet use, and the demand on the network, progresses slowly relative to the available bandwidth. Capacity greatly outstrips demand so prices fall, yet new capacity is only lit up incrementally in a bid by carriers to maintain (somewhat) higher prices than otherwise would be the case. Hence, the Internet's topology continues to be largely U.S.-centric, because provisioning high capacity backbones via the U.S. is still cheaper than many direct connections. Similarly, the trend towards convergence is just that, a slowly progressing trend.

But there's one "wild card" that must be on every carrier's radar screen: the role of entertainment. Web users are watching less television. It might not be because Internet users are smarter than the rest of us. It's because the Net is fast developing into an entertainment medium. Soon, as cable modems, Internet-ready TV appliances and sites such as Broadcast.com gain mainstream acceptance, the difference between the TV and the computer may vanish. But will the Net's infrastructure morph accordingly? Probably not, though it is far too early to say. What is certain is that it will keep the regulators busy in their efforts to modernize national and international rules for network convergence.

Despite the growth of satellite TV transmission, local programming still remains the most popular around the world, barring noted exceptions like *Dallas*, Michael Jordan, and *The X-Files*. CNN and Dow Jones' *Wall Street Journal* know this: They've invested heavily in local editions of their products.

Thus, despite the "world wide" name of the Web, as the Net becomes more entertainment-oriented, we should expect more local content, not less (see Figure 31). That should boost regional traffic on Internet backbones, not trans-oceanic volumes.

So stay tuned. The future, as it's often said, may not be what it used to be. Will telecom carriers be prepared?

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Figure 30. Internet Protocol Developments on the Horizon

On going changes to the base Internet Protocol are intended to make the Net as reliable and scalable as its voice telephony counterpart. Here are a few additions to the alphabet soup of Internet abbreviations:

QoS - Internet engineers are devising ways to build quality of service (QoS) into IP, which specify a class of service for which the user pays extra. Two models are being studied. One specifies priority traffic and gives those packets precedence to tunnel through congested routers. Another simply drops "out-of-profile" packets in periods of congestion, i.e. "pay up or die..." Either way, the result is the same: not all packets are treated equally.

RSVP - Another protocol enhancement, called Resource Reservation Protocol (RSVP), reserves bandwidth in routers all along the path, similar to "call set-up" on the PSTN. Users are assured of getting the bandwidth an application or session requires, but pay extra for it, since it effectively denies the bandwidth to other users even if it is not all used. Yet the technique doesn't scale very well: There's a small limit to the number of simultaneous reservations a router can handle, and there is no way to assure another RSVP-compliant network will respect the bandwidth reservation. Nevertheless, it suggests the telephony and data worlds are drawing closer.

IPv6 - An Internet Protocol address which assigns unique numbers used for routing traffic, is limited in size to 32 bits which allows for four billion hosts. However, as Christian Huitema, the former head of the Internet Architecture Board, points out, "it would be immoral" not to provision for at least every human—with perhaps 100 different devices connected, from pace makers to toasters. IPv6, so far only deployed on research networks, uses a 128-bit address, allowing for a quadrillion separate hosts. It also has security, multicast, and real-time flow enhancements to today's IPv4 (version 5 exists experimentally). Yet, lacking a sufficient incentive to migrate to IPv6, the marketplace has resisted it.

Acknowledgments
I gratefully thank my editors, Jason Kowal and Greg Staple of TeleGeography, who (patiently) challenged and encouraged me. While scores of conversations helped form this article, the following people deserve special mention: Fred Baker, Erik Bataller, Scott Bradner, Robert Cohen, James Crowe, Mike O'Dell, George Gilder, Barry and Laina Raveendran Greene, Geoff Huston, David Isenberg, Mark McFadden, Sam Paltridge, Robert Pepper, Kevin Werbach, and, of course, Robert Young. Finally, appreciation is due *CommunicationsWeek International* for providing me the opportunity to report on the Internet.

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Figure 31. *Quelle Langue* is the Internet in?

Ce n'est pas étonnant que l'Internet est centralisé aux Etats-Unis when you consider that the majority of its content is in English.

Language matters. The entertainment industry knows well that local programming draws viewers. That's one reason why media companies produce regional editions of their content. The Web directory Yahoo already boasts 11 non-English-based search engines specializing in local language sites.

As more local content is created in local languages, Internet traffic may remain local too.

While it is difficult to determine the breakdown of English-language Web sites relative to other tongues, a 1996 survey by the Internet Society (www.isoc.org) noted that English accounts for 82 percent of home pages on the Web, trailed by German with four percent, Japanese with 1.5 percent, French at 1.5 percent, and Spanish at 1.1 percent. And a July 1998 study by Network Wizards shows that over half of all domain names are registered in the United States.

Luckily, technical obstacles are being overcome. Netscape and Microsoft have both released browsers in Arabic, Japanese, and other Asian and European languages. Software products now easily render Web sites based on Unicode, a computer standard capable of coding all the world's languages that do not use the Latin alphabet, and thus can not be digitized in ASCII (American Standard Code for Information Interchange).

As the Web invades new nations, this diversity of language will grow. A symbol of this came in July 1998 when Deja News, a Web site that archives Internet newsgroups, said it would support 17 different languages. The company's president, Guy Hoffman, said "as much as 30 percent" of the 50,000 monitored e-mail forums are not in English. The next most popular languages were Chinese, Russian, and German.

But politics still gets in the way. A French association dedicated to preserving the language went so far as to sue a U.S. university's study-abroad program since its site was in English, though the case was latter thrown out on technical grounds. Now, France's Ministry of Culture funds French-language content creators in an effort to boost the language's use over the Net.

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Internet Hosts by Economy, 1993-1997

Figure 1. Internet Host Computers by Economy, A-D

Country	1993	1994	1995	1996	1997	CAGR 1993-97
Afghanistan	0	0	0	0	1	n.a.
Albania	0	0	35	79	117	n.a.
Algeria	0	10	16	28	49	n.a.
Andorra	0	0	10	171	491	n.a.
Angola	0	0	0	2	4	n.a.
Antigua & Barbuda	0	0	160	169	184	n.a.
Argentina	762	3,159	9,468	19,697	36,828	163.7%
Armenia	0	0	173	177	443	n.a.
Aruba	0	0	0	98	87	n.a.
Australia	92,879	169,183	327,127	544,385	736,604	67.8%
Austria	16,274	30,157	59,595	99,354	133,811	69.3%
Azerbaijan	0	0	16	30	347	n.a.
Bahamas	346	864	2,169	3,388	7,888	118.6%
Bahrain	0	0	142	841	339	n.a.
Bangladesh	0	0	0	0	0	n.a.
Barbados	0	0	2	21	23	n.a.
Belarus	0	1	18	257	710	n.a.
Belgium	8,459	20,885	38,206	77,858	137,557	100.8%
Belize	0	0	1	12	258	n.a.
Benin	0	0	0	9	13	n.a.
Bermuda	75	662	1,019	1,968	3,657	164.2%
Bhutan	0	0	0	0	2	n.a.
Bolivia	0	0	66	431	552	n.a.
Bosnia	0	0	0	36	373	n.a.
Botswana	0	0	24	25	552	n.a.
Brazil	5,646	10,954	31,195	95,839	162,122	131.5%
Brunei Darussalam	0	0	156	206	340	n.a.
Bulgaria	17	138	1,060	3,327	6,851	348.4%
Burkina Faso	0	0	0	1	45	n.a.
Burundi	0	0	0	0	0	n.a.
Cambodia	0	0	0	0	48	n.a.
Cameroon	0	0	0	0	2	n.a.
Canada	128,904	293,184	606,151	996,754	1,784,698	92.9%
Cape Verde	0	0	0	0	0	n.a.
Central African Rep.	0	0	0	6	0	n.a.
Chad	0	0	0	0	0	n.a.
Chile	1,478	3,319	9,608	16,865	20,177	92.2%
China	14	604	2,223	19,816	16,634	202.0%
Colombia	315	1,913	3,985	11,960	17,157	171.8%
Comoros	0	0	0	0	0	n.a.
Congo	0	0	0	1	4	n.a.
Costa Rica	418	1,304	2,605	5,362	7,463	105.6%
Côte d'Ivoire	0	0	3	202	253	n.a.
Croatia	339	1,047	2,467	4,644	8,263	122.2%
Cuba	0	0	1	24	51	n.a.
Cyprus	0	1	392	1,460	3,023	821.7%
Czech Republic	4,582	10,683	22,483	41,904	59,411	89.8%
Denmark	11,131	25,335	65,739	132,339	230,912	113.4%
Djibouti	0	0	0	4	0	n.a.
Dominica	0	0	0	55	76	n.a.

Note: An Internet host typically represents one computer connected to the Internet, although many users may be connected through a single host. Data distributes the generic Top Level Domain (gTLD) host registrations between countries according to registrations in September 1997.
Source: International Telecommunication Union, *Challenges to the Network: Internet for Development*, drawing upon Internet host data published by Network Wizards and RIPE, and global Top Level Domain (gTLD) distribution data published by Imperative.com.

Figure 2. Internet Host Computers by Economy, D-L

Country	1993	1994	1995	1996	1997	CAGR 1993-97
Dominican Rep.	96	239	663	3,184	6,976	n.a.
Ecuador	246	570	1,042	1,497	3,215	90.1%
Egypt	63	285	850	2,464	2,978	162.4%
El Salvador	0	0	23	132	196	n.a.
Equatorial Guinea	0	0	0	0	0	n.a.
Eritrea	0	0	0	0	0	n.a.
Estonia	439	1,160	3,590	8,000	15,880	145.2%
Ethiopia	0	0	1	1	78	n.a.
Faroe Islands	0	0	52	96	285	n.a.
Fiji	5	5	52	75	92	107.1%
Finland	33,878	70,244	220,046	321,464	504,411	96.4%
France	62,042	104,050	196,504	313,332	538,788	71.7%
French Guiana	0	0	0	27	120	n.a.
French Polynesia	0	0	0	25	190	n.a.
Gabon	0	0	0	0	5	n.a.
Gambia	0	0	0	0	0	n.a.
Georgia	0	0	57	213	414	n.a.
Germany	124,011	229,825	542,239	806,328	1,407,274	83.5%
Ghana	0	0	6	203	252	n.a.
Greece	1,952	4,070	8,954	18,784	33,048	102.8%
Greenland	0	3	88	215	294	n.a.
Grenada	0	0	0	0	1	n.a.
Guadeloupe	0	0	0	7	57	n.a.
Guam	0	0	55	122	77	n.a.
Guatemala	48	121	291	720	1,736	n.a.
Guernsey	0	0	0	5	22	n.a.
Guinea	0	2	2	2	0	n.a.
Guinea-Bissau	0	0	0	0	11	n.a.
Guyana	0	0	0	52	67	n.a.
Haiti	0	0	0	10	0	n.a.
Honduras	0	0	0	408	74	n.a.
Hong Kong	10,048	23,253	41,391	89,133	162,681	100.6%
Hungary	3,196	7,192	16,594	31,192	71,137	117.2%
Iceland	1,782	4,579	8,425	11,736	18,986	80.7%
India	148	383	841	3,191	7,390	168.2%
Indonesia	702	1,932	6,197	16,077	25,192	n.a.
Iran	0	18	271	285	204	n.a.
Iraq	0	0	0	0	0	n.a.
Ireland	2,886	6,912	16,559	32,164	52,529	106.5%
Israel	7,110	14,686	32,104	56,813	104,966	96.0%
Italy	21,077	40,330	101,580	192,071	360,520	103.4%
Jamaica	0	76	164	249	267	n.a.
Japan	42,769	96,632	269,327	734,406	1,168,956	128.6%
Jersey	0	0	0	6	3	n.a.
Jordan	117	294	662	1,225	2,856	n.a.
Kazakhstan	0	7	188	809	1,213	n.a.
Kenya	0	0	17	274	459	n.a.
Kiribati	0	0	0	0	0	n.a.
Korea, D.P.R.	0	0	0	0	0	n.a.
Korea, Republic of	11,646	24,703	43,884	90,850	181,027	98.6%
Kuwait	139	221	1,236	2,925	4,070	132.8%
Kyrgyzstan	0	0	0	0	147	n.a.
Lao P.D.R.	0	0	0	0	0	n.a.
Latvia	60	526	1,326	5,789	7,110	230.0%
Lebanon	80	199	524	1,337	2,903	n.a.

Note: An Internet host typically represents one computer connected to the Internet, although many users may be connected through a single host. Data distributes the generic Top Level Domain (gTLD) host registrations between countries according to registrations in September 1997.
Source: International Telecommunication Union, *Challenges to the Network: Internet for Development*, drawing upon Internet host data published by Network Wizards and RIPE, and global Top Level Domain (gTLD) distribution data published by Imperative.com.

Figure 3. Internet Host Computers by Economy, L-S

Country	1993	1994	1995	1996	1997	CAGR 1993-97
Lesotho	0	0	0	1	0	n.a.
Liberia	0	0	0	0	1	n.a.
Libya	0	0	0	0	1	n.a.
Lithuania	1	128	461	1,735	4,057	n.a.
Luxembourg	427	838	2,608	4,746	7,695	106.0%
Macau	0	12	65	179	151	n.a.
Macedonia	0	0	90	194	501	n.a.
Madagascar	0	0	0	27	17	n.a.
Malawi	0	0	0	0	0	n.a.
Malaysia	946	2,883	6,992	29,919	43,611	160.6%
Maldives	0	0	0	33	52	n.a.
Mali	0	0	0	15	0	n.a.
Malta	0	0	69	494	824	n.a.
Marshall Islands	0	0	0	0	2	n.a.
Martinique	0	0	0	0	12	n.a.
Mauritania	0	0	0	0	0	n.a.
Mauritius	0	0	0	122	202	n.a.
Mayotte	0	0	0	0	0	n.a.
Mexico	4,155	8,124	17,003	35,264	54,696	90.5%
Micronesia	0	0	0	38	60	n.a.
Moldova	0	0	5	6	246	n.a.
Mongolia	0	0	0	10	13	n.a.
Morocco	0	0	230	470	1,409	n.a.
Mozambique	0	0	0	31	69	n.a.
Myanmar	0	0	0	0	0	n.a.
Namibia	0	0	11	263	642	n.a.
Nepal	0	0	19	60	139	n.a.
Neth. Antilles	83	208	455	813	1,846	n.a.
Netherlands	48,796	98,554	199,396	317,115	503,235	79.2%
New Caledonia	0	0	1	23	82	n.a.
New Zealand	6,140	32,131	55,618	87,918	177,403	131.8%
Nicaragua	0	49	141	532	506	117.5%
Niger	0	0	0	5	2	n.a.
Nigeria	0	0	0	4	49	n.a.
Northern Marianas	0	0	0	0	6	n.a.
Norway	30,673	50,817	89,669	159,197	314,172	78.9%
Oman	0	0	1	1	672	n.a.
Pakistan	0	0	18	513	1,293	n.a.
Panama	0	0	0	0	0	n.a.
Papua New Guinea	0	0	0	1	53	n.a.
Paraguay	0	0	0	187	299	n.a.
Peru	0	172	816	5,196	3,426	821.7%
Philippines	372	1,264	3,809	7,065	12,573	n.a.
Poland	4,983	11,038	23,679	53,856	90,866	106.6%
Portugal	3,819	5,771	13,347	26,132	48,817	89.1%
Puerto Rico	0	82	82	82	260	n.a.
Qatar	0	0	0	21	190	n.a.
Réunion	0	0	0	0	1	n.a.
Romania	69	527	1,749	7,832	13,611	274.9%
Russia	1,673	7,143	23,268	60,331	113,972	187.3%
Rwanda	0	0	0	1	0	n.a.
Sao Tomé & Principe	0	0	0	0	12	n.a.
Samoa	0	0	0	0	0	n.a.
Saudi Arabia	302	758	1,683	3,069	6,751	117.4%
Senegal	0	0	14	69	117	n.a.

Note: An Internet host typically represents one computer connected to the Internet, although many users may be connected through a single host. Data distributes the generic Top Level Domain (gTLD) host registrations between countries according to registrations in September 1997.
Source: International Telecommunication Union, *Challenges to the Network: Internet for Development*, drawing upon Internet host data published by Network Wizards and RIPE, and global Top Level Domain (gTLD) distribution data published by Imperative.com.

Figure 4. Internet Host Computers by Economy, S-Z

Country	1993	1994	1995	1996	1997	CAGR 1993-97
Seychelles	0	0	0	1	1	n.a.
Sierra Leone	0	0	0	0	0	n.a.
Singapore	3,665	7,481	27,653	37,129	77,403	114.4%
Slovak Republic	377	1,482	3,136	8,182	15,107	151.5%
Slovenia	676	1,787	5,966	14,400	20,920	135.8%
Solomon Islands	0	0	9	154	17	n.a.
Somalia	0	0	0	0	0	n.a.
South Africa	11,576	28,601	51,698	105,053	135,891	85.1%
Spain	19,386	40,669	80,139	161,606	312,675	100.4%
Sri Lanka	0	0	7	350	681	n.a.
St. Kitts and Nevis	0	0	0	2	5	n.a.
St. Lucia	0	0	0	21	14	n.a.
St. Vincent	0	0	0	0	10	n.a.
Sudan	0	0	0	0	0	n.a.
Suriname	0	0	0	4	1	n.a.
Swaziland	0	0	1	226	331	n.a.
Sweden	46,911	89,037	177,651	293,165	481,596	79.0%
Switzerland	35,715	58,213	98,526	163,945	263,728	64.8%
Syria	0	0	0	0	0	n.a.
Taiwan	7,995	14,679	25,858	34,877	177,382	117.0%
Tajikistan	0	0	0	0	11	n.a.
Tanzania	0	0	0	3	25	n.a.
Thailand	956	3,428	7,779	15,526	29,473	135.6%
Togo	0	0	0	5	37	n.a.
Tonga	0	0	2	8	728	n.a.
Trinidad & Tobago	71	177	443	796	2,493	143.5%
Tunisia	0	54	79	41	51	n.a.
Turkey	1,809	5,099	12,595	29,390	63,587	143.5%
Turkmenistan	0	0	0	0	3	n.a.
Uganda	0	0	58	17	30	n.a.
Ukraine	185	534	2,420	6,595	14,039	n.a.
United Arab Emirates	0	1	366	1,804	1,946	821.7%
United Kingdom	127,090	266,573	528,475	868,951	1,347,322	80.4%
United States	1,323,375	2,753,210	5,220,695	8,706,416	17,247,802	90.0%
Uruguay	1	176	634	1,836	10,327	821.7%
Uzbekistan	0	0	35	122	98	n.a.
Vanuatu	0	0	0	7	46	n.a.
Venezuela	910	1,858	4,078	7,330	15,677	n.a.
Vietnam	0	0	0	5	0	n.a.
Virgin Islands (US)	133	331	726	1,242	3,252	122.6%
Yemen	0	0	0	2	10	n.a.
Yugoslavia	3	2	4	2,541	4,912	n.a.
Zambia	0	69	69	173	181	37.9%
Zimbabwe	0	19	93	177	600	214.9%
Africa	**11,639**	**29,042**	**53,175**	**109,929**	**144,379**	**87.7%**
Americas	**1,467,062**	**3,080,753**	**5,913,686**	**9,918,654**	**19,394,554**	**90.7%**
Asia	**87,009**	**193,440**	**473,678**	**1,149,020**	**2,032,630**	**119.8%**
Europe	**614,721**	**1,195,352**	**2,569,217**	**4,283,025**	**7,213,688**	**85.1%**
Oceania	**99,024**	**201,319**	**382,863**	**632,757**	**915,355**	**74.4%**
WORLD	**2,279,456**	**4,699,907**	**9,392,620**	**16,093,385**	**29,700,605**	**90.0%**

Note: An Internet host typically represents one computer connected to the Internet, although many users may be connected through a single host. Data distributes the generic Top Level Domain (gTLD) host registrations between countries according to registrations in September 1997.
Source: International Telecommunication Union, *Challenges to the Network: Internet for Development*, drawing upon Internet host data published by Network Wizards and RIPE, and global Top Level Domain (gTLD) distribution data published by Imperative.com.

Journey to the Center of the Web

by Martin Dodge, University College London

Introduction

Where is the center of the World Wide Web? How do the tens of millions of pages connect to form the Web? How does the density of connections vary through web space? Are some parts tightly woven, while others remain loosely linked backwaters? This article explores how we might measure and map the structure of the Web to help answer these questions.

To analyze the Web's structure, I developed a metric of the centrality of web sites called WebX distance (Web ConneXions) based on the outgoing and incoming hyperlinks for any given site. [1] The structure of hyperlinks has been used by a number of academic researchers to analyze web structure. [2] Alternative methods use web traffic to determine the most popular and, therefore, central sites. [3]

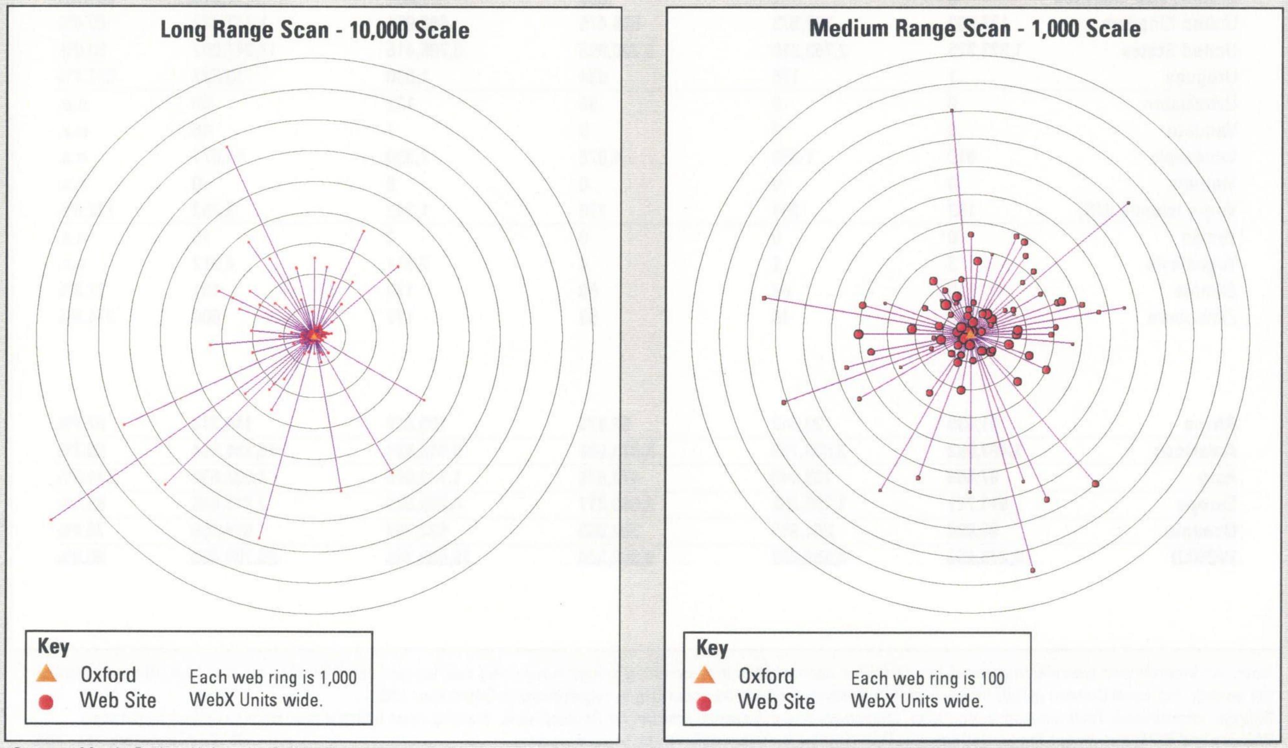
To illustrate the potential of the WebX distance metric, I analyzed a subset of the Web—122 sites of the universities and major colleges in the United Kingdom. I visualize the results as Web Scans, using a style derived from astronomical charts.

To the Center of the Web

Data on the size of Web sites of the U.K. universities and number of hyperlinks between them was gathered using the AltaVista search engine. A script was used to make the 14,884 separate queries to AltaVista, using the syntax +url:<site1>.ac.uk +link:<site2>.ac.uk, necessary to count the interconnection between sites. Over 450,000 links were reported, although the vast majority were internal ones within sites. The connectivity data was analyzed to find the central web site, that is the node that has greatest connectivity to all the other 121 universities. This was the web site of the University of Oxford (http://www.ox.ac.uk).

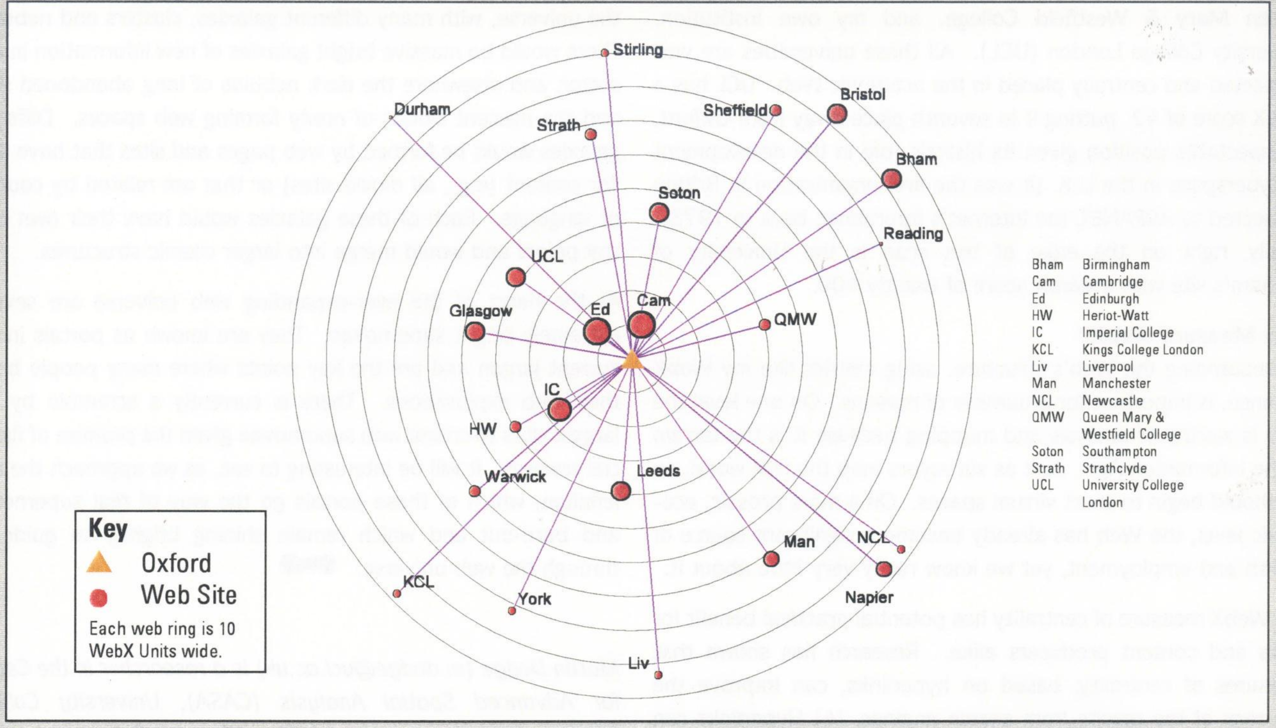
To calculate the relative distance between web sites, hyperlinks were used to create a virtual distance measure—the WebX distance—which was inversely proportional to the number of links between any two given sites. So the more links between two sites, the closer they are in WebX terms. The WebX distance from each university to every other one was calculated and stored as a graph. This graph was analyzed using a shortest path program to measure the distance from each web site to every other one.

Figure 1. Long and Medium Range Web Scans



Source: Martin Dodge, University College London

Figure 2. Short Range Web Scan



Source: Martin Dodge, University College London

The results were normalized by web site size. Oxford's web site had the lowest mean distance being the closest to all other sites. The centrality of other web sites can then be expressed in term of their distance from the Oxford center point (see Figures 1 and 2).

Web Scans

Taking an astronomic metaphor, the Web Scans have Oxford's site as the sun. It is the central point of gravity and light for our small Web solar system, around which 121 planetary web sites spin, their orbital distances being equal to their WebX distance from Oxford. Purple trace lines highlight this distance from the sun. The closer a site is to the Oxford sun, the more central it is. The orientation of the web sites is arbitrary, based on five degree intervals determined alphabetically from the name of the university, although in the future this position could be used to encode other data such as their approximate geographic location. Rings are overlaid on the scans, spaced at regular WebX distance intervals, to act as a visual guide to the scale of the system. Three Web Scans are shown in this article, mapping the system at different scales. They were created using a GIS (geographical information system). Even though GIS technology is usually employed to analyze the real world, it is quite capable of mapping virtual worlds like the Web.

The largest scale, "long range" Web Scan, shown in Figure 1 above, shows the whole system, including the most distant Web sites. The furthest away—the equivalent of Pluto in our Web solar system—is the University of Wales Institute Cardiff (http://www.uwic.ac.uk) way out beyond the 10,000 unit ring, by far the least well connected web site. The most striking feature is the dense cluster of web sites at the center of this system, forming a dense red nebula inside the smallest ring. There are a number of peripheral sites, such as the University of Westminster, Humberside University, the London Business School and Dartington College of Arts. To see more detail at the heart of the system we switch to a mid range Web Scan.

The "medium range" scan in Figure 1 shows only the sites that are 1,000 units or closer to Oxford. At this scale, the web sites have become recognizable as planet-like disks rather than just red dots, their size proportional to the number of pages the site contains. At 874 WebX units from Oxford, Liverpool John Moores University is the furthest out in this scan, followed by University College Chester orbiting at 807—and because it is a small site, with just over 700 pages, it is represented by a very small red dot.

The "short range" scan shows the 24 Web sites that are closest to the sun (see Figure 2). These are the core of the academic Web in the United Kingdom. Immediately striking are the two giant sites very close to Oxford, the universities of Cambridge and Edinburgh, which have large Web sites and are very closely interconnected. Cambridge has a WebX distance of ten and Edinburgh is only slightly further out at 13. Imperial College comes next with a WebX distance of 26, double that of the second place site. Further out from the top three, there is a cluster of sites around the 40 WebX mark. These are Heriot-Watt University, the universities of Leeds, Glasgow, Southampton, Queen Mary & Westfield College, and my own institution, University College London (UCL). All these universities are well connected and centrally placed in the academic Web. UCL has a WebX score of 42, putting it in seventh place away from Oxford, a respectable position given its historic role in the development of Cyberspace in the U.K. (it was the first organization in Britain connected to ARPANET, the Internet's forerunner, back in 1973). Finally, right on the edge of this scan is the University of Durham's site with a WebX score of exactly 100.

Why Measure WebX?

Understanding the Web's structure, using metrics like my WebX distance, is important for a number of reasons. On one level the Web is worthy of analysis and mapping because it is the terrain of the Information Age. Just as surveyors map the real world, so we should begin to chart virtual spaces. On a more prosaic, economic level, the Web has already become a significant source of wealth and employment, yet we know really very little about it.

The WebX measure of centrality has potential practical benefit for users and content producers alike. Research has shown that measures of centrality, based on hyperlinks, can improve the accuracy of the results from search engines. [4] Hyperlinks can be thought of as virtual citations, which can aid in assessing the credibility and veracity of web sites. Knowledge of a page's connectivity and centrality would prove useful in this regard.

Perhaps what is required is a dynamic Web Scan map which is built into browser software so one can assess the location of the current web page in relation to a central site for the category of interest. It would enable users to see at a glance whether they are in the bustling downtown or lost out in the backwaters. The Web Scan could also help find potentially useful pages and sites that are nearby but are not immediately visible from your current location.

The browser tool developed by Alexa Internet (http://www.alexa.com) offers some of the functionality described above. It can recommend sites similar to the one you are viewing, but lacks any map presentation. Carl Malamud and Marshall Rose, at Invisible Worlds (http://invisible.net), plan to create interactive 3D web maps so that browsers can visualize the relationship between different information resources on the Internet. Two demonstration maps are planned for 1999, one focusing on financial information and the other on music and media.

Web Galaxies in the WWW Universe

I analyzed one small web galaxy, the sites of U.K. academia, which is a homogenous and well connected part of the Web Universe. The U.K. academic web is part of larger stellar structures, as it is an important component of the U.K. Web and is also connected to academic sites in other countries.

There are really many different centers of the Web depending on what you are interested in. We might envision the Web as like the universe, with many different galaxies, clusters and nebulas. There would be massive bright galaxies of new information in one sector, and elsewhere the dark nebulas of long abandoned sites and the nascent clouds of newly forming web spaces. Different galaxies would be formed by web pages and sites that have similar content (e.g., all movie sites) or that are related by country or language. Each of these galaxies would have their own central points and would merge into larger cosmic structures.

At the heart of the ever-expanding web universe are several extremely bright supernovae. They are known as portals in the current jargon and are the key points where many people begin their web explorations. There is currently a scramble by the largest sites to create web supernovae given the promise of financial rewards. It will be interesting to see, as we approach the millennium, which of these portals go the way of real supernovae and burn-out and which remain shining brightly to guide us through the web universe.

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Notes

[1] I am very grateful to Naru Shiode for his assistance in calculating the WebX distance metric.

[2] See for example, Tim Bray, "Measuring the Web" (http://www5conf.inria.fr/fich_html/papers/P9/Overview.html) and Jon Kleinberg, "Authoritative sources in a hyperlinked environment" (http//simon.cs.cornell.edu/home/kleinber/auth.pdf)

[3] Several commercial companies survey Web site popularity, including Relevant Knowledge (http://www.relevantknowledge.com), Media Metrix (http://www.mediametrix.com), Web21 (www.100hot.com).

[4] See Mark Frauen Felder, "The Future of Search Engines," *The Industry Standard,* September 28, 1998, pp. 34-37; see also technical papers by Massimo Marchiori, "The Quest for Correct Information on the Web: Hyper Search Engines," http://decweb.ethz.ch/WWW6/Technical/Paper222/Paper222.html; Jeromy Carriere and Rick Kazman, "WebQuery: Searching and Visualizing the Web through Connectivity," http://www.cgl.uwaterloo.ca/Projects/Vanish/webquery-1.html. Also, see Google (google.stanford.edu), an experimental search engine created by researchers at Stanford University.

Traffic

Albania

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Italy	15.8	38.7%
2. Greece	14.1	34.6%
3. Germany	2.0	4.9%
4. United States	1.8	4.4%
5. France	0.7	1.8%
6. Switzerland	0.7	1.6%
7. Turkey	0.6	1.6%
8. Yugoslavia	0.6	1.5%
9. United Kingdom	0.6	1.4%
10. Austria	0.5	1.3%
11. Belgium	0.4	1.0%
12. Macedonia	0.4	0.9%
13. Bulgaria	0.2	0.6%
14. Croatia	0.2	0.4%
15. Canada	0.2	0.4%
16. Netherlands	0.2	0.4%
17. Egypt	0.2	0.4%
18. Romania	0.2	0.4%
19. Spain	0.1	0.4%
20. Hungary	0.1	0.3%
Other	1.2	2.9%
Total	**40.8**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	37.3	46.0	n.a.
Outgoing	23.1	20.6	40.8
Surplus (Deficit)	4.2	15.4	n.a.
Total Volume	60.4	66.6	n.a.

Note: MiTT is Minutes of Telecommunications Traffic Data are in millions of minutes of public switched traffic Data for 1997 are based on billing point of traffic. Route data may exclude some cross-border traffic to Yugoslavia.

Andorra

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Spain	30.1	71.3%
2. France	7.4	17.6%
3. Portugal	2.0	4.7%
4. United Kingdom	0.9	2.2%
5. Germany	0.3	0.6%
6. Belgium	0.2	0.6%
7. Netherlands	0.2	0.5%
8. Switzerland	0.2	0.5%
9. Italy	0.2	0.5%
10. United States	0.2	0.4%
Other	0.5	1.2%
Total	**42.2**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	27.3	30.1
Outgoing	36.0	37.8	42.2
Surplus (Deficit)	n.a.	(10.5)	(12.1)
Total Volume	n.a.	65.1	72.3

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Argentina

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	42.3	18.9%
2. Uruguay	35.4	15.9%
3. Brazil	27.4	12.3%
4. Chile	19.5	8.7%
5. Spain	14.2	6.4%
6. Italy	11.2	5.0%
7. Peru	10.7	4.8%
8. Bolivia	10.2	4.6%
9. Paraguay	10.2	4.6%
10. France	4.5	2.0%
11. Mexico	4.1	1.8%
12. Germany	4.0	1.8%
13. United Kingdom	3.8	1.7%
14. Canada	2.6	1.2%
15. Venezuela	2.3	1.0%
16. Colombia	2.3	1.0%
17. Switzerland	1.6	0.7%
18. Israel	1.3	0.6%
19. China	1.2	0.5%
20. Cuba	1.0	0.5%
Other	13.7	6.1%
Total	**223.4**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	299.4	390.7	444.2
Outgoing	179.4	181.3	223.4
Surplus (Deficit)	119.9	209.4	220.7
Total Volume	478.8	572.0	667.6

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic Data for 1995 and 1996 are based on billing point of traffic Data for 1997 based on originating point of traffic.

Armenia

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Russia	29.9	61.1%
2. Ukraine	3.2	6.6%
3. Georgia	1.5	3.1%
4. Belarus	0.6	1.2%
5. Uzbekistan	0.5	1.0%
6. Kazakhstan	0.4	0.8%
7. Moldova	0.1	0.3%
8. Turkmenistan	0.1	0.2%
Other	12.5	25.5%
Total	**48.8**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	n.a.
Outgoing	n.a.	48.1	48.8
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Totals for 1996 include only traffic to other member states of the Commonwealth of Independent States The "Other" category may include routes to non-CIS member states, including an estimated 1 0 million minutes to the U S., that rank among the top destinations for outgoing traffic.

Australia

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United Kingdom	230	15.2%
2. New Zealand	175	11.6%
3. United States	170	11.3%
4. Singapore	65	4.3%
5. Hong Kong	60	4.0%
6. Japan	40	2.6%
7. Indonesia	40	2.6%
8. China	40	2.6%
9. Malaysia	40	2.6%
10. Canada	40	2.6%
Other	610	40.4%
Total	**1,510**	

National Traffic Balance

MiTT	1995	FY 1996/97	FY 1997/98
Incoming	n.a.	n.a.	1,250
Outgoing	1,024	1,305	1,510
Surplus (Deficit)	n.a.	n.a.	(260)
Total Volume	n.a.	n.a.	2,760

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Route data are rounded to the nearest 5 million minutes. Because fiscal year reporting replaced calendar year reporting in 1996, totals for 1995, FY 1996/97, and FY 1997/98 are not directly comparable. Fiscal year ends 30 June.

Austria

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	427.6	42.9%
2. Italy	60.6	6.1%
3. Hungary	39.3	3.9%
4. Yugoslavia	38.1	3.8%
5. United Kingdom	33.6	3.4%
6. Turkey	29.1	2.9%
7. Poland	27.5	2.8%
8. United States	24.8	2.5%
9. Netherlands	24.6	2.5%
10. Croatia	24.2	2.4%
11. France	23.9	2.4%
12. Czech Republic	23.7	2.4%
13. Slovenia	14.9	1.5%
14. Slovak Republic	14.6	1.5%
15. Romania	13.7	1.4%
16. Switzerland	12.9	1.3%
17. Bosnia-Herzegovina	12.3	1.2%
18. Spain	12.1	1.2%
19. Belgium	12.0	1.2%
20. Sweden	10.5	1.1%
Other	115.9	11.6%
Total	**996.0**	

National Traffic Balance

MiTT	**1995**	**1996**	**1997**
Incoming	n.a.	n.a.	957.7
Outgoing	901	960	995.5
Surplus (Deficit)	n.a.	n.a.	(37.8)
Total Volume	n.a.	n.a.	1953.2

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic Traffic figures exclude most cross-border traffic to Switzerland.

Bahamas

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	53.6	85.7%
2. Canada	3.2	5.1%
3. United Kingdom	1.6	2.5%
4. Jamaica	1.2	2.0%
5. Switzerland	0.4	0.7%
6. Germany	0.3	0.5%
7. France	0.3	0.5%
8. Haiti	0.3	0.5%
9. Turks & Caicos Islands	0.3	0.4%
10. Brazil	0.2	0.4%
Other	1.3	2.0%
Total	**62.7**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	n.a.
Outgoing	n.a.	56.7	62.7
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Bahrain

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. India	20.5	19.2%
2. Saudi Arabia	15.4	14.4%
3. United Arab Emirates	13.2	12.4%
4. United Kingdom	9.0	8.4%
5. Kuwait	5.5	5.2%
6. Pakistan	5.1	4.8%
7. Egypt	4.8	4.5%
8. United States	4.8	4.5%
9. Qatar	4.3	4.0%
10. Philippines	2.3	2.2%
11. Oman	2.2	2.1%
12. Jordan	1.8	1.7%
13. Bangladesh	1.4	1.3%
14. Sri Lanka	1.3	1.2%
15. Morocco	1.0	1.0%
16. France	0.9	0.9%
17. Syria	0.9	0.9%
18. Germany	0.8	0.7%
19. Switzerland	0.7	0.7%
20. Yemen	0.7	0.7%
Other	9.9	9.3%
Total	**106.6**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	62.6	69.4	85.4
Outgoing	88.7	92.2	106.6
Surplus (Deficit)	(26.1)	(22.8)	(21.2)
Total Volume	151.3	161.5	192.0

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Bangladesh

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. India	5.5	11.8%
2. United Kingdom	5.1	10.8%
3. United States	4.5	9.5%
4. Saudi Arabia	2.8	5.9%
5. Singapore	2.7	5.7%
6. Rep. of Korea	2.0	4.3%
7. Hong Kong	2.0	4.3%
8. United Arab Emirates	1.8	3.9%
9. Malaysia	1.7	3.5%
10. Pakistan	1.4	3.0%
11. China	0.9	1.8%
12. Germany	0.8	1.7%
13. Japan	0.8	1.7%
14. Italy	0.8	1.6%
15. Canada	0.7	1.4%
16. France	0.6	1.3%
17. Thailand	0.6	1.2%
18. Australia	0.5	1.1%
Other	11.9	25.4%
Total	**46.9**	

National Traffic Balance

MiTT	**1995**	**1996**	**1997**
Incoming	122.1	129.2	187.0
Outgoing	33.0	38.3	46.9
Surplus (Deficit)	89.1	90.9	140.2
Total Volume	55.1	167.5	233.9

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Belarus

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Russia	84.9	57.1%
2. Ukraine	22.7	15.3%
3. Moldova	2.1	1.4%
4. Kazakhstan	2.0	1.4%
5. Armenia	1.3	0.9%
6. Azerbaijan	1.0	0.7%
7. Uzbekistan	0.9	0.6%
8. Georgia	0.6	0.4%
9. Kyrgyzstan	0.2	0.2%
10. Turkmenistan	0.2	0.1%
11. Tajikistan	0.2	0.1%
Other	32.4	21.8%
Total	**148.6**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	185.2
Outgoing	106.6	104.9	148.6
Surplus (Deficit)	n.a.	n.a.	36.5
Total Volume	n.a.	n.a.	333.8

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic. Data for 1995 and 1996 include only traffic to other member states of the Commonwealth of Independent States. The "Other" category may include routes to non-CIS member states, including an estimated 3.0 million minutes to Germany, that rank among the top destinations for outgoing traffic.

Belgium

Largest Telecommunications Routes, 1996

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. France	285.0	23.2%
2. Netherlands	253.4	20.6%
3. Germany	148.9	12.1%
4. United Kingdom	108.3	8.8%
5. Italy	65.1	5.3%
6. United States	45.1	3.7%
7. Luxembourg	43.8	3.6%
8. Spain	40.9	3.3%
9. Switzerland	26.2	2.1%
10. Sweden	14.4	1.2%
11. Portugal	13.2	1.1%
12. Greece	12.3	1.0%
13. Denmark	11.9	1.0%
14. Turkey	11.4	0.9%
15. Austria	10.8	0.9%
16. Morocco	9.9	0.8%
17. Poland	9.9	0.8%
18. Ireland	7.4	0.6%
19. Canada	6.2	0.5%
20. Russia	5.9	0.5%
Other	98.4	8.0%
Total	**1,228.4**	

National Traffic Balance

MiTT	**1995**	**1996**	**1997**
Incoming	1,172.0	1,289.1	1,420
Outgoing	1,105.7	1,228.4	1,340
Surplus (Deficit)	66.3	60.6	80
Total Volume	2,277.7	2,517.5	2,760

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data is based on billing point of traffic.

Bolivia

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	5.1	22.5%
2. Argentina	3.3	14.5%
3. Brazil	2.8	12.3%
4. Chile	2.6	11.5%
5. Peru	2.0	8.8%
6. Germany	0.6	2.6%
7. Colombia	0.5	2.2%
8. Spain	0.5	2.2%
9. Mexico	0.5	2.2%
10. Paraguay	0.4	1.8%
11. Canada	0.3	1.3%
12. Italy	0.3	1.3%
13. Venezuela	0.3	1.3%
14. Ecuador	0.3	1.3%
15. Japan	0.3	1.3%
16. United Kingdom	0.2	0.9%
17. France	0.2	0.9%
18. Uruguay	0.2	0.9%
19. Switzerland	0.2	0.9%
20. Panama	0.2	0.9%
Other	1.7	7.5%
Total	**22.7**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	49.2	53.9	69.3
Outgoing	20.8	21.4	22.7
Surplus (Deficit)	28.4	32.5	46.6
Total Volume	70.0	75.3	92.0

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Botswana

Largest Telecommunications Routes, 1996

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. South Africa	21.7	70.4%
2. Zimbabwe	2.9	9.4%
3. United Kingdom	1.3	4.3%
4. United States	0.7	2.3%
5. Zambia	0.5	1.6%
6. India	0.4	1.3%
7. Namibia	0.3	1.0%
8. Germany	0.2	0.5%
9. Swaziland	0.2	0.5%
10. Kenya	0.1	0.5%
11. Lesotho	0.1	0.5%
12. Malawi	0.1	0.4%
13. Canada	0.1	0.4%
14. Australia	0.1	0.4%
15. China	0.1	0.3%
16. Tanzania	0.1	0.3%
17. France	0.1	0.3%
18. Belgium	0.1	0.2%
19. Sri Lanka	0.1	0.2%
Other	1.4	4.6%
Total	**30.8**	

National Traffic Balance

MiTT	1994	1995	1996
Incoming	21.9	21.8	22.7
Outgoing	28.4	29.8	30.8
Surplus (Deficit)	(6.5)	(8)	(8.1)
Total Volume	50.3	51.6	53.6

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Brazil

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	150.0	32.7%
2. Argentina	35.9	7.8%
3. Italy	21.5	4.7%
4. Germany	19.1	4.2%
5. Portugal	18.5	4.0%
6. United Kingdom	17.7	3.9%
7. France	14.9	3.2%
8. Japan	13.3	2.9%
9. Spain	12.7	2.8%
10. Uruguay	10.1	2.2%
11. Canada	9.4	2.1%
12. São Tomé & Principe	8.8	1.9%
13. Paraguay	8.8	1.9%
14. Chile	8.6	1.9%
15. Bolivia	8.5	1.8%
16. Moldova	7.8	1.7%
17. Switzerland	6.6	1.4%
18. Mexico	6.0	1.3%
19. Guyana	4.5	1.0%
20. Venezuela	4.5	1.0%
Other	72.0	15.7%
Total	**459.1**	

National Traffic Balance

MiTT	**1995**	**1996**	**1997**
Incoming	495.5	624.4	761.3
Outgoing	319.4	366.9	459.1
Surplus (Deficit)	176.1	257.5	302.2
Total Volume	814.8	991.3	1,220.4

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Brunei

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Malaysia	12.3	34.6%
2. Singapore	4.1	11.6%
3. Philippines	3.0	8.4%
4. United Kingdom	3.0	8.4%
5. Indonesia	1.5	4.2%
6. Thailand	1.2	3.4%
7. Australia	1.1	3.1%
8. India	1.0	2.8%
9. United States	0.6	1.7%
10. Hong Kong	0.4	1.1%
11. New Zealand	0.3	0.8%
12. Japan	0.3	0.7%
13. Canada	0.2	0.6%
14. Netherlands	0.2	0.5%
15. Germany	0.2	0.5%
16. Bangladesh	0.2	0.4%
17. Sri Lanka	0.1	0.4%
18. China	0.1	0.4%
19. Taiwan	0.1	0.4%
20. France	0.1	0.3%
Other	5.1	14.3%
Total	**35.6**	

National Traffic Balance

MiTT	**1995**	**1996**	**1997**
Incoming	n.a.	n.a.	22.0
Outgoing	30.7	35.2	35.6
Surplus (Deficit)	n.a.	n.a.	(13.6)
Total Volume	n.a.	n.a.	57.6

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Canada

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	3,175	74.1%
2. United Kingdom	160	3.7%
3. Hong Kong	75	1.7%
4. France	55	1.3%
5. Germany	55	1.3%
6. Italy	50	1.2%
7. Philippines	35	0.8%
8. India	35	0.8%
9. Australia	35	0.8%
10. Mexico	35	0.8%
11. Jamaica	25	0.6%
12. Netherlands	20	0.5%
Other	531	12.4%
Total	**4,286**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	3,895.8	4,313.3	4,635.1
Outgoing	2,667.1	3,519.8	4,286.3
Surplus (Deficit)	1,228.7	793.5	348.7
Total Volume	6,562.9	7,833.1	8,921.4

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic. Route data rounded to the nearest five million minutes. U.S. route data include public switched and ISR traffic, but ISR is not included for other routes (e.g., to the U.K.).

Chile

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	75	31.0%
2. Argentina	35	14.5%
3. Brazil	15	6.2%
4. Spain	13	5.4%
5. Peru	11	4.5%
6. Canada	8	3.3%
7. Mexico	6	2.5%
8. Germany	5	2.1%
9. France	5	2.1%
10. United Kingdom	5	2.1%
11. Ecuador	5	2.1%
12. Italy	5	2.1%
13. Bolivia	4	1.7%
14. Colombia	4	1.7%
15. Venezuela	3	1.2%
Other	43	17.8%
Total	**242**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	n.a.
Outgoing	136.9	173.8	242
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

China

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Hong Kong	855	52.4%
2. Taiwan	150	9.2%
3. Japan	105	6.4%
4. United States	60	3.7%
5. Rep. of Korea	55	3.4%
6. Macau	35	2.1%
7. Singapore	30	1.8%
8. Australia	15	0.9%
9. Germany	15	0.9%
10. Canada	15	0.9%
11. United Kingdom	12	0.7%
12. France	9	0.6%
13. Thailand	7	0.4%
14. Russia	8	0.5%
15. Malaysia	8	0.5%
16. Italy	8	0.5%
17. Indonesia	5	0.3%
Other	240	14.7%
Total	**1,632**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	n.a.
Outgoing	1,339.1	1,433.2	1,631.8
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Colombia

Largest Telecommunications Routes, 1996

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	60.2	44.4%
2. Venezuela	14.1	10.4%
3. Ecuador	6.3	4.6%
4. Spain	5.7	4.2%
5. Mexico	4.8	3.5%
6. Panama	4.8	3.5%
7. Brazil	2.9	2.1%
8. Italy	2.8	2.1%
9. Peru	2.8	2.1%
10. United Kingdom	2.5	1.8%
11. Germany	2.5	1.8%
12. Argentina	2.3	1.7%
13. France	2.3	1.7%
14. Canada	2.3	1.7%
15. Chile	1.7	1.3%
16. Costa Rica	1.6	1.2%
17. Dominican Republic	1.1	1.2%
18. Switzerland	0.9	0.8%
19. Puerto Rico	0.9	0.7%
20. Japan	0.5	0.7%
Other	12.5	9.2%
Total	**135.5**	

National Traffic Balance

MiTT	1994	1995	1996
Incoming	302.8	351.5	384.2
Outgoing	120.3	127.3	135.5
Surplus (Deficit)	182.5	224.2	248.7
Total Volume	423.1	478.8	519.7

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Commonwealth of Independent States

1997 Outgoing International Traffic among C.I.S. Member States (Millions of Minutes)

Origin \ Destination	Armenia	Azerbaijan	Belarus	Georgia	Kazakhstan	Kyrgyzstan	Moldova	Russia	Tajikistan	Turkmenistan	Ukraine	Uzbek.
Armenia	—	—	0.6	1.5	0.4	0.0	0.1	29.9	0.0	0.1	3.2	0.5
Azerbaijan	—	—	0.6	1.1	0.8	0.1	0.1	16.1	0.0	0.4	2.7	0.5
Belarus	1.3	1.0	—	0.6	2.0	0.2	2.1	84.9	0.2	0.2	22.7	0.9
Georgia	1.7	1.5	0.5	—	0.4	0.0	0.1	25.5	0.0	0.1	3.0	0.2
Kazakhstan	1.0	1.4	2.0	0.5	—	5.8	0.4	68.9	1.2	1.1	5.9	7.8
Kyrgyzstan	0.0	0.1	0.3	0.0	7.9	—	0.1	13.9	0.6	0.2	0.7	3.5
Moldova	0.2	0.1	2.0	0.1	0.2	0.0	—	24.0	0.0	0.1	17.0	0.1
Russia	25.7	27.5	98.9	27.6	90.6	14.4	15.7	—	7.3	5.5	249.0	32.3
Tajikistan	0.0	0.0	0.1	0.0	0.7	0.4	0.0	9.8	—	0.1	0.4	1.6
Turkmenistan	0.5	0.6	0.2	0.1	0.7	0.2	0.2	4.0	0.2	—	1.0	1.1
Ukraine	7.3	4.1	26.0	4.1	5.4	0.7	20.0	296.7	0.5	1.1	—	4.6
Uzbekistan	0.5	0.6	0.8	0.3	7.9	3.4	0.2	29.6	2.1	1.2	3.1	—

Source: Regional Commonwealth in the Field of Communications (RCC)

Costa Rica

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	25.2	37.7%
2. Nicaragua	10.1	15.1%
3. Panama	4.4	6.6%
4. Mexico	3.9	5.9%
5. Guatemala	3.7	5.5%
6. El Salvador	3.1	4.6%
7. Honduras	2.4	3.6%
8. Colombia	1.7	2.5%
9. Canada	1.0	1.5%
10. Italy	0.9	1.3%
11. Spain	0.8	1.2%
12. Germany	0.8	1.1%
13. Venezuela	0.6	0.9%
14. Peru	0.6	0.8%
15. Argentina	0.5	0.8%
16. Cuba	0.5	0.7%
17. Dominican Republic	0.5	0.7%
18. Brazil	0.5	0.7%
19. Ecuador	0.4	0.7%
20. Chile	0.4	0.7%
Other	4.9	7.3%
Total	**66.9**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	87.8	111.6
Outgoing	52.8	55.0	66.9
Surplus (Deficit)	n.a.	32.8	44.7
Total Volume	n.a.	142.8	178.5

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic Data based on billing point of traffic

Cyprus

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United Kingdom	34.9	22.6%
2. Greece	34.6	22.4%
3. Lebanon	13.0	8.4%
4. Russia	7.8	5.1%
5. Germany	5.7	3.7%
6. United States	5.1	3.3%
7. Romania	3.8	2.4%
8. Egypt	3.7	2.4%
9. Bulgaria	3.1	2.0%
10. Syria	3.0	1.9%
11. Italy	2.8	1.8%
12. Ukraine	2.8	1.8%
13. Yugoslavia	2.2	1.4%
14. Jordan	2.1	1.4%
15. France	2.0	1.3%
16. Switzerland	1.9	1.2%
17. Sweden	1.8	1.2%
18. Israel	1.7	1.1%
19. Netherlands	1.6	1.0%
20. Canada	1.2	0.8%
Other	19.4	12.6%
Total	**154.4**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	87.3	92.0	115.2
Outgoing	117.4	128.6	154.4
Surplus (Deficit)	(30.2)	(36.6)	(39.2)
Total Volume	204.7	220.5	269.6

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data exclude traffic to Turkey and some traffic to Greece.

Czech Republic

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	73.8	24.1%
2. Slovak Republic	67.9	22.2%
3. Austria	20.4	6.7%
4. United Kingdom	15.9	5.2%
5. Italy	12.0	3.9%
6. Poland	11.4	3.7%
7. France	9.3	3.0%
8. Ukraine	8.8	2.9%
9. United States	8.7	2.8%
10. Netherlands	7.6	2.5%
11. Russia	7.4	2.4%
12. Switzerland	6.9	2.3%
13. Belgium	4.3	1.4%
14. Hungary	4.0	1.3%
15. Spain	3.5	1.1%
16. Sweden	3.0	1.0%
17. Croatia	2.7	0.9%
18. Bulgaria	2.2	0.7%
19. Greece	2.2	0.7%
20. Yugoslavia	2.1	0.7%
Other	32.1	10.5%
Total	**306.1**	

National Traffic Balance

MiTT	**1995**	**1996**	**1997**
Incoming	223.7	324.4	355.0
Outgoing	186.8	281.2	306.1
Surplus (Deficit)	36.9	43.2	48.9
Total Volume	410.5	605.6	661.1

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic. Data for 1995 exclude traffic to and from the Slovak Republic.

Denmark

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	115	18.3%
2. Sweden	104	16.6%
3. United Kingdom	61	9.7%
4. Norway	59	9.4%
5. United States	28	4.5%
6. Netherlands	24	3.8%
7. France	23	3.7%
8. Italy	14	2.2%
9. Finland	13	2.1%
10. Belgium	12	1.9%
11. Spain	12	1.9%
12. Poland	12	1.9%
13. Switzerland	11	1.8%
14. Faroe Islands	10	1.6%
15. Turkey	8	1.3%
Other	122	19.4%
Total	**628**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	551.0	600.0	682
Outgoing	532.6	573.2	628
Surplus (Deficit)	18.4	26.8	54
Total Volume	1,083.6	1,173.2	1,310

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic. Totals for 1997 are for all carriers; route data are for Tele Danmark only. Totals for 1996 are for Tele Danmark only

Dominican Republic

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	112.5	79.2%
2. Spain	3.5	2.4%
3. Italy	2.7	1.9%
4. Canada	2.6	1.8%
5. Germany	2.3	1.6%
6. Venezuela	1.3	0.9%
7. Mexico	1.2	0.9%
8. Cuba	1.0	0.7%
9. Switzerland	1.0	0.7%
10. Colombia	1.0	0.7%
11. Haiti	1.0	0.7%
12. United Kingdom	0.9	0.6%
13. Argentina	0.8	0.5%
14. France	0.7	0.5%
15. Panama	0.7	0.5%
16. Netherlands Antilles	0.6	0.5%
17. Netherlands	0.5	0.4%
18. Chile	0.5	0.3%
19. Jamaica	0.4	0.3%
20. Costa Rica	0.4	0.3%
Other	6.6	4.6%
Total	**142.0**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	424.1	450.9	476.9
Outgoing	85.4	126.6	142.0
Surplus (Deficit)	338.7	324.3	334.9
Total Volume	509.4	577.5	618.9

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Outgoing totals for 1995 are for Codetel only.

El Salvador

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	12.8	37.3%
2. Guatemala	7.6	22.3%
3. Costa Rica	2.8	8.2%
4. Honduras	2.7	7.9%
5. Mexico	2.4	6.9%
6. Nicaragua	1.6	4.6%
7. Panama	0.9	2.5%
8. Canada	0.5	1.4%
9. Spain	0.3	0.9%
10. Colombia	0.3	0.9%
11. Germany	0.2	0.6%
12. Venezuela	0.2	0.5%
13. Italy	0.2	0.5%
14. Chile	0.1	0.4%
15. Rep. of Korea	0.1	0.4%
16. Argentina	0.1	0.4%
17. France	0.1	0.4%
18. Brazil	0.1	0.3%
19. Japan	0.1	0.3%
20. United Kingdom	0.1	0.3%
Other	1.0	3.0%
Total	**34.3**	

National Traffic Balance

MiTT	**1995**	**1996**	**1997**
Incoming	n.a.	160.5	168.2
Outgoing	64.1	28.6	34.3
Surplus (Deficit)	n.a.	131.9	133.9
Total Volume	n.a.	189.1	202.5

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data for 1996 and 1997 based on billing point of traffic.

Estonia

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Finland	19.3	29.1%
2. Russia	15.2	22.9%
3. Sweden	5.3	8.1%
4. Latvia	4.2	6.3%
5. Germany	4.1	6.3%
6. Ukraine	2.8	4.3%
7. Lithuania	2.5	3.8%
8. United Kingdom	1.8	2.6%
9. Denmark	1.5	2.3%
10. United States	1.3	2.0%
11. Belarus	1.1	1.6%
12. Netherlands	0.9	1.4%
13. Norway	0.8	1.3%
14. Italy	0.6	0.9%
15. France	0.6	0.9%
16. Poland	0.5	0.8%
17. Belgium	0.4	0.7%
18. Switzerland	0.4	0.6%
19. Austria	0.3	0.4%
20. Spain	0.2	0.4%
Other	2.3	3.5%
Total	**66.3**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	56.0	60.1	67.0
Outgoing	53.0	58.5	66.3
Surplus (Deficit)	3.0	1.6	0.7
Total Volume	109.0	118.6	133.3

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic

Finland

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Sweden	118.9	32.0%
2. Germany	33.5	9.0%
3. United Kingdom	26.0	7.0%
4. Russia	26.0	7.0%
5. Estonia	22.3	6.0%
6. United States	14.9	4.0%
7. Norway	14.9	4.0%
8. Denmark	11.2	3.0%
9. France	11.2	3.0%
10. Netherlands	7.4	2.0%
Other	81.8	22.0%
Total	**371.7**	

National Traffic Balance

MiTT	**1995**	**1996**	**1997**
Incoming	345.0	n.a.	n.a.
Outgoing	315.4	332.0	371.7
Surplus (Deficit)	29.6	n.a.	n.a.
Total Volume	660.4	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

France

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	412	11.6%
2. United Kingdom	386	10.9%
3. Belgium	304	8.6%
4. Italy	298	8.4%
5. Switzerland	246	6.9%
6. Spain	233	6.6%
7. United States	201	5.7%
8. Portugal	153	4.3%
9. Morocco	125	3.5%
10. Netherlands	122	3.4%
11. Algeria	100	2.8%
12. Tunisia	66	1.8%
13. Canada	50	1.4%
14. Turkey	45	1.3%
15. Poland	35	1.0%
16. Sweden	32	0.9%
17. Denmark	25	0.7%
18. Austria	25	0.7%
19. Luxembourg	25	0.7%
20. Greece	24	0.7%
Other	638	18.0%
Total	**3,545**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	2,958.9	3,283	3,609
Outgoing	2,804.6	3,273	3,545
Surplus (Deficit)	154.3	10	64
Total Volume	5,763.5	6,556	7,154

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. The outgoing total for 1995 excludes an estimated 150 million minutes of cross-border traffic.

French Polynesia

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. France	5.7	63.1%
2. United States	0.9	9.5%
3. New Caledonia	0.6	6.8%
4. New Zealand	0.3	2.8%
5. Australia	0.2	2.7%
6. Cook Islands	0.2	2.0%
7. Japan	0.1	1.1%
8. Italy	0.1	1.0%
9. Reunion	0.1	0.6%
10. United Kingdom	0.1	0.6%
Other	0.9	9.4%
Total	**9.1**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	n.a.
Outgoing	7.6	7.9	9.1
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Germany

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Austria	384.9	7.2%
2. Turkey	377.4	7.1%
3. Italy	368.5	6.9%
4. Poland	353.7	6.6%
5. Switzerland	339.9	6.4%
6. France	331.8	6.2%
7. Netherlands	327.3	6.1%
8. United Kingdom	326.9	6.1%
9. United States	319.2	6.0%
10. Spain	209.4	3.9%
11. Greece	132.1	2.5%
12. Belgium	125.4	2.4%
13. Yugoslavia	101.4	1.9%
14. Denmark	97.1	1.8%
15. Croatia	94.8	1.8%
16. Czech Republic	94.2	1.8%
17. Hungary	72.3	1.4%
18. Portugal	67.3	1.3%
19. Romania	59.4	1.1%
20. Sweden	50.6	0.9%
Other	1,099.5	20.6%
Total	**5,333.1**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	4,215	n.a.	5,206.0
Outgoing	5,238	5,100	5,333.1
Surplus (Deficit)	(1,023)	n.a.	(127.1)
Total Volume	9,453	n.a.	10,539.1

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data for 1997 are based on billing point of traffic; data for 1995 and 1996 are based on originating point. Route data exclude some cross-border traffic to neighboring countries

Greece

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	98.3	16.6%
2. United Kingdom	82.3	13.9%
3. Italy	51.4	8.7%
4. United States	35.5	6.0%
5. France	25.4	4.3%
6. Albania	23.5	4.0%
7. Cyprus	22.8	3.8%
8. Bulgaria	21.4	3.6%
9. Romania	15.7	2.6%
10. Netherlands	13.2	2.2%
11. Belgium	13.1	2.2%
12. Canada	12.4	2.1%
13. Switzerland	11.2	1.9%
14. Sweden	10.4	1.8%
15. Russia	9.4	1.6%
16. Yugoslavia	9.4	1.6%
17. Ukraine	9.0	1.5%
18. Turkey	8.7	1.5%
19. Australia	8.6	1.5%
20. Austria	8.2	1.4%
Other	103.9	17.5%
Total	**593.7**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	505.4	557.3	634.6
Outgoing	467.9	515.6	593.7
Surplus (Deficit)	37.5	41.7	40.9
Total Volume	973.3	1,072.8	1,228.3

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Guyana

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	12.5	51.9%
2. Canada	3.4	14.0%
3. Trinidad & Tobago	1.8	7.3%
4. United Kingdom	1.2	4.9%
5. Barbados	1.1	4.7%
6. Suriname	0.4	1.6%
7. Antigua & Barbuda	0.4	1.5%
8. Jamaica	0.3	1.3%
9. St. Lucia	0.3	1.1%
10. French Guiana	0.3	1.1%
Other	2.6	10.8%
Total	**24.1**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	139.7	162.8	142.4
Outgoing	20.6	29.8	24.1
Surplus (Deficit)	119.1	133.1	118.2
Total Volume	160.2	192.6	166.5

Note: MiTT is Minutes of Telecommunications Traffic Data are in millions of minutes of public switched traffic.

Hong Kong

Largest Telecommunications Routes, FY 1997/98

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. China	1,065.2	62.0%
2. United States	68.7	4.0%
3. Philippines	68.7	4.0%
4. Taiwan	51.5	3.0%
5. Japan	51.5	3.0%
6. United Kingdom	51.5	3.0%
7. Macau	51.5	3.0%
8. Singapore	51.5	3.0%
9. Canada	34.4	2.0%
10. Australia	34.4	2.0%
Other	189.0	11.0%
Total	**1,718.0**	

National Traffic Balance

MiTT	FY 1995/96	FY 1996/97	FY 1997/98
Incoming	1,598.3	1,940.8	2,100.3
Outgoing	1,691.8	1,738.6	1,718.0
Surplus (Deficit)	(93.5)	202.2	382.2
Total Volume	3,290.2	3,679.4	3,818.2

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic. Fiscal year ends 31 March.

Hungary

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	71.0	24.7%
2. Austria	35.8	12.5%
3. Romania	17.3	6.0%
4. United Kingdom	16.9	5.9%
5. Italy	16.0	5.6%
6. United States	14.8	5.2%
7. France	10.2	3.6%
8. Netherlands	8.0	2.8%
9. Yugoslavia	7.9	2.7%
10. Switzerland	7.8	2.7%
11. Russia	7.6	2.7%
12. Slovak Republic	7.2	2.5%
13. Ukraine	6.1	2.1%
14. Sweden	4.6	1.6%
15. Poland	4.6	1.6%
16. Belgium	4.6	1.6%
17. Czech Republic	4.1	1.4%
18. Croatia	4.0	1.4%
19. Greece	3.2	1.1%
20. Canada	3.0	1.1%
Other	32.3	11.2%
Total	**287.1**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	243.7	n.a.	324.6
Outgoing	247.5	265	287.1
Surplus (Deficit)	(24.7)	n.a.	37.5
Total Volume	448.5	n.a.	611.7

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Iceland

Largest Telecommunications Routes, 1996

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	7.2	22.2%
2. Denmark	5.5	16.9%
3. United Kingdom	3.5	10.8%
4. Sweden	3.1	9.5%
5. Norway	3.0	9.2%
6. Germany	2.5	7.7%
7. France	0.8	2.5%
8. Netherlands	0.8	2.5%
9. Spain	0.6	1.8%
10. Faroe Islands	0.6	1.8%
11. Canada	0.5	1.5%
12. Italy	0.5	1.5%
13. Belgium	0.4	1.2%
14. Finland	0.4	1.2%
15. Switzerland	0.3	0.9%
16. Luxembourg	0.2	0.6%
17. Austria	0.2	0.6%
18. Russia	0.2	0.6%
19. Portugal	0.2	0.6%
20. Poland	0.2	0.6%
Other	1.9	5.8%
Total	**32.5**	

National Traffic Balance

MiTT	**1994**	**1995**	**1996**
Incoming	25.5	28.4	32.0
Outgoing	26.0	28.9	32.5
Surplus (Deficit)	(0.4)	(0.6)	(0.5)
Total Volume	51.5	57.3	64.5

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

India

Largest Telecommunications Routes, FY 1997/98

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Saudi Arabia	85.9	20.4%
2. United States	52.1	12.4%
3. United Kingdom	37.6	8.9%
4. United Arab Emirates	34.1	8.1%
5. Singapore	18.6	4.4%
6. Oman	14.1	3.4%
7. Germany	14.0	3.3%
8. Canada	11.1	2.6%
9. Hong Kong	9.2	2.2%
10. Kuwait	9.2	2.2%
11. Japan	8.3	2.0%
12. Australia	7.2	1.7%
13. France	6.7	1.6%
14. Italy	6.1	1.4%
15. Sri Lanka	6.0	1.4%
16. Bangladesh	5.6	1.3%
17. Malaysia	5.5	1.3%
18. Philippines	4.8	1.1%
19. Qatar	4.2	1.0%
20. Pakistan	4.1	1.0%
Other	76.1	18.1%
Total	**420.5**	

National Traffic Balance

MiTT	FY 1995/96	FY 1996/97	FY 1997/98
Incoming	805.4	1000.0	1,256.6
Outgoing	341.4	384.2	420.5
Surplus (Deficit)	464.0	615.8	836.1
Total Volume	1,146.8	1384.2	1,677.1

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic, and route traffic and totals exclude cross-border traffic to Bangladesh, Nepal and Pakistan.

Indonesia

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Singapore	70.8	23.7%
2. Australia	28.0	9.4%
3. United States	26.2	8.8%
4. Japan	24.5	8.2%
5. Malaysia	23.0	7.7%
6. Hong Kong	15.3	5.1%
7. Taiwan	10.7	3.6%
8. Rep. of Korea	10.4	3.5%
9. United Kingdom	9.4	3.1%
10. Germany	6.6	2.2%
11. Philippines	6.4	2.2%
12. China	6.4	2.2%
13. Saudi Arabia	6.1	2.0%
14. Netherlands	5.4	1.8%
15. Canada	4.9	1.6%
16. India	4.5	1.5%
17. Thailand	4.4	1.5%
18. France	3.8	1.3%
19. Italy	2.7	0.9%
20. Switzerland	1.6	0.5%
Other	26.8	9.0%
Total	**298.1**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	294.0	356.4	456.0
Outgoing	182.5	280.2	351.6
Surplus (Deficit)	77.4	76.2	104.4
Total Volume	510.6	636.6	807.6

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic Data based on billing point of traffic. Totals include traffic for PT Indosat and Satelindo; route data are for PT Indosat only.

Iran

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United Arab Emirates	25.7	16.0%
2. Germany	17.7	11.0%
3. United States	14.6	9.1%
4. Pakistan	8.8	5.5%
5. United Kingdom	8.8	5.4%
6. Turkey	8.7	5.4%
7. Kuwait	6.2	3.9%
8. Canada	6.1	3.8%
9. Saudi Arabia	5.1	3.2%
10. Sweden	5.0	3.1%
11. France	4.1	2.5%
12. Azerbaijan	3.4	2.1%
13. Italy	3.3	2.0%
14. Netherlands	2.1	1.3%
15. Russia	2.0	1.3%
16. Japan	2.0	1.2%
17. Austria	1.8	1.1%
18. Switzerland	1.7	1.1%
19. Qatar	1.6	1.0%
20. Armenia	1.5	0.9%
Other	30.5	19.0%
Total	**160.7**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	199	n.a.	130.2
Outgoing	210.4	183.2	160.7
Surplus (Deficit)	(11)	n.a.	(30.5)
Total Volume	409	n.a.	290.9

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Ireland

Largest Telecommunications Routes, FY 1997/98

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United Kingdom	515	74.1%
2. United States	55	7.9%
3. Germany	20	2.9%
4. France	20	2.9%
5. Netherlands	17	2.4%
6. Italy	9	1.3%
7. Spain	7	1.0%
8. Canada	7	1.0%
9. Belgium	6	0.9%
10. Australia	5	0.7%
Other	34	4.9%
Total	**695**	

National Traffic Balance

MiTT	FY 1995/96	FY 1996/97	FY 1997/98
Incoming	n.a.	n.a.	n.a.
Outgoing	407	580	695
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data for the top four routes are rounded to the nearest five million. Totals for FY 1995/96 and 1996/97 exclude some cross-border traffic to Northern Ireland. Fiscal year ends March 31.

Israel

Largest Telecommunications Routes, 1996

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	103.5	32.4%
2. United Kingdom	29.0	9.1%
3. Canada	23.7	7.4%
4. France	18.4	5.8%
5. Jordan	17.6	5.5%
6. Germany	16.5	5.2%
7. Italy	12.0	3.8%
8. Russia	11.1	3.5%
9. Ukraine	7.1	2.2%
10. Netherlands	6.5	2.0%
11. Turkey	6.2	1.9%
12. Australia	5.9	1.8%
13. Switzerland	5.8	1.8%
14. Belgium	3.8	1.2%
15. Spain	3.7	1.2%
16. Romania	3.6	1.1%
17. South Africa	3.4	1.1%
18. Egypt	2.8	0.9%
19. Sweden	2.4	0.8%
20. Austria	2.3	0.7%
Other	34.4	10.8%
Total	**319.7**	

National Traffic Balance

MiTT	1994	1995	1996
Incoming	n.a.	345.6	468.1
Outgoing	213.0	252.3	319.7
Surplus (Deficit)	n.a.	93.3	148.4
Total Volume	n.a.	597.9	787.9

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Italy

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	340.3	14.5%
2. France	266.3	11.3%
3. United States	251.4	10.7%
4. Switzerland	198.1	8.4%
5. United Kingdom	196.8	8.4%
6. Spain	91.2	3.9%
7. Belgium	64.7	2.8%
8. Austria	60.8	2.6%
9. Netherlands	54.4	2.3%
10. Romania	46.0	2.0%
11. Greece	42.6	1.8%
12. Morocco	37.6	1.6%
13. Croatia	32.9	1.4%
14. Tunisia	28.0	1.2%
15. Albania	27.2	1.2%
16. Canada	26.8	1.1%
17. Chile	23.7	1.0%
18. Russia	22.5	1.0%
19. Sweden	20.5	0.9%
20. Australia	19.9	0.8%
Other	500.2	21.3%
Total	**2,351.9**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	1,999.8	2,253.5	2,475.1
Outgoing	1,908.2	2,124.0	2,351.9
Surplus (Deficit)	91.6	129.5	123.2
Total Volume	3,908.1	4,377.4	4,827.0

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data exclude some traffic to France, Poland, Slovenia, and Switzerland.

Japan

Largest Telecommunications Routes, FY 1997/98

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	339.2	20.0%
2. China	229.5	13.6%
3. Rep. of Korea	156.0	9.2%
4. Philippines	154.3	9.1%
5. Taiwan	88.3	5.2%
6. Thailand	72.4	4.3%
7. Hong Kong	59.5	3.5%
8. United Kingdom	52.6	3.1%
9. Brazil	52.4	3.1%
10. Singapore	44.6	2.6%
11. Australia	38.4	2.3%
12. Indonesia	34.7	2.1%
13. Malaysia	30.5	1.8%
14. Russia	30.3	1.8%
15. Canada	28.3	1.7%
16. Germany	27.4	1.6%
17. France	22.5	1.3%
18. Peru	15.3	0.9%
19. Italy	13.7	0.8%
20. India	12.4	0.7%
Other	190.3	11.2%
Total	**1,692.6**	

National Traffic Balance

MiTT	FY 1995/96	FY 1996/97	FY 1997/98
Incoming	1,320.8	1,519.1	1,635.0
Outgoing	1,631.3	1,710.6	1,771.7
Surplus (Deficit)	(310.5)	(191.5)	(136.7)
Total Volume	2,952.1	3,229.7	3,406.7

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Route data include only International Direct Dial (IDD) calls, while totals include operator assisted calls as well. Fiscal year ends 31 March.

Jordan

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Israel	13.6	14.8%
2. Saudi Arabia	12.1	13.2%
3. Egypt	9.3	10.1%
4. Syria	8.1	8.8%
5. United Arab Emirates	6.4	7.0%
6. United States	5.4	5.9%
7. Iraq	4.8	5.3%
8. Lebanon	3.7	4.1%
9. United Kingdom	3.6	3.9%
10. Kuwait	3.4	3.7%
11. Germany	1.8	1.9%
12. Qatar	1.7	1.8%
13. Italy	1.3	1.4%
14. France	1.2	1.3%
15. Oman	1.0	1.1%
16. Yemen	1.0	1.1%
17. Canada	0.9	1.0%
18. Turkey	0.9	1.0%
19. Bahrain	0.9	1.0%
20. Switzerland	0.5	0.6%
Other	10.3	11.2%
Total	**91.9**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	118.0	133.1	145.0
Outgoing	71.7	74.6	91.9
Surplus (Deficit)	46.3	58.5	53.1
Total Volume	189.7	207.7	236.9

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Jordan-Israel route data include traffic to the Occupied Territories (West Bank)

Kazakhstan

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Russia	68.9	60.1%
2. Uzbekistan	7.8	6.8%
3. Ukraine	5.9	5.2%
4. Kyrgyzstan	5.8	5.1%
5. Belarus	2.0	1.7%
6. Azerbaijan	1.4	1.2%
7. Tajikistan	1.2	1.1%
8. Turkmenistan	1.1	1.0%
9. Armenia	1.0	0.9%
10. Georgia	0.5	0.5%
11. Moldova	0.4	0.3%
Other	18.4	16.1%
Total	**114.7**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	n.a.
Outgoing	111.1	102.5	114.7
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Totals for 1995 and 1996 include only traffic to other member states of the Commonwealth of Independent States The "Dther" category may include routes to non-CIS member states, including an estimated 3.5 million minutes to Germany and 1.6 million minutes to the U.S., that rank among the top destinations for outgoing traffic.

Republic of Korea

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	205	23.2%
2. China	160	18.1%
3. Japan	150	16.9%
4. Hong Kong	35	4.0%
5. Australia	20	2.3%
6. Indonesia	17	1.9%
7. Canada	16	1.8%
8. Germany	15	1.7%
9. United Kingdom	15	1.7%
10. Philippines	14	1.6%
11. Taiwan	12	1.4%
12. Thailand	12	1.4%
13. Singapore	11	1.2%
14. Vietnam	10	1.1%
15. France	7	0.8%
Other	186	21.0%
Total	**885**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	672	740.6	n.a.
Outgoing	557	699.3	885
Surplus (Deficit)	115	41.3	n.a.
Total Volume	1,229	1,439.9	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Route data for top five routes are rounded to the nearest five million minutes.

Kuwait

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Egypt	27.8	17.3%
2. India	17.8	11.1%
3. Saudi Arabia	16.2	10.1%
4. Syria	10.9	6.8%
5. United Arab Emirates	10.1	6.3%
6. United States	8.8	5.5%
7. Iran	8.8	5.5%
8. Pakistan	8.5	5.3%
9. United Kingdom	8.2	5.1%
10. Jordan	5.4	3.4%
11. Lebanon	4.6	2.9%
12. Bahrain	4.3	2.7%
13. Bangladesh	2.4	1.5%
14. Philippines	1.6	1.0%
15. Canada	1.6	1.0%
16. Qatar	1.5	0.9%
17. France	1.3	0.8%
18. Germany	1.3	0.8%
19. Sri Lanka	1.2	0.8%
20. Oman	1.2	0.7%
Other	17.0	10.6%
Total	**160.5**	

National Traffic Balance

MiTT	**1995**	**1996**	**1997**
Incoming	130.2	131.2	n.a.
Outgoing	125.9	140.7	160.5
Surplus (Deficit)	4.3	(9.4)	n.a.
Total Volume	256.1	271.9	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Luxembourg

Largest Telecommunications Routes, 1996

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Belgium	56.2	22.6%
2. Germany	50.9	20.5%
3. France	50.3	20.2%
4. Portugal	15.7	6.3%
5. United Kingdom	14.0	5.6%
6. Italy	11.4	4.6%
7. Netherlands	8.7	3.5%
8. Switzerland	6.6	2.7%
9. United States	5.7	2.3%
10. Spain	3.9	1.6%
11. Denmark	3.2	1.3%
12. Austria	2.3	0.9%
13. Sweden	2.3	0.9%
14. Greece	1.7	0.7%
15. Ireland	1.1	0.4%
16. Finland	1.0	0.4%
17. Poland	0.9	0.4%
18. Russia	0.8	0.3%
19. Japan	0.7	0.3%
20. Canada	0.7	0.3%
Other	10.7	4.3%
Total	**248.5**	

National Traffic Balance

MiTT	1994	1995	1996
Incoming	145.2	174.5	189.8
Outgoing	213.5	232.2	248.5
Surplus (Deficit)	(68.3)	(57.7)	(58.8)
Total Volume	358.7	406.7	438.3

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Macau

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Hong Kong	50.3	42.2%
2. China	50.2	42.1%
3. Portugal	3.8	3.2%
4. Taiwan	3.6	3.0%
5. United States	1.8	1.5%
6. Philippines	1.5	1.3%
7. Canada	1.4	1.2%
8. Thailand	1.1	0.9%
9. Australia	0.9	0.8%
10. United Kingdom	0.7	0.6%
11. Singapore	0.5	0.4%
12. Japan	0.4	0.4%
13. Malaysia	0.3	0.3%
14. South Korea	0.3	0.3%
15. France	0.3	0.2%
16. Indonesia	0.2	0.2%
17. New Zealand	0.1	0.1%
18. Germany	0.1	0.1%
19. Vietnam	0.1	0.1%
Other	1.3	1.1%
Total	**119.0**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	90.4	92.1	92.2
Outgoing	108.1	112.5	119.0
Surplus (Deficit)	(17.7)	(20.4)	(26.7)
Total Volume	198.5	204.6	211.2

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Macedonia

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Yugoslavia	18.0	34.8%
2. Germany	5.0	9.6%
3. Bulgaria	3.2	6.2%
4. Switzerland	2.6	5.1%
5. Greece	2.6	4.9%
6. Slovenia	2.1	4.0%
7. Turkey	2.0	3.9%
8. Croatia	2.0	3.9%
9. United States	1.7	3.2%
10. Italy	1.6	3.0%
11. Austria	1.3	2.5%
12. Canada	1.0	2.0%
13. Australia	0.9	1.8%
14. United Kingdom	0.8	1.5%
15. Sweden	0.6	1.1%
16. Albania	0.6	1.1%
17. Netherlands	0.6	1.1%
18. Russia	0.5	0.9%
19. Bosnia-Herzegovina	0.5	0.9%
20. Belgium	0.4	0.7%
Other	4.0	7.7%
Total	**51.7**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	82.0	81.9	85.2
Outgoing	45.0	51.0	51.7
Surplus (Deficit)	37.0	30.9	33.5
Total Volume	127.0	132.9	136.9

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Malaysia

Largest Telecommunications Routes, FY 1997/98

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Singapore	330.1	56.1%
2. Indonesia	37.3	6.3%
3. Japan	25.1	4.3%
4. United Kingdom	22.4	3.8%
5. Australia	21.5	3.7%
6. United States	18.0	3.1%
7. Thailand	15.2	2.6%
8. Hong Kong	15.0	2.5%
9. India	13.0	2.2%
10. Taiwan	11.5	2.0%
11. Philippines	10.4	1.8%
12. China	7.1	1.2%
13. Bangladesh	6.0	1.0%
14. Germany	5.0	0.8%
15. South Korea	4.2	0.7%
16. Pakistan	3.7	0.6%
17. Canada	3.4	0.6%
18. Saudi Arabia	3.2	0.5%
19. Myanmar	3.1	0.5%
20. Brunei	2.8	0.5%
Other	30.5	5.2%
Total	**588.5**	

National Traffic Balance

MiTT	FY 1995/96	FY 1996/97	FY 1997/98
Incoming	442.0	581.9	592.0
Outgoing	408.3	570.5	588.5
Surplus (Deficit)	33.7	11.4	3.5
Total Volume	850.3	1,152.4	1180.5

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic Traffic figures for FY 1995/96 exclude some cross-border traffic to Singapore. Traffic is for Telekom Malaysia only. Other carriers originated an estimated 135 million minutes of additional traffic in FY 1997/98. Fiscal year ends 31 March.

Malta

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United Kingdom	11.3	32.7%
2. Italy	5.5	16.1%
3. Germany	2.8	8.1%
4. Libya	1.5	4.2%
5. France	1.3	3.8%
6. United States	1.3	3.8%
7. Netherlands	1.0	2.9%
8. Australia	0.9	2.6%
9. Russia	0.8	2.5%
10. Switzerland	0.6	1.9%
11. Belgium	0.5	1.6%
12. Canada	0.5	1.3%
13. Tunisia	0.4	1.1%
14. Austria	0.4	1.1%
15. Egypt	0.3	1.0%
16. Spain	0.3	0.9%
17. Greece	0.3	0.9%
18. Turkey	0.3	0.9%
19. Sweden	0.3	0.8%
20. Yugoslavia	0.3	0.8%
Other	3.8	11.0%
Total	**34.4**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	31.0	34.0	n.a.
Outgoing	28.5	31.7	34.4
Surplus (Deficit)	2.5	2.3	n.a.
Total Volume	69.5	65.7	n.a.

Note: MiTT is Minutes of Telecommunications Traffic Data are in millions of minutes of public switched traffic.

Mexico

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	893.5	88.6%
2. Canada	16.2	1.6%
3. Spain	9.4	0.9%
4. Italy	6.0	0.6%
5. Germany	5.9	0.6%
6. France	5.8	0.6%
7. Guatemala	5.6	0.6%
8. United Kingdom	4.4	0.4%
9. Colombia	4.2	0.4%
10. Cuba	3.9	0.4%
11. Costa Rica	3.8	0.4%
12. Argentina	3.6	0.4%
13. Chile	3.6	0.4%
14. Brazil	3.6	0.4%
15. Peru	3.0	0.3%
16. El Salvador	2.7	0.3%
17. Japan	2.6	0.3%
18. Venezuela	2.4	0.2%
19. Puerto Rico	2.2	0.2%
20. Honduras	2.0	0.2%
Other	24.4	2.4%
Total	**1,008.9**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	2,114.0	2,489.7	n.a.
Outgoing	950.0	1,070.7	1,200
Surplus (Deficit)	1,164.0	1,419.0	n.a.
Total Volume	3,064.0	3,560.4	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic Totals for 1997 include all carriers; route data are for Telmex only.

Moldova

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Russia	24.0	42.2%
2. Ukraine	17.0	29.9%
3. Romania	5.0	8.8%
4. Belarus	2.0	3.5%
5. Germany	1.5	2.6%
6. United States	0.7	1.2%
7. Israel	0.7	1.2%
8. Greece	0.7	1.2%
9. Bulgaria	0.6	1.1%
10. Turkey	0.5	0.9%
11. Italy	0.5	0.8%
12. Poland	0.3	0.5%
13. United Kingdom	0.2	0.4%
14. Hungary	0.2	0.4%
15. France	0.2	0.4%
16. Kazakhstan	0.2	0.4%
17. Canada	0.2	0.4%
18. Lithuania	0.2	0.3%
19. Latvia	0.2	0.3%
20. Czech Republic	0.2	0.3%
Other	1.8	3.1%
Total	**56.8**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	80.2
Outgoing	50.8	50.2	56.8
Surplus (Deficit)	n.a.	n.a.	23.3
Total Volume	n.a.	n.a.	137.0

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic. Totals for 1995 and 1996 include only traffic to other member states of the Commonwealth of Independent States. See page 174 for a matrix of traffic from other CIS member states.

Namibia

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. South Africa	42.5	81.2%
2. Germany	1.7	3.3%
3. United Kingdom	0.8	1.6%
4. United States	0.6	1.2%
5. Zimbabwe	0.6	1.1%
6. Botswana	0.4	0.8%
7. Angola	0.4	0.7%
8. Zambia	0.3	0.7%
9. Spain	0.2	0.4%
10. France	0.2	0.4%
11. Italy	0.2	0.3%
12. Netherlands	0.2	0.3%
13. Portugal	0.1	0.3%
14. Switzerland	0.1	0.3%
15. China	0.1	0.2%
16. Australia	0.1	0.2%
17. Norway	0.1	0.2%
18. Austria	0.1	0.2%
19. Moldova	0.1	0.2%
20. Russia	0.1	0.2%
Other	3.3	6.3%
Total	**52.3**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	47.0
Outgoing	50.9	51.4	52.3
Surplus (Deficit)	n.a.	n.a.	(5.3)
Total Volume	n.a.	n.a.	99.3

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic

Netherlands

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	346.7	22.6%
2. Belgium	254.5	16.6%
3. United Kingdom	198.3	12.9%
4. France	111.2	7.2%
5. United States	96.1	6.3%
6. Italy	48.3	3.1%
7. Spain	46.8	3.0%
8. Switzerland	39.8	2.6%
9. Turkey	30.5	2.0%
10. Sweden	24.6	1.6%
11. Denmark	21.2	1.4%
12. Austria	20.0	1.3%
13. Canada	19.6	1.3%
14. Poland	16.0	1.0%
15. Ireland	12.5	0.8%
16. Norway	12.5	0.8%
17. Portugal	12.2	0.8%
18. Greece	11.5	0.7%
19. Morocco	10.7	0.7%
20. Suriname	10.5	0.7%
Other	191.6	12.5%
Total	**1,535.0**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	1,453.0	1,584.6	1,712.2
Outgoing	1,458.7	1,534.1	1,535.0
Surplus (Deficit)	(5.7)	50.5	177.2
Total Volume	2,911.7	3,118.7	3,247.3

Note: MiTT is Minutes of Telecommunications Traffic Data are in millions of minutes of public switched traffic. Data based on billing point of traffic Traffic is for PTT Telecom (KPN) only.

New Zealand

Largest Telecommunications Routes, FY 1997/98

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Australia	185	45.5%
2. United Kingdom	50	12.3%
3. United States	40	9.8%
4. Japan	9	2.2%
5. Canada	9	2.2%
6. Hong Kong	8	2.0%
7. Fiji	8	2.0%
8. Singapore	7	1.7%
9. Malaysia	6	1.5%
10. Western Samoa	5	1.2%
11. Germany	5	1.2%
12. Taiwan	4	1.0%
Other	71	17.4%
Total	**407**	

National Traffic Balance

MiTT	FY 1995/96	FY 1996/97	FY 1997/98
Incoming	327	380	n.a.
Outgoing	312	353	407
Surplus (Deficit)	15	27	n.a.
Total Volume	639	733	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Fiscal Year ends 31 March.

Nicaragua

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	16.1	39.7%
2. Costa Rica	9.2	22.8%
3. Guatemala	3.3	8.2%
4. El Salvador	3.0	7.5%
5. Honduras	2.8	7.0%
6. Mexico	1.0	2.6%
7. Panama	0.9	2.3%
8. Canada	0.7	1.7%
9. Spain	0.5	1.3%
10. Colombia	0.3	0.6%
11. Brazil	0.2	0.5%
12. Cuba	0.2	0.5%
13. Germany	0.2	0.4%
14. Argentina	0.2	0.4%
15. Italy	0.2	0.4%
16. Chile	0.1	0.3%
17. Netherlands	0.1	0.3%
18. Peru	0.1	0.3%
19. Venezuela	0.1	0.2%
20. France	0.1	0.2%
Other	1.1	2.8%
Total	**40.4**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	52.5
Outgoing	29.4	n.a.	40.4
Surplus (Deficit)	n.a.	n.a.	12.1
Total Volume	n.a.	n.a.	92.9

Note: MiTT is Minutes of Telecommunications Traffic Data are in millions of minutes of public switched traffic. Data based on billing point of traffic

Norway

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Sweden	125	26.0%
2. Denmark	70	14.6%
3. United Kingdom	65	13.5%
4. United States	50	10.4%
5. Germany	27	5.6%
6. Netherlands	17	3.5%
7. France	13	2.7%
8. Finland	12	2.5%
9. Spain	10	2.1%
10. Italy	9	1.9%
11. Switzerland	6	1.2%
12. Russia	6	1.2%
13. Poland	6	1.2%
14. Belgium	5	1.0%
15. Canada	5	1.0%
Other	55	11.4%
Total	**481**	

National Traffic Balance

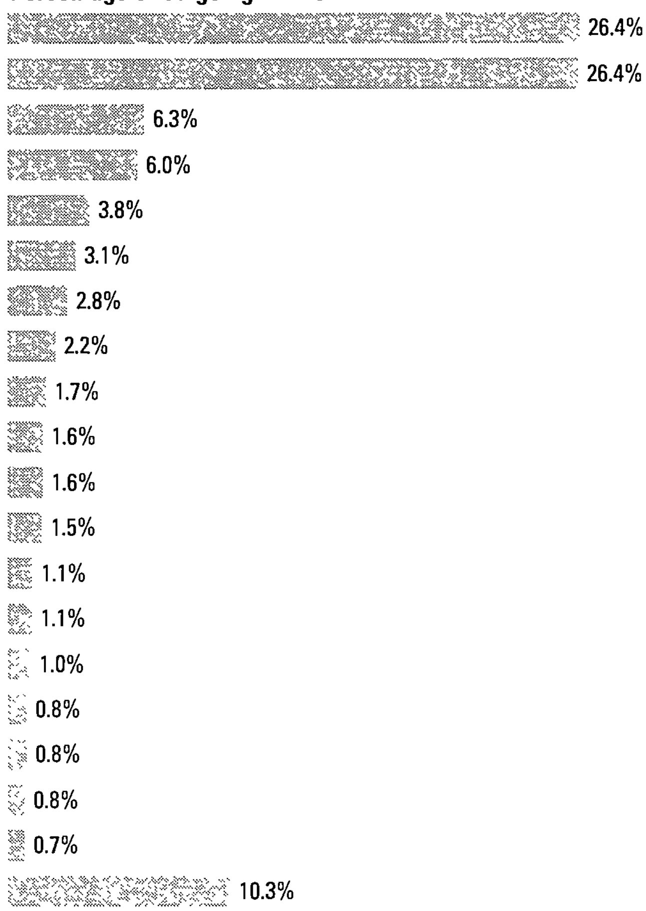
MiTT	1995	1996	1997
Incoming	373.2	422.3	n.a.
Outgoing	431.5	443.5	481
Surplus (Deficit)	(58.3)	(21.2)	n.a.
Total Volume	804.7	865.8	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic Data for 1995 based on billing point of traffic.

Oman

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United Arab Emirates	19.7	26.4%
2. India	19.6	26.4%
3. United Kingdom	4.7	6.3%
4. Pakistan	4.4	6.0%
5. Egypt	2.8	3.8%
6. Saudi Arabia	2.3	3.1%
7. Bahrain	2.1	2.8%
8. Bangladesh	1.6	2.2%
9. Jordan	1.3	1.7%
10. Qatar	1.2	1.6%
11. Kuwait	1.2	1.6%
12. United States	1.1	1.5%
13. Sri Lanka	0.8	1.1%
14. Tanzania	0.8	1.1%
15. Philippines	0.7	1.0%
16. Germany	0.6	0.8%
17. France	0.6	0.8%
18. Netherlands	0.6	0.8%
19. Canada	0.6	0.7%
Other	7.6	10.3%
Total	**74.3**	



National Traffic Balance

MiTT	1995	1996	1997
Incoming	53.3	58.0	70.4
Outgoing	54.4	62.6	74.3
Surplus (Deficit)	(1.1)	(4.6)	(3.9)
Total Volume	107.6	120.6	144.7

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Pakistan

Largest Telecommunications Routes, FY 1997/98

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	15.6	18.6%
2. United Kingdom	14.7	17.5%
3. United Arab Emirates	9.9	11.8%
4. Saudi Arabia	7.1	8.4%
5. Canada	4.2	5.0%
6. Italy	3.2	3.9%
7. Germany	2.8	3.3%
8. France	2.6	3.1%
9. Singapore	2.3	2.7%
10. Japan	2.3	2.7%
11. India	2.0	2.4%
12. Kuwait	1.6	1.9%
13. Hong Kong	1.4	1.7%
14. Netherlands	1.1	1.3%
15. China	1.0	1.2%
16. Bangladesh	1.0	1.2%
17. Turkey	1.0	1.2%
18. Iran	1.0	1.2%
19. Oman	0.8	1.0%
20. Switzerland	0.6	0.8%
Other	7.8	9.3%
Total	**84.1**	

National Traffic Balance

MiTT	FY 1995/96	FY 1996/97	FY 1997/98
Incoming	362.1	488.4	557.8
Outgoing	65.9	77.0	84.1
Surplus (Deficit)	296.2	411.5	473.7
Total Volume	428.0	565.4	641.9

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Fiscal year ends 30 June. Data exclude some cross-border traffic to India.

Panama

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	18.1	43.8%
2. Colombia	4.7	11.3%
3. Costa Rica	2.8	6.7%
4. Mexico	1.8	4.3%
5. Venezuela	1.0	2.5%
6. Guatemala	0.9	2.2%
7. Ecuador	0.8	2.0%
8. Dominican Republic	0.8	2.0%
9. Brazil	0.7	1.8%
10. El Salvador	0.7	1.7%
11. Spain	0.7	1.7%
12. Peru	0.6	1.5%
13. Nicaragua	0.6	1.4%
14. Cuba	0.5	1.2%
15. Honduras	0.5	1.2%
16. Canada	0.5	1.1%
17. Argentina	0.5	1.1%
18. Chile	0.4	1.1%
19. United Kingdom	0.4	1.0%
Other	4.0	9.5%
Total	**41.4**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	94.2	97.7	95.1
Outgoing	39.5	41.2	41.4
Surplus (Deficit)	54.7	56.5	53.7
Total Volume	133.7	138.9	136.5

Note: MiTT is Minutes of Telecommunications Traffic Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Papua New Guinea

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Australia	16.2	69.0%
2. Philippines	1.0	4.4%
3. Malaysia	1.0	4.1%
4. New Zealand	0.9	3.8%
5. United States	0.7	3.2%
6. Singapore	0.6	2.7%
7. United Kingdom	0.6	2.4%
8. Indonesia	0.4	1.8%
9. French Polynesia	0.4	1.6%
10. Japan	0.4	1.6%
Other	1.2	5.1%
Total	**23.4**	

National Traffic Balance

MiTT	**1995**	**1996**	**1997**
Incoming	n.a.	n.a.	20.6
Outgoing	23.9	26.9	23.4
Surplus (Deficit)	n.a.	n.a.	(2.8)
Total Volume	n.a.	n.a.	44.0

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Paraguay

Largest Telecommunications Routes, 1996

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Argentina	8.2	32.9%
2. Brazil	6.3	25.3%
3. United States	3.0	12.0%
4. Chile	1.2	4.8%
5. Uruguay	1.2	4.8%
6. Germany	0.5	2.0%
7. Taiwan	0.4	1.6%
8. Spain	0.4	1.6%
9. Rep. of Korea	0.4	1.6%
10. Bolivia	0.3	1.2%
11. Peru	0.3	1.2%
12. Italy	0.2	0.8%
13. Japan	0.2	0.8%
14. France	0.2	0.8%
15. Mexico	0.2	0.8%
16. Colombia	0.2	0.8%
17. United Kingdom	0.1	0.4%
18. Panama	0.1	0.4%
19. Switzerland	0.1	0.4%
20. Hong Kong	0.1	0.4%
Other	1.3	5.2%
Total	**24.9**	

National Traffic Balance

MiTT	1994	1995	1996
Incoming	30.6	n.a.	49.4
Outgoing	18.1	20.9	24.9
Surplus (Deficit)	12.5	n.a.	24.5
Total Volume	48.7	n.a.	74.3

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Peru

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	29.7	37.3%
2. Chile	6.0	7.6%
3. Spain	5.8	7.4%
4. Argentina	5.5	6.9%
5. Japan	3.5	4.4%
6. Italy	3.3	4.2%
7. Colombia	3.2	4.1%
8. Brazil	2.7	3.3%
9. Venezuela	2.6	3.3%
10. Bolivia	2.4	3.0%
11. Mexico	2.1	2.7%
12. Canada	1.9	2.4%
13. Germany	1.5	1.9%
14. United Kingdom	1.4	1.7%
15. Ecuador	1.3	1.7%
16. France	1.0	1.3%
Other	5.5	6.9%
Total	**79.4**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	195.4	226.5	256.9
Outgoing	62.6	66.7	79.4
Surplus (Deficit)	132.8	159.7	177.5
Total Volume	258.0	293.2	336.4

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic Data based on billing point of traffic.

Philippines

Largest Telecommunications Routes, FY 1997/98

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	90	30.5%
2. Japan	40	13.6%
3. Hong Kong	35	11.9%
4. Canada	15	5.1%
5. Singapore	14	4.7%
6. Taiwan	12	4.1%
7. Rep. of Korea	12	4.1%
8. Australia	10	3.4%
9. Saudi Arabia	7	2.4%
10. Malaysia	6	2.0%
Other	54	18.3%
Total	**295**	

National Traffic Balance

MiTT	FY 1995/96	FY 1996/97	FY 1997/98
Incoming	691	767	930
Outgoing	174	240	295
Surplus (Deficit)	517	527	635
Total Volume	865	1,007	1,225

Note: MiTT is Minutes of Telecommunications Traffic Data are in millions of minutes of public switched traffic. Data based on billing point of traffic. Route data for top four routes rounded to the nearest five million minutes. Fiscal year ends 31 March

Poland

Largest Telecommunications Routes, 1996

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	172.4	39.4%
2. United Kingdom	25.0	5.7%
3. United States	24.2	5.5%
4. France	23.2	5.3%
5. Italy	22.3	5.1%
6. Austria	15.0	3.4%
7. Netherlands	13.9	3.2%
8. Russia	13.1	3.0%
9. Ukraine	12.5	2.9%
10. Sweden	12.0	2.7%
11. Belgium	9.0	2.1%
12. Czech Republic	8.7	2.0%
13. Canada	8.1	1.9%
14. Denmark	7.4	1.7%
15. Switzerland	6.2	1.4%
16. Belarus	6.0	1.4%
17. Vietnam	5.2	1.2%
18. Spain	4.4	1.0%
19. Hungary	3.4	0.8%
20. Norway	3.2	0.7%
Other	42.0	9.6%
Total	**437.2**	

National Traffic Balance

MiTT	1994	1995	1996
Incoming	643.8	649.3	725.5
Outgoing	356.6	381.4	437.2
Surplus (Deficit)	287.2	267.9	288.3
Total Volume	1,000.4	1,030.7	1,162.7

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Portugal

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. France	76.3	19.4%
2. Spain	66.8	17.0%
3. Germany	42.5	10.8%
4. United Kingdom	41.9	10.6%
5. Switzerland	18.6	4.7%
6. Brazil	16.8	4.3%
7. United States	14.8	3.8%
8. Italy	14.6	3.7%
9. Netherlands	13.5	3.4%
10. Belgium	10.2	2.6%
11. Angola	8.9	2.3%
12. Canada	5.4	1.4%
13. Luxembourg	4.2	1.1%
14. Cape Verde	4.0	1.0%
15. Guinea-Bissau	3.9	1.0%
16. Mozambique	3.1	0.8%
17. Sweden	3.0	0.8%
18. South Africa	2.8	0.7%
19. Denmark	2.7	0.7%
20. Venezuela	2.7	0.7%
Other	36.5	9.3%
Total	**393.3**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	525.0	571.4	628.8
Outgoing	283.9	340.0	393.3
Surplus (Deficit)	241.1	231.4	235.5
Total Volume	808.9	911.4	1,022.1

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Romania

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	20.5	18.5%
2. Italy	15.6	14.1%
3. Hungary	7.7	6.9%
4. France	7.4	6.7%
5. Greece	5.9	5.3%
6. United Kingdom	5.8	5.2%
7. Turkey	5.6	5.1%
8. United States	4.9	4.4%
9. Austria	4.8	4.3%
10. Netherlands	2.8	2.5%
11. Switzerland	2.3	2.1%
12. Belgium	2.2	2.0%
13. Israel	2.1	1.9%
14. Canada	1.6	1.4%
15. Yugoslavia	1.5	1.4%
16. Sweden	1.3	1.2%
17. Spain	1.2	1.1%
18. Bulgaria	1.1	1.0%
19. Russia	0.9	0.8%
20. Ukraine	0.8	0.7%
Other	14.8	13.4%
Total	**110.8**	

National Traffic Balance

MiTT	**1995**	**1996**	**1997**
Incoming	198.0	237.5	278.6
Outgoing	78.1	91.5	110.8
Surplus (Deficit)	119.9	146.0	167.8
Total Volume	276.1	429.0	389.4

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Russia

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Ukraine	249.0	26.5%
2. Belarus	98.9	10.5%
3. Kazakhstan	90.6	9.6%
4. Germany	48.9	5.2%
5. Uzbekistan	32.3	3.4%
6. Georgia	27.6	2.9%
7. Azerbaijan	27.5	2.9%
8. Armenia	25.7	2.7%
9. Latvia	22.2	2.4%
10. United States	21.6	2.3%
11. Lithuania	16.5	1.8%
12. United Kingdom	16.1	1.7%
13. Moldova	15.7	1.7%
14. Kyrgyzstan	14.4	1.5%
15. Italy	13.8	1.5%
16. Estonia	13.1	1.4%
17. Finland	12.4	1.3%
18. Turkey	11.2	1.2%
19. France	11.1	1.2%
20. Israel	9.6	1.0%
Other	161.1	17.2%
Total	**939.3**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	448.1	1,037.6	1,035.6
Outgoing	287.4	851.3	939.3
Surplus (Deficit)	160.7	186.3	96.3
Total Volume	735.5	1,888.9	1,974.3

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data is for Rostelecom only. Data for 1995 include traffic to other member states of the Commonwealth of Independent States only. See page 174 for a matrix of traffic from other CIS member states.

Saudi Arabia

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Egypt	164	24.8%
2. Pakistan	82	12.4%
3. India	68	10.3%
4. Syria	36	5.5%
5. United States	32	4.8%
6. United Kingdom	30	4.5%
7. Bahrain	24	3.6%
8. Yemen	19	2.9%
9. Jordan	19	2.9%
10. Philippines	18	2.7%
11. United Arab Emirates	17	2.6%
12. Kuwait	15	2.3%
Other	136	20.6%
Total	**660**	

National Traffic Balance

MiTT	**1995**	**1996**	**1997**
Incoming	n.a.	n.a.	n.a.
Outgoing	537.3	584.4	660
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Singapore

Largest Telecommunications Routes, FY 1997/98

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Malaysia	408	35.1%
2. Indonesia	90	7.8%
3. Hong Kong	85	7.3%
4. United States	65	5.6%
5. Australia	55	4.7%
6. China	55	4.7%
7. Japan	50	4.3%
8. Thailand	40	3.4%
9. United Kingdom	35	3.0%
10. India	35	3.0%
11. Philippines	35	3.0%
Other	208	17.9%
Total	**1,161**	

National Traffic Balance

MiTT	FY 1995/96	FY 1996/97	FY 1997/98
Incoming	n.a.	n.a.	n.a.
Outgoing	773	942	1,161
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic. Data for 1995 excludes some cross-border traffic with Malaysia Fiscal year ends 31 March

Slovak Republic

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Czech Republic	64.9	44.8%
2. Germany	16.0	11.1%
3. Austria	11.9	8.2%
4. Hungary	7.1	4.9%
5. United Kingdom	5.3	3.6%
6. Italy	4.7	3.2%
7. Poland	3.4	2.4%
8. United States	3.3	2.3%
9. France	3.1	2.1%
10. Ukraine	3.1	2.1%
11. Russia	2.6	1.8%
12. Switzerland	2.5	1.7%
13. Netherlands	1.9	1.3%
14. Belgium	1.3	0.9%
15. Croatia	1.2	0.8%
16. Yugoslavia	1.0	0.7%
17. Vietnam	0.8	0.6%
18. Sweden	0.7	0.5%
19. Spain	0.7	0.5%
20. Greece	0.6	0.4%
Other	8.5	5.8%
Total	**144.7**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	81.6	159.0	174.4
Outgoing	58.8	134.1	144.7
Surplus (Deficit)	22.8	24.9	29.8
Total Volume	140.4	293.1	319.1

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic. Data for 1995 exclude cross-border traffic with the Czech Republic

Slovenia

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Croatia	28.4	25.0%
2. Austria	13.5	11.9%
3. Germany	13.0	11.5%
4. Italy	12.8	11.3%
5. Yugoslavia	11.8	10.4%
6. Bosnia-Herzegovina	5.1	4.5%
7. Macedonia	2.7	2.3%
8. Switzerland	2.6	2.3%
9. United Kingdom	2.6	2.3%
10. France	2.4	2.1%
11. United States	1.9	1.7%
12. Hungary	1.8	1.6%
13. Russia	1.6	1.4%
14. Netherlands	1.4	1.2%
15. Czech Republic	1.2	1.0%
16. Sweden	0.9	0.8%
17. Belgium	0.9	0.8%
18. Poland	0.7	0.6%
19. Canada	0.6	0.6%
20. Ukraine	0.6	0.5%
Other	7.0	6.1%
Total	**113.5**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	121.2	113.9	118.9
Outgoing	100.6	105.3	113.5
Surplus (Deficit)	20.6	8.6	5.4
Total Volume	221.8	219.2	232.4

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

South Africa

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United Kingdom	75	20.3%
2. Zimbabwe	40	10.8%
3. United States	35	9.5%
4. Namibia	35	9.5%
5. Mozambique	15	4.1%
6. Botswana	15	4.1%
7. Germany	13	3.5%
8. Swaziland	12	3.3%
9. Australia	10	2.7%
10. Lesotho	9	2.4%
11. Netherlands	7	1.9%
12. France	7	1.9%
13. Canada	7	1.9%
14. Zambia	6	1.6%
15. Italy	6	1.6%
16. Portugal	5	1.4%
17. Switzerland	5	1.4%
18. India	5	1.4%
19. Malawi	4	1.1%
20. New Zealand	4	1.1%
Other	54	14.6%
Total	**368.8**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	343.2
Outgoing	305.0	353.0	368.8
Surplus (Deficit)	n.a.	n.a.	(25.6)
Total Volume	n.a.	n.a.	712.0

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Route data for top six routes rounded to the nearest five million minutes.

Spain

Largest Telecommunications Routes, 1995

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	160.7	13.5%
2. France	158.2	13.3%
3. United Kingdom	147.0	12.4%
4. Italy	68.2	5.7%
5. United States	48.3	4.1%
6. Portugal	40.6	3.4%
7. Switzerland	36.1	3.0%
8. Belgium	35.4	3.0%
9. Netherlands	35.3	3.0%
10. Morocco	22.8	1.9%
11. Andorra	17.2	1.4%
12. Argentina	17.1	1.4%
13. Sweden	14.5	1.2%
14. Chile	12.9	1.1%
15. Colombia	10.5	0.9%
16. Denmark	9.5	0.8%
17. Mexico	8.9	0.7%
18. Brazil	8.8	0.7%
19. Cuba	8.7	0.7%
20. Austria	8.4	0.7%
Other	155.8	13.1%
Total	**1,024.9**	

National Traffic Balance

MiTT	1994	1995	1996
Incoming	969.9	1,076.4	n.a.
Outgoing	948.3	1,024.6	1,189.0
Surplus (Deficit)	21.6	51.8	n.a.
Total Volume	1,918.2	2,101.0	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Sri Lanka

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. India	6.2	18.6%
2. United Kingdom	3.4	10.2%
3. Singapore	2.5	7.5%
4. Japan	1.9	5.8%
5. United States	1.8	5.5%
6. Australia	1.6	4.8%
7. Hong Kong	1.4	4.3%
8. Rep. of Korea	1.1	3.4%
9. Germany	1.1	3.2%
10. United Arab Emirates	1.1	3.2%
11. Saudi Arabia	0.9	2.7%
12. Italy	0.8	2.5%
13. Maldives	0.7	2.1%
14. Pakistan	0.6	1.9%
15. France	0.6	1.9%
16. Canada	0.6	1.9%
17. Kuwait	0.6	1.8%
18. Thailand	0.5	1.7%
19. Malaysia	0.5	1.6%
20. Switzerland	0.5	1.5%
Other	4.6	14.0%
Total	**33.2**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	92.0	96.0	124.3
Outgoing	27.5	29.3	33.2
Surplus (Deficit)	64.5	66.7	91.1
Total Volume	119.5	125.3	157.5

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Sweden

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United Kingdom	160	14.0%
2. Finland	145	12.7%
3. Norway	135	11.8%
4. Denmark	110	9.6%
5. Germany	100	8.8%
6. United States	100	8.8%
7. Netherlands	35	3.1%
8. France	30	2.6%
9. Poland	30	2.6%
10. Switzerland	25	2.2%
Other	270	23.7%
Total	**1,140**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	n.a.
Outgoing	900	1,026	1,140
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Route data rounded to the nearest five million minutes Data based on billing point of traffic.

Switzerland

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	477	22.0%
2. France	344	15.9%
3. Italy	292	13.5%
4. United Kingdom	119	5.5%
5. United States	97	4.5%
6. Austria	88	4.1%
7. Portugal	72	3.3%
8. Spain	71	3.3%
9. Netherlands	52	2.4%
10. Yugoslavia	50	2.3%
Other	502	23.2%
Total	**2,164**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	1439.3	1,562.8	1,723
Outgoing	1,778.4	1,935.5	2,164
Surplus (Deficit)	(339.1)	(372.7)	(441)
Total Volume	3,217.7	3,498.4	3,887

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

Syria

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Lebanon	23.2	26.0%
2. Saudi Arabia	13.9	15.6%
3. United Arab Emirates	5.9	6.6%
4. Jordan	6.4	7.1%
5. Kuwait	4.9	5.5%
6. Canada	4.4	4.9%
7. United States	4.3	4.8%
8. Egypt	3.1	3.5%
9. France	2.8	3.1%
10. Germany	2.3	2.5%
11. Turkey	2.2	2.5%
12. United Kingdom	1.6	1.8%
13. Italy	1.6	1.8%
14. Russia	1.0	1.1%
15. Greece	0.7	0.8%
16. Cyprus	0.7	0.8%
17. Sudan	0.7	0.7%
18. Qatar	0.6	0.6%
Other	8.9	10.0%
Total	**89.3**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	100	156.0	173.2
Outgoing	60	78.9	89.3
Surplus (Deficit)	40	77.1	83.9
Total Volume	160	234.9	262.5

Note: MiTT is Minutes of Telecommunications Traffic Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Taiwan

Largest Telecommunications Routes, FY 1997/98

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. China	198.1	25.1%
2. United States	153.6	19.5%
3. Japan	73.3	9.3%
4. Hong Kong	70.9	9.0%
5. Philippines	45.1	5.7%
6. Thailand	33.5	4.2%
7. Canada	27.1	3.4%
8. Singapore	23.5	3.0%
9. Indonesia	17.1	2.2%
10. Australia	16.0	2.0%
11. Vietnam	15.2	1.9%
12. Malaysia	14.5	1.8%
13. United Kingdom	10.7	1.4%
14. Germany	9.8	1.2%
15. Rep. of Korea	9.4	1.2%
16. Russia	6.4	0.8%
17. New Zealand	6.5	0.8%
18. France	5.6	0.7%
19. Macau	4.1	0.5%
Other	48.7	6.2%
Total	**789.0**	

National Traffic Balance

MiTT	FY 1995/96	FY 1996/97	FY 1997/98
Incoming	545.3	736.8	842.2
Outgoing	592.8	674.0	789.0
Surplus (Deficit)	(47.5)	62.8	53.2
Total Volume	1,138.1	1,410.8	1,631.2

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Fiscal year ends 31 March.

Thailand

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Japan	44.9	16.1%
2. Singapore	31.2	11.2%
3. United States	30.0	10.8%
4. Hong Kong	19.6	7.0%
5. Taiwan	15.7	5.6%
6. United Kingdom	15.3	5.5%
7. Australia	12.7	4.6%
8. China	12.3	4.4%
9. Germany	10.9	3.9%
10. Rep. of Korea	7.2	2.6%
11. Myanmar	6.7	2.4%
12. India	6.6	2.4%
13. France	5.6	2.0%
14. Philippines	5.5	2.0%
15. Indonesia	5.1	1.8%
16. Italy	3.7	1.3%
17. Switzerland	3.5	1.3%
18. Vietnam	3.2	1.1%
19. Canada	2.7	1.0%
20. Netherlands	2.7	1.0%
Other	33.4	12.0%
Total	**278.4**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	277.7	376.2	408.5
Outgoing	218.8	247.4	278.4
Surplus (Deficit)	58.9	128.7	130.1
Total Volume	496.5	623.6	686.9

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic. Data does not include cross-border traffic with Laos and Malaysia

Turkey

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	172.5	30.9%
2. United Kingdom	38.5	6.9%
3. France	29.2	5.2%
4. Netherlands	24.1	4.3%
5. United States	24.1	4.3%
6. Russia	23.9	4.3%
7. Italy	18.1	3.2%
8. Switzerland	15.0	2.7%
9. Austria	14.4	2.6%
10. Romania	13.4	2.4%
11. Belgium	11.4	2.0%
12. Bulgaria	10.9	2.0%
13. Greece	8.5	1.5%
14. Azerbaijan	8.1	1.5%
15. Ukraine	8.1	1.4%
16. Iran	6.0	1.1%
17. Sweden	5.5	1.0%
18. Saudi Arabia	4.9	0.9%
19. Israel	4.9	0.9%
20. Denmark	4.4	0.8%
Other	111.7	20.0%
Total	**557.5**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	705.0	755.0	836.0
Outgoing	373.6	473.4	557.5
Surplus (Deficit)	331.5	281.6	278.5
Total Volume	1,078.6	1,228.4	1,393.5

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic

Ukraine

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Russia	296.7	61.0%
2. Belarus	26.0	5.3%
3. Moldova	20.0	4.1%
4. Germany	15.9	3.3%
5. Poland	10.7	2.2%
6. Armenia	7.3	1.5%
7. United States	6.7	1.4%
8. Kazakhstan	5.4	1.1%
9. Czech Republic	4.9	1.0%
10. Latvia	4.7	1.0%
11. Uzbekistan	4.6	0.9%
12. United Kingdom	4.5	0.9%
13. Georgia	4.1	0.8%
14. Azerbaijan	4.1	0.8%
15. Hungary	4.1	0.8%
16. Turkey	3.5	0.7%
17. Italy	3.5	0.7%
18. Israel	3.4	0.7%
19. Lithuania	3.3	0.7%
20. Bulgaria	3.0	0.6%
Other	50.4	10.4%
Total	**486.8**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	n.a.
Outgoing	301.8	340.8	486.8
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data for 1995 and 1996 include traffic to other member states of the Commonwealth of Independent States only. See page 174 for a matrix of traffic from other CIS member states.

United Arab Emirates

Largest Telecommunications Routes, 1995

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. India	108.4	21.5%
2. Pakistan	49.0	9.7%
3. United Kingdom	33.5	6.7%
4. Egypt	33.2	6.6%
5. Saudi Arabia	30.9	6.1%
6. United States	23.4	4.6%
7. Oman	21.0	4.2%
8. Syria	18.7	3.7%
9. Iran	16.7	3.3%
10. Qatar	13.1	2.6%
11. Jordan	12.7	2.5%
12. Bahrain	12.1	2.4%
13. Kuwait	11.3	2.2%
14. Philippines	9.4	1.9%
15. Lebanon	9.0	1.8%
16. Bangladesh	7.8	1.5%
17. Sudan	6.3	1.3%
18. France	6.1	1.2%
19. Germany	5.9	1.2%
20. Yemen	4.9	1.0%
Other	70.2	13.9%
Total	**503.6**	

National Traffic Balance

MiTT	1994	1995	1996
Incoming	n.a.	n.a.	n.a.
Outgoing	428.2	503.6	589.3
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

United Kingdom—Outgoing

Largest Telecommunications Routes, FY 1997/98

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	735.8	12.7%
2. Ireland	658.6	11.4%
3. Germany	504.5	8.7%
4. France	502.0	8.7%
5. Spain	270.6	4.7%
6. Italy	270.1	4.7%
7. Netherlands	223.2	3.8%
8. Australia	175.2	3.0%
9. Canada	153.9	2.7%
10. Belgium	143.9	2.5%
11. Switzerland	125.5	2.2%
12. Greece	103.6	1.8%
13. Hong Kong	98.0	1.7%
14. Turkey	94.7	1.6%
15. South Africa	86.9	1.5%
16. Sweden	79.3	1.4%
17. Poland	78.7	1.4%
18. India	77.8	1.3%
19. Denmark	74.2	1.3%
20. Portugal	73.9	1.3%
Other	1,269.4	21.9%
Total	**5,799.5**	

National Traffic Balance

MiTT	FY 1995/96	FY 1996/97	FY 1997/98
Incoming	4,021	4,360.0	n.a.
Outgoing	4,016	4,569.2	6,600
Surplus (Deficit)	5	(209.2)	n.a.
Total Volume	8,037	8,929.2	n.a.

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic. Outgoing total for FY 1997/98 includes public switched and ISR traffic data from all carriers and may include some traffic refiled via the U.K., thus overstating U.K.-originated volumes. FY 1997/98 route data and totals from previous years are for BT and C&W Communications only.

United Kingdom—Incoming

Largest Telecommunications Routes, FY 1997/98

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	1,229.0	24.4%
2. Ireland	479.3	9.5%
3. France	405.1	8.0%
4. Germany	376.1	7.5%
5. Spain	218.7	4.3%
6. Australia	201.6	4.0%
7. Italy	182.7	3.6%
8. Netherlands	169.0	3.3%
9. Canada	146.6	2.9%
10. Sweden	129.1	2.6%
11. Switzerland	111.0	2.2%
12. Belgium	109.6	2.2%
13. Greece	86.1	1.7%
14. South Africa	73.2	1.5%
15. Norway	61.6	1.2%
16. Denmark	57.0	1.1%
17. Japan	50.4	1.0%
18. Portugal	45.0	0.9%
19. Hong Kong	42.9	0.8%
20. Turkey	40.9	0.8%
Other	831.8	16.5%
Total	**5,046.8**	

U.K. Top 100 Correspondents

Country	October - December 1997 Outgoing MiTT	Incoming MiTT	Country	October - December 1997 Outgoing MiTT	Incoming MiTT
Algeria	4.8	2.0	Libya	1.6	1.2
Argentina	2.2	1.2	Lithuania	1.2	0.2
Armenia	1.4	0.5	Luxembourg	6.0	3.8
Australia	55.9	59.3	Malaysia	6.3	6.2
Austria	19.8	8.4	Malta	3.6	2.8
Bahrain	2.3	3.1	Mauritius	2.8	1.1
Bangladesh	5.6	0.9	Mexico	2.7	1.3
Barbados	2.2	1.1	Monaco	1.7	1.4
Belgium	43.8	32.5	Morocco	9.3	1.5
Bermuda	1.3	1.7	Myanmar	1.2	0.6
Bosnia	1.4	0.6	Netherlands Antilles	2.3	2.1
Brazil	5.8	4.1	Netherlands	61.9	49.0
Bulgaria	2.2	0.9	New Zealand	12.1	12.8
Canada	42.6	38.9	Nigeria	11.9	3.7
Chile	2.5	1.0	Norway	17.6	16.9
China	8.4	3.0	Oman	2.1	1.5
Colombia	2.8	1.0	Pakistan	22.5	7.1
Congo	2.1	0.5	Philippines	4.0	1.6
Cote d'Ivoire	2.2	0.3	Poland	20.2	8.0
Croatia	3.6	1.5	Portugal	19.4	11.0
Cyprus	9.3	7.8	Qatar	2.2	1.6
Czech Republic	8.9	4.6	Romania	2.9	1.7
Denmark	22.1	15.2	Russia	19.8	8.5
Ecuador	1.1	0.2	Saudi Arabia	15.3	12.5
Egypt	7.2	2.6	Senegal	2.9	0.2
Ethiopia	2.2	0.4	Sierra Leone	1.5	0.2
Finland	9.2	7.4	Singapore	13.0	6.1
France	147.4	101.4	Slovak Republic	3.9	15.0
Germany	151.3	98.6	Slovenia	1.3	0.8
Ghana	5.7	2.4	South Africa	29.6	18.9
Gibraltar	2.1	1.5	Spain	73.4	52.0
Greece	29.2	21.7	Sri Lanka	4.3	1.0
Guyana	2.5	0.3	Sweden	26.8	41.2
Hong Kong	25.1	12.9	Switzerland	35.6	27.6
Hungary	8.2	4.1	Syria	2.1	0.5
Iceland	1.6	1.2	Taiwan	3.4	2.3
India	25.6	11.8	Tanzania	1.3	0.5
Indonesia	4.2	3.0	Thailand	4.3	3.8
Iran	4.0	2.2	Trinidad & Tobago	3.7	1.6
Ireland	190.3	128.5	Tunisia	3.9	0.7
Israel	10.1	4.3	Turkey	24.0	10.1
Italy	81.4	46.7	Tuvalu	1.5	0.0
Jamaica	6.7	1.3	UAE	9.5	11.5
Japan	19.4	12.8	Ukraine	3.2	1.1
Jordan	3.4	1.0	United States	264.0	332.8
Kenya	3.7	1.6	Uzbekistan	3.0	0.4
Korea, Rep. of	4.8	3.7	Vietnam	7.5	0.9
Kuwait	4.1	2.0	Yemen	2.3	0.3
Latvia	2.0	0.8	Yugoslavia	2.8	1.3
Lebanon	4.4	0.6	Zimbabwe	2.4	2.2

Note: Data are millions of minutes of public switched and International Simple Resale (ISR) traffic for the seventeen largest U.K. international carriers during the October-December quarter of 1997 Route data may include some calls refiled via the U.K., thus overstating actual U.K.-originated traffic.

Source Office of Telecommunications (OFTEL)

United States—Outgoing

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Canada	3,926.6	17.3%
2. Mexico	2,757.6	12.1%
3. United Kingdom	1,532.6	6.8%
4. Germany	994.3	4.4%
5. Japan	830.5	3.7%
6. Hong Kong	673.2	3.0%
7. India	579.4	2.6%
8. France	500.0	2.2%
9. Brazil	497.3	2.2%
10. Italy	475.6	2.1%
11. Rep. of Korea	421.9	1.9%
12. Philippines	417.2	1.8%
13. Dominican Republic	392.1	1.7%
14. China	388.1	1.7%
15. Australia	383.5	1.7%
16. Taiwan	379.1	1.7%
17. Jamaica	262.6	1.2%
18. Colombia	260.5	1.1%
19. Argentina	228.1	1.0%
20. Switzerland	225.8	1.0%
Other	6,574.4	29.0%
Total	**22,700.1**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	7,004.6	8,194.9	9,219.3
Outgoing	15,837.1	19,119.1	22,700.1
Surplus (Deficit)	(8,832.5)	(10,924.1)	(13,480.8)
Total Volume	22,841.7	27,314.0	31,919.4

Note: MiTT is Minutes of Telecommunications Traffic. Data are millions of minutes of public switched and International Simple Resale (ISR) traffic. Data based on billing point of traffic. Carriers and traffic from outside the U.S states and Puerto Rico (e.g., Virgin Islands, Guam) are excluded

United States—Incoming

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Canada	3,173.3	34.4%
2. United Kingdom	950.2	10.3%
3. Mexico	946.5	10.3%
4. Japan	339.4	3.7%
5. Germany	324.6	3.5%
6. France	216.6	2.3%
7. Rep. of Korea	203.5	2.2%
8. Taiwan	174.3	1.9%
9. Israel	161.7	1.8%
10. Brazil	159.6	1.7%
11. Australia	123.5	1.3%
12. Italy	121.9	1.3%
13. Switzerland	108.1	1.2%
14. Netherlands	105.8	1.1%
15. Spain	100.6	1.1%
16. Dominican Republic	95.6	1.0%
17. Spain	88.1	1.0%
18. Hong Kong	82.4	0.9%
19. Chile	75.1	0.8%
20. Colombia	68.7	0.7%
Other	1,599.7	17.4%
Total	**9,219.3**	

U.S. Top 100 Correspondents

Country	Outgoing MiTT 1996	Outgoing MiTT 1997	Incoming MiTT 1996	Incoming MiTT 1997
Antigua & Barbuda	25.6	52.6	6.7	6.7
Argentina	221.4	228.1	22.4	38.8
Aruba	14.4	16.8	6.1	6.6
Australia	282.5	383.5	155.8	123.5
Austria	53.9	58.8	24.6	24.9
Bahamas	61.8	66.4	46.0	46.5
Bahrain	12.4	11.7	4.3	4.7
Bangladesh	46.3	59.0	1.5	4.5
Barbados	33.2	38.4	12.0	12.8
Belgium	113.5	120.7	43.2	49.7
Belize	14.9	14.5	3.7	4.2
Bermuda	35.8	38.7	29.5	29.9
Bolivia	29.6	34.5	4.8	3.6
Bosnia	23.0	20.3	1.3	2.6
Brazil	372.8	497.3	123.5	159.6
Bulgaria	12.0	12.2	1.7	1.3
Canada	3,463.4	3,926.6	2,845.9	3,173.3
Cayman Islands	19.3	21.9	12.8	12.1
Chile	79.0	115.5	52.0	75.1
China	298.4	388.1	58.3	61.7
Colombia	284.9	260.5	61.4	68.7
Costa Rica	67.4	75.3	24.0	26.4
Croatia	17.3	22.5	5.0	6.0
Cuba	103.0	118.9	0.8	1.2
Czech Rep.	25.8	26.9	8.0	9.2
Denmark	60.7	75.3	28.2	27.9
Dominica	10.5	16.4	2.2	1.9
Dominican Rep.	416.4	392.1	125.1	95.6
Ecuador	156.6	156.7	15.1	17.8
Egypt	89.7	111.2	9.6	10.7
El Salvador	141.3	154.6	9.9	12.8
Ethiopia	18.3	18.0	1.7	1.6
Finland	26.7	29.4	17.0	17.8
France	442.1	500.0	203.6	216.6
Germany	781.8	994.3	313.0	324.6
Ghana	32.8	50.0	4.0	5.2
Greece	90.6	97.4	33.0	35.0
Grenada	14.0	16.9	2.5	2.4
Guatemala	127.7	126.1	11.8	15.5
Guyana	86.7	59.7	15.8	12.5
Haiti	78.7	92.2	7.1	5.1
Honduras	89.8	111.1	9.4	11.5
Hong Kong	539.5	673.2	96.3	82.4
Hungary	36.1	41.0	14.5	15.2
India	423.9	579.4	50.1	49.7
Indonesia	92.1	119.2	24.8	28.1
Iran	55.5	46.0	15.3	16.0
Ireland	121.0	134.8	53.4	49.0
Israel	238.6	216.5	78.9	161.7
Italy	334.1	475.6	114.4	121.9
Ivory Coast	12.8	14.8	2.6	4.4
Jamaica	219.4	262.6	50.1	50.2
Japan	703.1	830.5	346.5	339.4
Jordan	43.0	57.1	4.8	5.4
Kenya	25.4	24.2	2.8	3.5
Korea, Rep. of	382.5	421.9	159.1	203.5
Kuwait	40.8	48.3	8.5	8.8
Lebanon	54.0	38.6	3.5	4.4
Malaysia	67.8	83.4	19.4	26.4
Mexico	2,380.9	2,757.6	948.1	946.5
Montserrat	4.5	12.4	0.4	0.4
Morocco	13.3	13.8	4.8	5.8
Netherlands	207.1	222.3	85.6	105.8
NL Antilles	33.9	42.3	11.1	6.0
New Zealand	58.9	107.8	29.3	40.6
Nicaragua	45.2	50.3	5.2	6.1
Nigeria	75.0	101.8	9.2	8.7
Norway	50.9	66.5	34.2	52.5
Pakistan	133.6	162.9	10.0	10.5
Panama	69.5	68.2	17.9	19.3
Paraguay	14.4	10.4	2.6	3.3
Peru	144.2	164.9	25.5	24.5
Philippines	356.1	417.2	50.2	32.2
Poland	160.4	170.9	27.1	27.3
Portugal	44.6	54.8	14.1	15.1
Romania	30.6	28.9	5.1	5.2
Russia	99.9	102.9	31.0	32.9
St. Lucia	12.7	14.7	3.0	3.2
St. Vincent	22.9	16.7	1.7	1.7
Saudi Arabia	101.2	111.4	27.2	32.1
Senegal	17.0	18.9	1.6	1.7
Singapore	148.7	197.8	53.5	63.5
South Africa	97.4	110.6	29.3	31.2
Spain	147.3	190.8	61.5	88.1
Sri Lanka	14.3	16.2	1.9	2.0
Sweden	103.2	140.0	70.4	100.6
Switzerland	181.0	225.8	91.9	108.1
Syria	18.1	15.2	3.1	2.9
Taiwan	321.7	379.1	112.2	174.3
Thailand	114.5	117.7	29.7	26.2
Trinidad & Tobago	86.4	94.4	26.6	26.2
Turkey	58.4	62.0	25.9	28.3
Ukraine	36.2	44.4	6.5	6.9
UAE	53.8	52.3	26.2	28.4
United Kingdom	1,226.4	1,532.6	737.7	950.2
Uruguay	24.9	26.2	5.6	7.5
Venezuela	154.2	219.8	58.5	63.9
Vietnam	114.2	157.0	5.2	4.0
Yemen	21.2	23.9	1.2	1.2
Yugoslavia	25.5	15.7	9.3	5.5

Note All data are millions of minutes of public switched and International Simple Resale (ISR) traffic. Because data are based on the billing point of the traffic, route data may not exactly correspond with traffic volumes as measured by the originating point of traffic (see Methodology on page 268). Carriers and traffic from outside the U.S. states and Puerto Rico (e.g., Virgin Islands, Guam) are excluded.

U.S.—Traffic by Carrier

Market Share of International Traffic by Route, 1997

	U.S. Billed Traffic				*Foreign Billed Traffic*			
	AT&T	**MCI**	**Sprint**	**WorldCom**	**AT&T**	**MCI**	**Sprint**	**WorldCom**
Argentina	36.68	31.87	16.91	7.94	43.40	30.37	15.37	7.02
Australia	14.75	19.64	8.89	6.71	11.39	32.08	24.23	10.79
Brazil	47.17	14.93	17.51	18.57	53.45	16.17	19.62	10.61
Canada	51.02	22.95	14.15	1.23	44.10	20.33	28.56	1.50
China	38.83	24.90	10.28	4.32	54.32	27.18	12.80	4.63
Colombia	48.03	19.61	12.16	15.50	48.68	20.77	9.33	20.26
Dominican Republic	18.27	21.45	10.93	18.22	26.61	42.81	6.85	14.51
Ecuador	53.60	17.49	11.57	14.46	15.20	70.82	9.15	4.82
France	42.19	27.42	12.73	12.66	39.18	28.56	16.22	15.93
Germany	43.73	28.32	9.32	10.64	45.63	30.71	9.93	9.95
Hong Kong	20.12	46.80	22.64	5.77	27.88	38.86	27.64	3.97
India	34.81	51.27	8.12	0.21	46.60	43.16	9.03	0.00
Israel	52.50	23.35	15.21	5.03	59.70	23.48	13.48	3.34
Italy	44.91	27.26	15.60	10.43	54.06	19.33	14.11	12.22
Jamaica	48.11	29.21	9.75	9.12	61.16	29.54	8.13	1.18
Japan	36.32	42.80	10.25	6.72	38.68	39.44	14.14	5.66
Rep. of Korea	42.69	27.84	13.95	7.88	56.26	28.91	11.00	3.75
Mexico	58.12	24.71	9.63	7.40	48.05	18.53	14.78	9.13
Netherlands	41.58	22.83	11.76	6.82	36.22	41.54	14.52	2.22
Philippines	56.34	16.48	9.45	2.32	72.67	18.46	8.86	0.00
Poland	70.29	17.91	6.40	0.98	46.28	29.29	16.08	5.70
Switzerland	36.51	21.13	9.26	8.11	44.96	14.53	18.31	14.96
Taiwan	34.77	35.69	15.78	5.50	48.44	31.49	13.50	4.07
United Kingdom	49.66	22.08	11.38	7.54	53.27	21.02	14.30	7.21
Venezuela	37.25	36.90	11.48	5.88	48.50	19.00	19.71	6.99

Traffic Carried by Second Tier U.S. Facilities-Based International Carriers, 1997

Carrier	Outbound Minutes (m)	Inbound Minutes (m)	Top Outbound Routes (Minutes)
Pacific Gateway Exchange (PGE)	742.9	95.5	Australia (133.1)
WorldxChange	430.1	—	Mexico (58.0)
Fonorola	405.4	169.9	Canada (405.4)
Facilicom	223.2	10.7	Germany (40.4)
STAR Telecommunications	116.2	19.2	China (59.7)
RSL Com USA	94.4	—	Dominican Rep. (85.2)
Viatel	58.5	—	Spain (11.4)
Primus	50.4	4.2	Australia (32.9)
Cable & Wireless, Inc.	44.0	—	U.K. (20.6)
Tricom USA	29.2	—	Dominican Rep. (29.1)
Total	**2,194.3**	**299.5**	

Note: All data in millions of minutes based on billing point of call. Carriers and traffic from outside the U.S. states and Puerto Rico (e.g., Virgin Islands, Guam) are excluded. Data includes traffic carried on International Simple Resale (ISR) facilities.

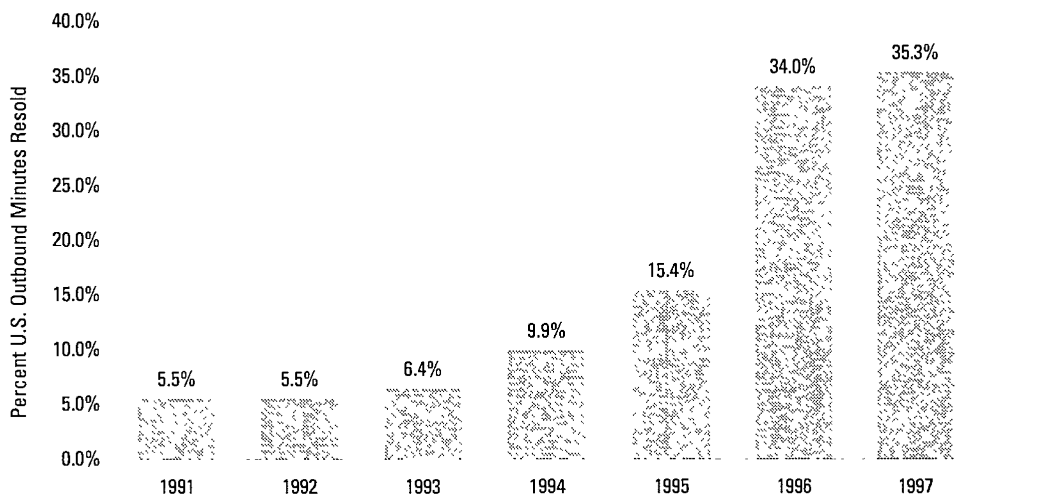
U.S.—Resale Traffic

Top 15 U.S. Switched Service Resale Carriers, 1997

Rank	Resale Carrier	Outbound Minutes (m)	Share of Outbound Resale Minutes
1.	Cable & Wireless	1,228.1	17.5%
2.	PT-1 Communications	714.0	10.2%
3.	STAR Telecommunications	636.8	9.1%
4.	WorldCom	600.1	8.6%
5.	RSL Com	321.1	4.6%
6.	Teleglobe USA	301.6	4.3%
7.	IDT	300.5	4.3%
8.	LCI International	297.1	4.2%
9.	Telegroup	276.9	4.0%
10.	Pacific Gateway Exchange (PGE)	209.0	3.0%
11.	Access Authority	189.3	2.7%
12.	Primus	158.2	2.3%
13.	ACC Long Distance	134.5	1.9%
14.	Sprint	124.2	1.8%
15.	Startec	120.9	1.7%
	Top 15 Total	**5,045.0**	**71.0%**

Note: All data in millions of minutes based on billing point of call. Carriers and traffic from outside the U.S. states and Puerto Rico (e.g., Virgin Islands, Guam) are excluded. Switched service resale carriers are resellers of the international switched voice services that are actually provided by other, facilities-based carriers. The 7.9 billion minutes of U.S. switched resale traffic are thus included in the U.S. outgoing traffic data on page 243.

Share of U.S. International Switched Traffic Resold, 1991-1997



Uruguay

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Argentina	35.9	52.6%
2. Brazil	9.0	13.2%
3. United States	7.0	10.3%
4. Spain	2.9	4.2%
5. Chile	1.6	2.4%
6. Paraguay	1.4	2.1%
7. Italy	1.2	1.8%
8. France	0.8	1.1%
9. Germany	0.7	1.0%
10. Mexico	0.6	0.9%
11. Canada	0.6	0.9%
12. United Kingdom	0.6	0.8%
13. Israel	0.5	0.7%
14. Venezuela	0.5	0.7%
15. Switzerland	0.4	0.5%
16. Australia	0.4	0.5%
17. Peru	0.4	0.5%
18. Colombia	0.3	0.5%
19. Bolivia	0.2	0.3%
20. Sweden	0.2	0.3%
Other	3.1	4.6%
Total	**68.4**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	73.9	80.1	93.7
Outgoing	49.9	54.5	68.4
Surplus (Deficit)	24.0	25.6	25.3
Total Volume	123.8	134.5	162.1

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Uzbekistan

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Russia	29.6	46.9%
2. Kazakhstan	7.9	12.5%
3. Kyrgyzstan	3.4	5.3%
4. Ukraine	3.1	4.9%
5. Tajikistan	2.1	3.3%
6. Turkmenistan	1.2	2.0%
7. Belarus	0.8	1.3%
8. Azerbaijan	0.6	0.9%
9. Armenia	0.5	0.8%
10. Georgia	0.3	0.4%
11. Moldova	0.2	0.2%
Other	13.6	21.5%
Total	**63.1**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	n.a.
Outgoing	n.a.	54.2	63.1
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: MiTT is Minutes of Telecommunications Traffic Data are in millions of minutes of public switched traffic. Data for 1996 include only traffic to other member states of the Commonwealth of Independent States The "Other" category may include routes to non-CIS member states, including an estimated 1.5 million minutes to the U.S. and 1.6 million minutes to the U.K., that rank among the top destinations for outgoing traffic

Venezuela

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. United States	74.8	47.0%
2. Colombia	16.0	10.0%
3. Canada	13.5	8.5%
4. Spain	8.0	5.0%
5. Italy	6.3	3.9%
6. United Kingdom	4.7	3.0%
7. Peru	3.4	2.1%
8. Mexico	2.7	1.7%
9. Brazil	2.6	1.7%
10. Argentina	2.5	1.6%
11. Ecuador	2.2	1.4%
12. Portugal	2.1	1.3%
13. France	1.9	1.2%
14. Dominican Republic	1.9	1.2%
15. Chile	1.9	1.2%
16. Germany	1.5	0.9%
17. Lebanon	1.4	0.9%
18. Cuba	1.3	0.9%
19. Trinidad & Tobago	1.3	0.8%
20. Panama	1.0	0.8%
Other	8.3	5.2%
Total	**159.2**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	186.6	228.8	286.9
Outgoing	129.1	139.0	159.2
Surplus (Deficit)	57.4	89.8	127.7
Total Volume	315.7	367.8	446.1

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data based on billing point of traffic.

Vietnam

Largest Telecommunications Routes, 1995

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. China	6.0	11.5%
2. Taiwan	3.0	5.7%
3. United States	3.0	5.7%
4. Philippines	2.0	3.8%
5. Hong Kong	2.0	3.8%
6. France	2.0	3.8%
7. Rep. of Korea	1.5	2.9%
8. Singapore	1.5	2.9%
9. Thailand	1.5	2.9%
10. Germany	1.0	1.9%
Other	11.5	21.9%
Total	**35.1**	

National Traffic Balance

MiTT	1995	1996	1997
Incoming	n.a.	n.a.	294.6
Outgoing	35.1	52.4	50.2
Surplus (Deficit)	n.a.	n.a.	244.4
Total Volume	n.a.	n.a.	344.8

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic

Yugoslavia

Largest Telecommunications Routes, 1997

Destination	Millions of MiTTs	Percentage of Outgoing Traffic
1. Germany	47.3	21.8%
2. Croatia	22.7	10.5%
3. Austria	20.5	9.4%
4. Switzerland	19.3	8.9%
5. Italy	11.4	5.3%
6. Slovenia	11.3	5.2%
7. Hungary	8.2	3.8%
8. Macedonia	8.1	3.7%
9. France	8.0	3.7%
10. Canada	8.0	3.7%
11. Greece	6.6	3.1%
12. United States	6.3	2.9%
13. United Kingdom	5.4	2.5%
14. Russia	5.3	2.5%
15. Sweden	4.6	2.1%
16. Australia	3.3	1.5%
17. Netherlands	3.1	1.4%
18. Turkey	2.9	1.4%
19. Romania	2.5	1.1%
20. Bulgaria	2.4	1.1%
Other	9.9	4.5%
Total	**217.0**	

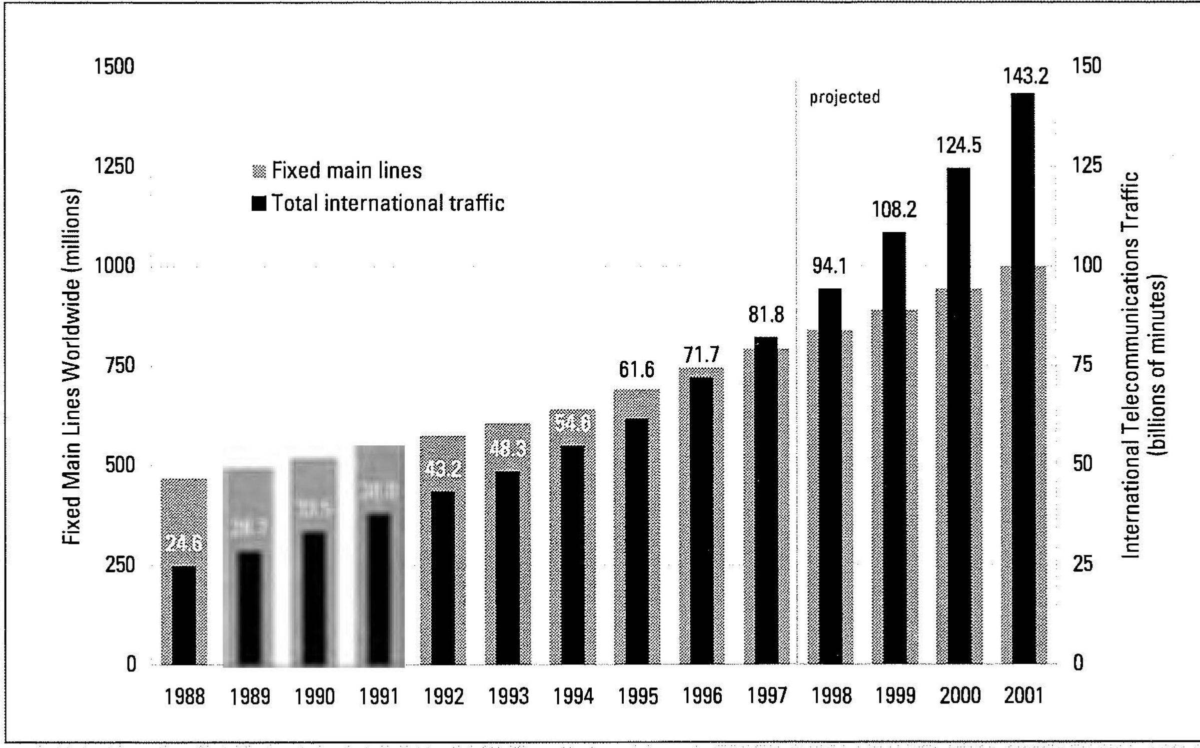
National Traffic Balance

MiTT	1995	1996	1997
Incoming	296.0	325.7	332.0
Outgoing	212.8	237.2	217.0
Surplus (Deficit)	83.2	88.5	115.0
Total Volume	508.8	562.9	549.0

Note: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic. Data exclude traffic to Bosnia.

Global Traffic Review

Figure 1. International Traffic and Main Line Growth



Note: Data include outbound international traffic on public networks only. Projections assume 15 percent traffic growth and 6 percent main line growth.
Source: ITU, TeleGeography, Inc.

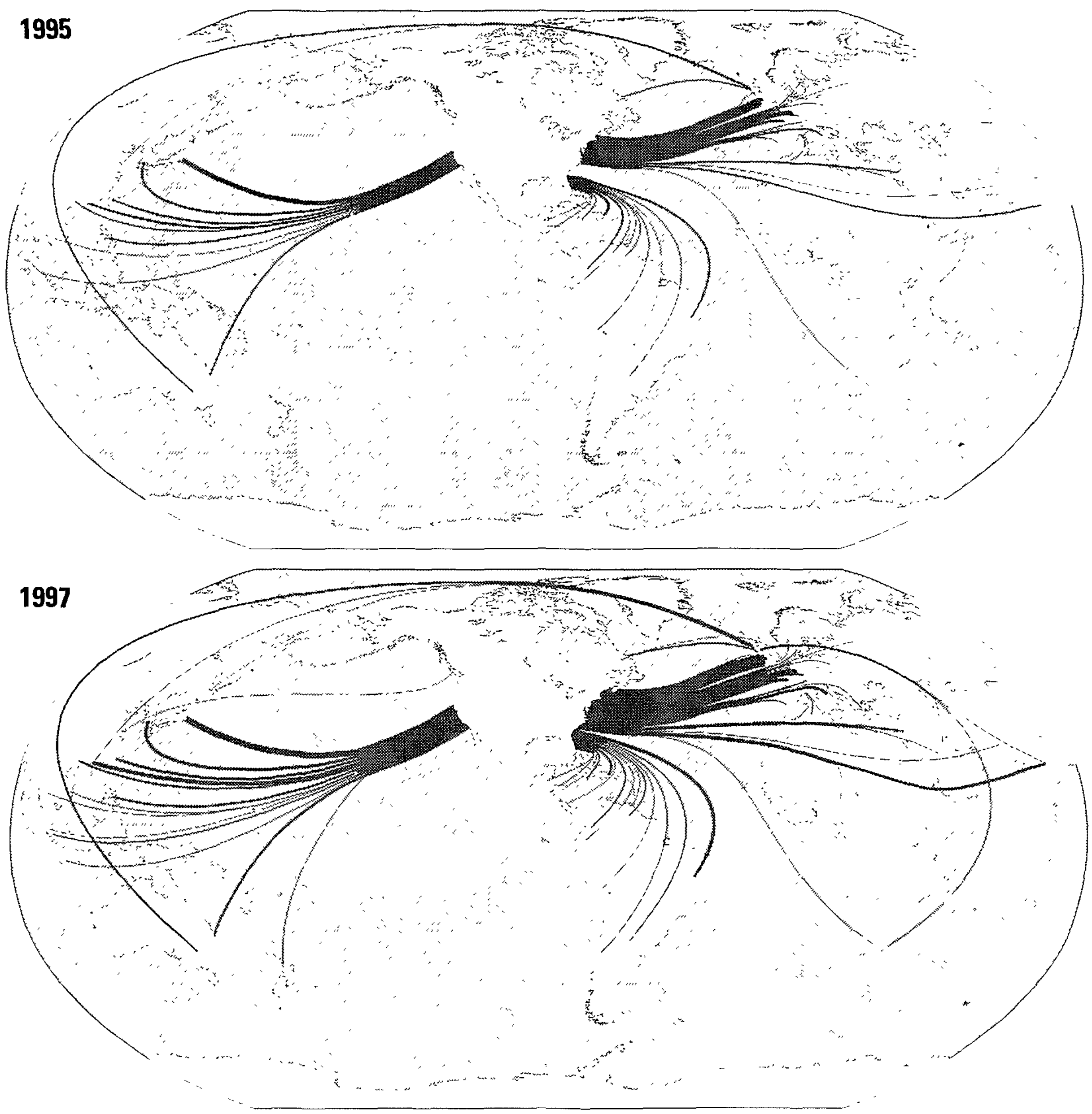
Figure 2. International Traffic, Revenue, and Subscriber Growth

	Historical Trend			*Slow Growth*		*Same Growth*		*Fast Growth*	
Indicator	**1988**	**1997**	**CAGR 1988-97**	**2001**	**CAGR 1997-2001**	**2001**	**CAGR 1997-2001**	**2001**	**CAGR 1997-2001**
Calls (Bn)	5.1	24.5	19.2%	46.8	17.2%	48.2	18.1%	53.5	21.2%
Estimated call length (mins)	4.4	3.3	-3.0%	3.0	-2.7%	3.0	-2.7%	3.0	-2.7%
Minutes (Bn)	22.3	81.8	15.5%	128.7	12%	143.1	15%	158.6	18%
Per main line subscriber	47.2	103.3	9.1%	132.0	6.3%	143.1	8.5%	154.7	10.6%
Per main line plus mobile	46.8	81.6	6.4%	91.6	2.9%	98.7	4.9%	106.1	6.8%
Revenue (US$bn)	26.8	65.9	10.6%	77.5	4.0%	79.0	4.5%	79.9	4.7%
Assumptions									
Price per MiTT (US$)	1.20	0.81	-4.3%	0.60	-7.1%	0.55	-9.1%	0.50	-11.3%
Main lines (M)	473	792	5.9%	975	5.3%	1'000	6.0%	1'025	6.7%
Mobile subscribers (M)	4.2	211	54.4%	430	19.5%	450	20.8%	470	22.2%

Note: 1988-97 based on reported data. 1998-2001 based on ITU forecasts. Scenarios are as follows:
1. Slow Growth: Traffic growth slows but network infrastructure continues on current growth trend.
2. Same Growth: Continuing traffic growth rate of last five years, assuming faster network growth rate and faster rates of price-cutting.
3. Fast Growth: Faster traffic growth rate than last five years, assuming a faster network growth rate and faster rates of price-cutting, plus a significant component of new demand created by international traffic generated from mobiles.

Source: ITU *World Telecommunication Indicators Database* and ITU estimates.

Figure 3. Intercontinental Traffic Flows, 1995 & 1997



Key *Traffic Flows*

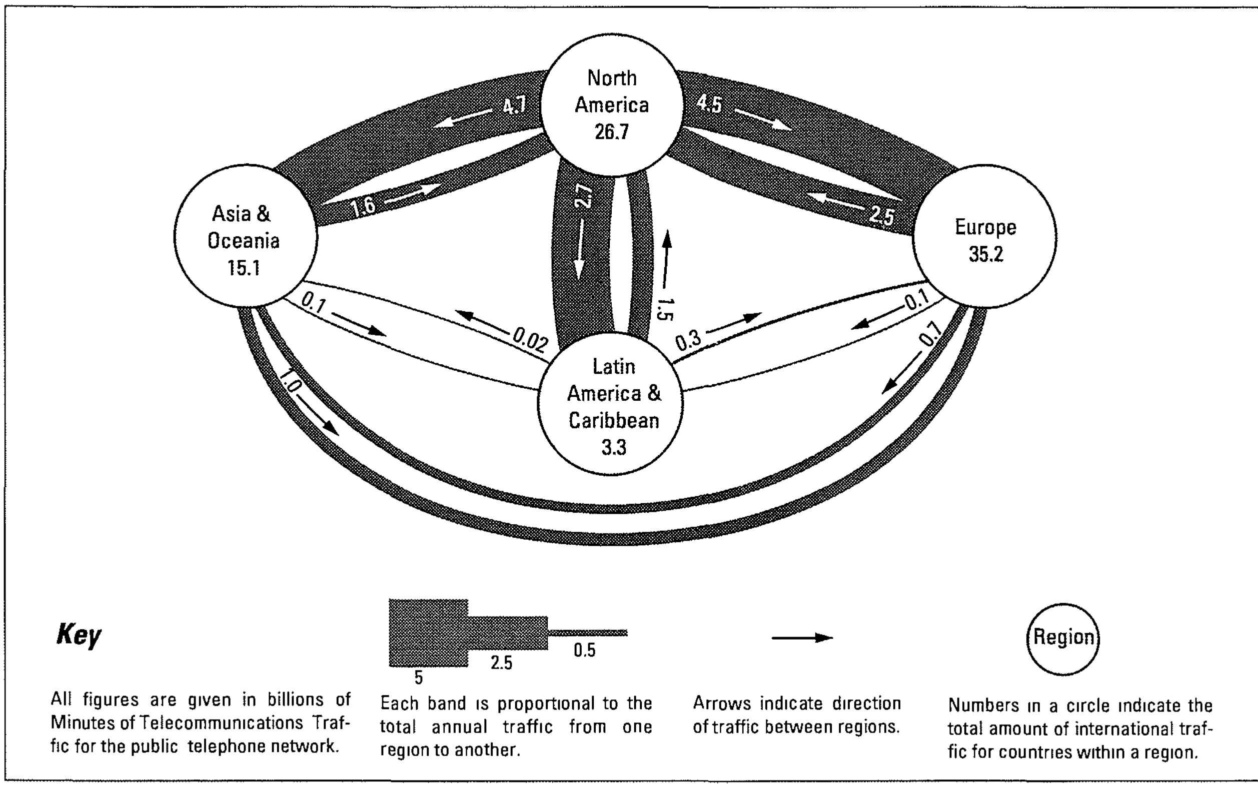
2,500 1,000 500 100 *(Millions of MiTTs)*

Each band is proportional to the total annual traffic on the public network in both directions between each pair of countries.

These maps shows all inter-continental routes with an annual volume of more than 100 million minutes. The total volume of these routes in 1997 was 20.8 billion minutes, approximately 25.8% of global international traffic.

International Traffic by Region

Figure 4. Interregional Traffic Flows, 1997



Note: *Data for interregional traffic based on top 20 international routes for 90 countries, accounting for approximately 25% of global international traffic.*

Figure 5. International Traffic by Origin, 1997

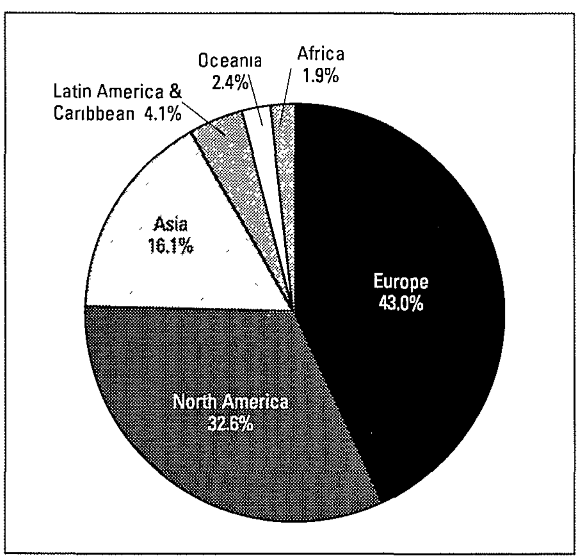


Figure 6. Traffic Growth by Region, 1996-1997

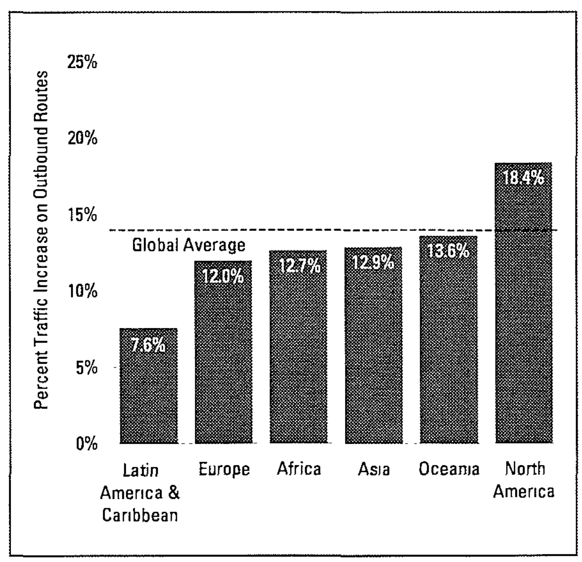
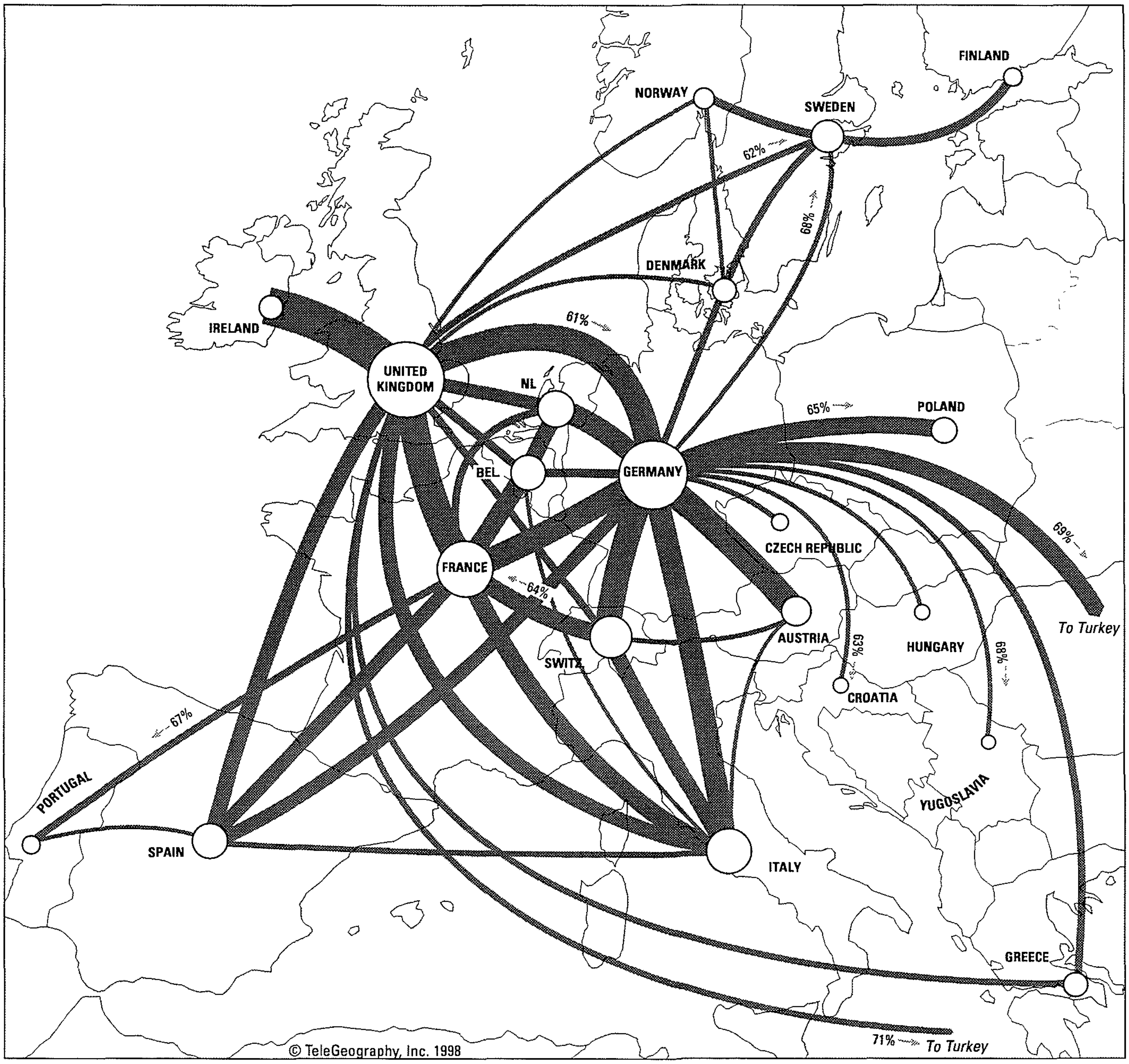


Figure 7. European Telecommunications Traffic Flows, 1997



Key

All figures are given in millions of Minutes of Telecommunications Traffic (mMiTTs), for the public telephone network.

The map shows all intra-European routes with a 1997 volume of more than 120 mMiTTs.

Traffic Flows

600 400 200

Each band is proportional to the total annual traffic on the public telephone network in both directions between each pair of countries.

Total Outgoing Traffic

250 1,000 5,000

The area of each circle is proportional to the volume of the total annual outgoing traffic from each country.

Balance of Traffic

On routes where traffic in one direction accounts for more than 60% of the total, an arrow shows the direction most of the traffic flows.

Figure 8. Latin American Telecommunications Traffic Flows, 1997

Key

All figures are given in millions of Minutes of Telecommunications Traffic (mMiTTs), for the public telephone network.

The map shows all routes within Latin America with a 1997 volume of more than 10 mMiTTs.

Traffic Flows

100 50 10

Each band is proportional to the total annual traffic on the public telephone network in both directions between each pair of countries.

Total Outgoing Traffic

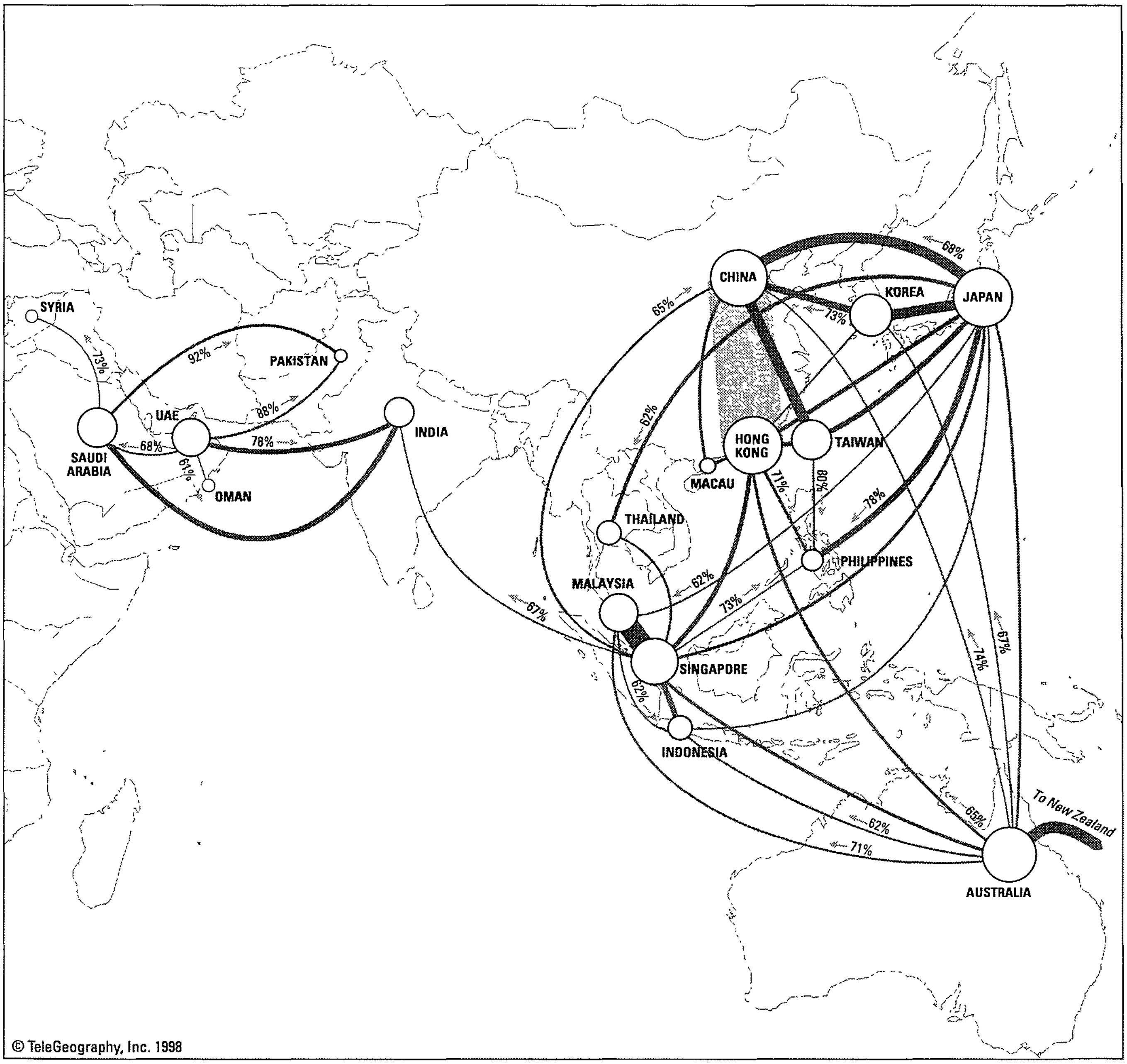
100
500
1,000

The area of each circle is proportional to the volume of the total annual outgoing traffic from each country.

Balance of Traffic

On routes where traffic in one direction accounts for more than 60% of the total, an arrow shows the direction most of the traffic flows.

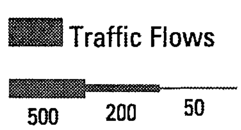
Figure 9. Asian Telecommunications Traffic Flows, 1997



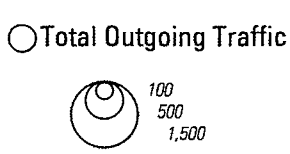
Key

All figures are given in millions of Minutes of Telecommunications Traffic (mMiTTs), for the public telephone network.

The map shows all intra-Asian routes with a 1997 volume of more than 50 mMiTTs.



Each band is proportional to the total annual traffic on the public telephone network in both directions between each pair of countries.



The area of each circle is proportional to the volume of the total annual outgoing traffic from each country.

On routes where traffic in one direction accounts for more than 60% of the total, an arrow shows the direction most of the traffic flows.

International Traffic by Country

Figure 10. International Telephone Traffic Growth for Selected Countries, 1996-1997

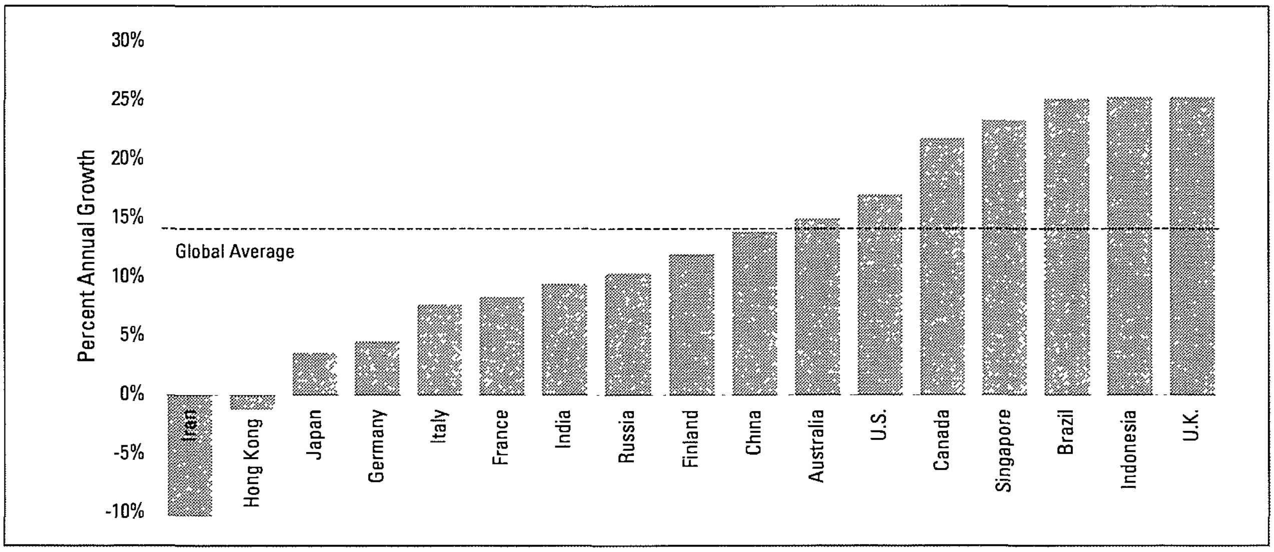


Figure 11. Telephone Traffic Balances for Selected Countries, 1997

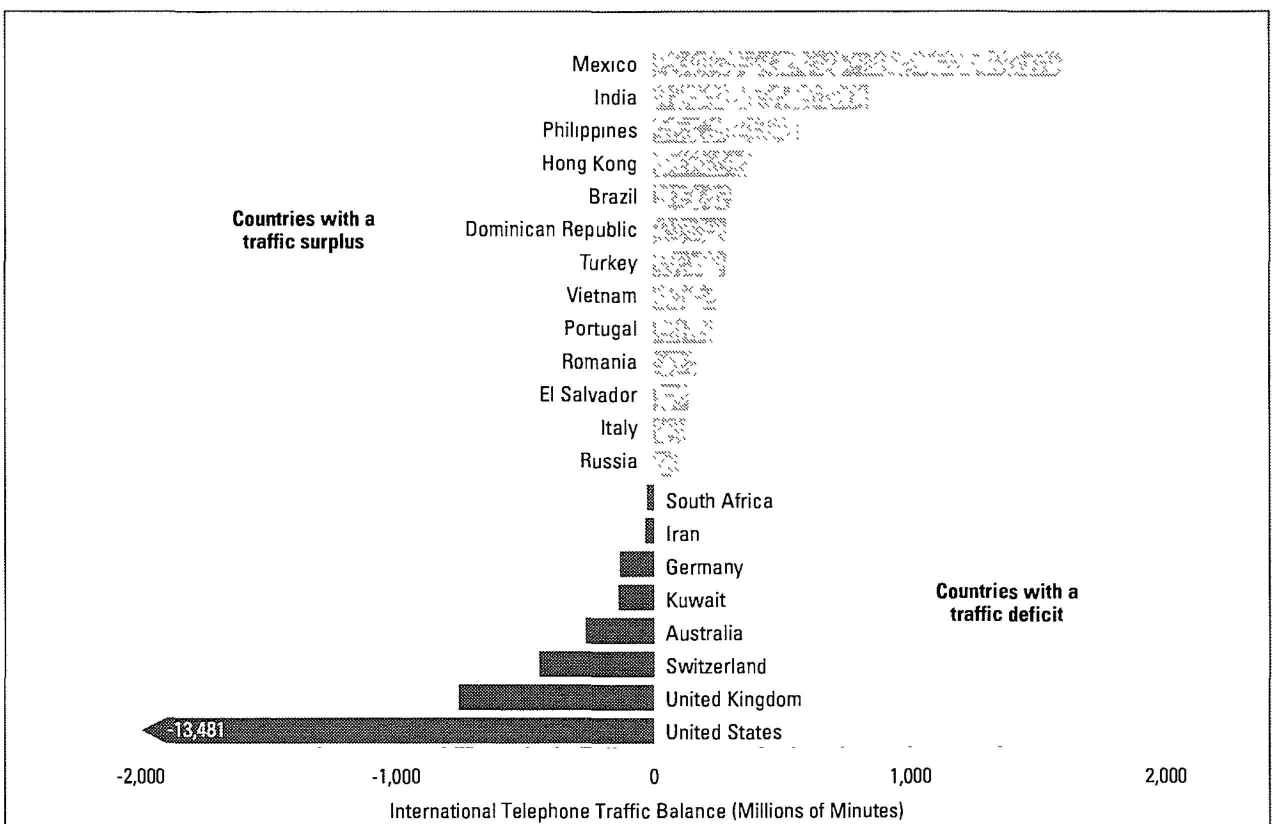


Figure 12. International Traffic Indicators, 1997

	International Traffic						
	Outgoing (mMiTT)	Incoming (mMiTT)	Surplus (Deficit) (mMiTT)	Population (m)	MiTT (Out) per Capita	Main Lines (thous.)	MiTT (Out) per Main Line
Albania (a,c)	40.8	n.a.	n.a.	3.3	12.4	87	469.0
Andorra	42.2	30.1	-12.1	0.1	659.4	32	1,318.8
Argentina	223.4	444.2	220.7	35.7	6.3	6,750	33.1
Armenia	48.8	n.a.	n.a.	3.4	14.2	n.a.	n.a.
Australia (b)	1,510.0	1,250.0	-260.0	18.4	81.9	9,350	161.5
Austria (a,c)	995.5	957.7	-37.8	8.1	122.4	3,969	250.8
Bahamas	62.7	n.a.	n.a.	0.3	227.2	96	653.1
Bahrain (a)	106.6	85.4	-21.2	0.6	176.7	152	701.3
Bangladesh	46.9	187.0	140.2	125.3	0.4	297	157.9
Belarus (a)	148.6	185.2	36.6	10.4	14.3	2,313	64.2
Belgium (a)	1,340.0	1,420.0	80.0	10.2	131.8	4,769	281.0
Bolivia	22.7	69.3	46.6	7.7	3.0	535	42.4
Botswana (d)	30.8	22.7	-8.1	1.5	20.5	84	366.7
Brazil (a)	459.1	761.3	302.2	164.5	2.8	15,106	30.4
Brunei	35.6	22.0	-13.6	0.3	115.7	79	450.6
Canada (a)	4,286.3	4,635.1	348.7	30.3	141.3	18,460	232.2
Chile	242.0	n.a.	n.a.	14.5	16.7	2,600	93.1
China	1,631.8	n.a.	n.a.	1,221.6	1.3	70,310	23.2
Colombia (a,d)	135.5	384.2	248.7	37.4	3.6	5,334	25.4
Costa Rica (a)	66.9	111.6	44.7	3.5	18.9	584	114.6
Cyprus (a,c)	154.4	115.2	-39.2	0.8	205.1	385	401.0
Czech Republic (a)	306.1	355.0	48.9	10.3	29.7	3,275	93.5
Denmark (a)	628.0	682.0	54.0	5.3	118.4	3,339	188.1
Dominican Republic	142.0	476.9	334.9	7.9	18.0	709	200.3
El Salvador (a)	34.3	168.2	133.9	5.7	6.1	325	105.5
Estonia (a)	66.3	67.0	0.7	1.4	46.2	469	141.4
Finland	371.7	n.a.	n.a.	5.1	72.4	2,866	129.7
France	3,545.0	3,609.0	64.0	58.6	60.5	33,700	105.2
French Polynesia	9.1	n.a.	n.a.	0.2	39.0	52	175.0
Germany (a,c)	5,333.1	5,206.0	-127.1	82.1	65.0	45,200	118.0
Greece	593.7	634.6	40.9	10.6	55.9	5,328	111.4
Guyana	24.1	142.4	118.2	0.7	34.1	50	482.0
Hong Kong (a,b)	1,718.0	2,100.3	382.3	6.5	262.4	3,647	471.1
Hungary (a)	287.1	324.6	37.5	10.2	28.1	n.a.	n.a.
Iceland (a,d)	32.5	32.0	-0.5	0.3	120.5	168	193.5
India (a,c)	420.5	1,256.6	836.1	966.8	0.4	17,802	23.6
Indonesia (a)	351.6	456.0	104.4	209.8	1.7	4,982	70.6
Iran	160.7	130.2	-30.5	67.5	2.4	6,513	24.7
Ireland (a,b)	695.0	n.a.	n.a.	3.6	192.7	1,500	463.3
Israel (a,d)	319.7	468.1	148.4	5.5	57.8	2,656	120.4
Italy (c)	2,351.9	2,475.1	123.2	56.8	41.4	25,698	91.5
Japan (b)	1,771.7	1,635.0	-136.7	125.7	14.1	60,381	29.3
Jordan (b)	91.9	145.0	53.1	4.3	21.3	403	228.0
Kazakhstan	114.7	n.a.	n.a.	16.9	6.8	1,917	59.8
Korea, Rep. of	885.0	n.a.	n.a.	45.9	19.3	20,422	43.3
Kuwait (a)	160.5	n.a.	n.a.	1.8	87.5	412	389.6

Notes: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.

a. International MiTT based on billing point of traffic.
b. International traffic for year ending 31 March. Australia and Pakistan ends 30 June.
c. Traffic data exclude some carriers or routes (See country table for details.)
d. Traffic data is for 1996.

Figure 12. International Traffic Indicators, 1997 (continued)

	International Traffic						
	Outgoing (mMiTT)	Incoming (mMiTT)	Surplus (Deficit) (mMiTT)	Population (m)	MiTT (Out) per Capita	Main Lines (thous.)	MiTT (Out) per Main Line
Luxembourg (d)	248.5	189.8	-58.8	0.4	591.1	245	1,014.3
Macau (a)	119.0	92.2	-26.7	0.5	236.9	170	700.0
Macedonia	51.7	85.2	33.5	2.0	25.9	n.a.	n.a.
Malaysia (a,b,c)	588.5	592.0	3.5	20.5	28.7	4,223	139.4
Malta	34.4	n.a.	n.a.	0.4	91.2	187	184.0
Mexico (a)	1,200.0	n.a.	n.a.	97.6	12.3	9,264	129.5
Moldova (a)	56.8	80.2	23.3	4.5	12.7	627	90.6
Namibia	52.3	47.0	-5.3	1.7	30.8	101	517.8
Netherlands (a,c)	1,535.0	1,712.2	177.2	15.6	98.1	8,860	173.3
New Zealand (b)	407.0	n.a.	n.a.	3.6	113.5	1,840	221.2
Nicaragua (a)	40.4	52.5	12.1	4.4	9.2	128	315.6
Norway	481.0	n.a.	n.a.	4.4	109.3	2,325	206.9
Oman (a)	74.3	70.4	-3.9	2.3	32.8	201	369.7
Pakistan (b,c)	84.1	557.8	473.7	132.2	0.6	2,557	32.9
Panama (a)	41.4	95.1	53.7	2.7	15.4	325	127.4
Papua New Guinea	23.4	20.6	-2.8	4.4	5.3	47	497.9
Paraguay (d)	24.9	49.4	24.5	5.7	4.4	176	141.5
Peru (a)	79.4	256.9	177.5	25.6	3.1	1,646	48.2
Philippines (a,b)	295.0	930.0	635.0	76.1	3.9	2,078	142.0
Poland (a,d)	437.2	725.5	288.3	38.6	11.3	7,510	58.2
Portugal (a)	393.3	628.8	235.5	9.9	39.6	3,819	103.0
Romania	110.8	278.6	167.8	22.5	4.9	n.a.	n.a.
Russia (c)	939.3	1,035.6	96.3	147.3	6.4	26,875	35.0
Saudi Arabia	660.0	n.a.	n.a.	20.1	32.9	2,285	288.8
Singapore (a,b)	1,161.0	n.a.	n.a.	3.4	337.4	1,685	689.0
Slovak Republic (a)	144.7	174.4	29.8	5.4	26.9	1,392	104.0
Slovenia	113.5	118.9	5.4	2.0	57.5	722	157.2
South Africa	368.8	343.2	-25.6	42.3	8.7	4,646	79.4
Spain (a,d)	1,189.0	n.a.	n.a.	39.1	30.4	15,854	75.0
Sri Lanka	33.2	124.3	91.1	18.7	1.8	315	105.4
Sweden (a)	1,140.0	n.a.	n.a.	8.9	128.6	6,010	189.7
Switzerland	2,164.0	1,723.0	-441.0	7.2	298.9	4,688	461.6
Syria (a)	89.3	173.3	84.0	16.1	5.5	1,312	68.1
Taiwan (b)	789.0	842.2	53.2	21.7	36.4	10,862	72.6
Thailand (a,c)	278.4	408.5	130.1	59.5	4.7	4,815	57.8
Turkey	557.5	836.0	278.5	63.5	8.8	15,744	35.4
Ukraine	486.8	n.a.	n.a.	50.4	9.6	9,410	51.7
United Arab Emirates (d)	589.3	n.a.	n.a.	2.3	260.5	835	705.7
United Kingdom (a,b)	6,600.0	n.a.	n.a.	57.6	115.6	14,300	465.7
United States (a)	22,700.1	9,219.3	-13,480.8	268.0	84.7	170,568	133.1
Uruguay (a)	68.4	93.7	25.3	3.3	20.9	761	89.9
Uzbekistan	63.1	n.a.	n.a.	23.5	2.7	1,531	41.2
Venezuela (a)	159.2	286.9	127.7	22.4	7.1	2,804	56.8
Vietnam (a)	50.2	294.6	244.4	75.1	0.7	1,587	31.6
Yugoslavia (c)	217.0	332.0	115.0	11.2	19.3	2,082	104.2

Notes: MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes of public switched traffic.
a. International MiTT based on billing point of traffic.
b International traffic for year ending 31 March. Australia and Pakistan ends 30 June.
c Traffic data exclude some carriers or routes. (See country table for details.)
d Traffic data is for 1996.

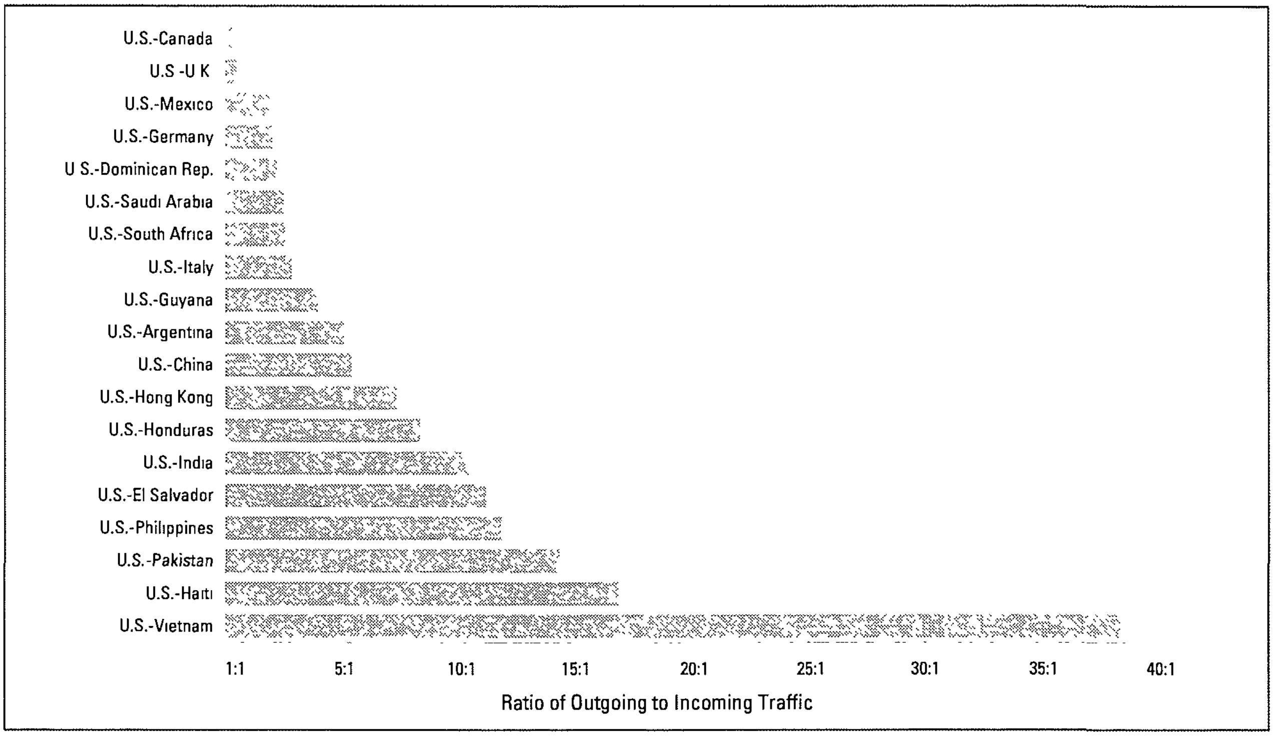
International Traffic by Route

Figure 13. The Top 50 International Routes, 1997

	Countries	MiTT each way	Total MiTT
1.	U.S. - Canada	3,926.6 - 3,173.3	7,099.9
2.	U.S. - Mexico	2,757.6 - 950.2	3,707.8
3.	U.S. - U.K.	1,532.6 - 946.5	2,479.0
4.	Hong Kong - China	1,065.2 - 855.0	1,920.2
5.	U.S. - Germany	994.3 - 324.6	1,318.9
6.	U.S. - Japan	830.5 - 339.4	1,169.9
7.	U.K. - Ireland	658.6 - 504.0	1,162.6
8.	U.K. - France	502.0 - 386.0	888.0
9.	U.K. - Germany	504.5 - 326.9	831.4
10.	Switzerland - Germany	477.0 - 339.9	816.9
11.	Austria - Germany	427.6 - 384.9	812.5
12.	U.S. - Hong Kong	673.2 - 82.4	755.6
13.	France - Germany	412.0 - 331.8	743.8
14.	Singapore - Malaysia	408.0 - 330.1	738.1
15.	U.S. - France	500.0 - 216.6	716.5
16.	Germany - Italy	368.5 - 340.3	708.8
17.	Netherlands - Germany	346.7 - 327.3	674.0
18.	U.S. - Brazil	497.3 - 159.6	656.9
19.	U.S. - India	579.4 - 49.7	629.1
20.	U.S. - Rep. of Korea	421.9 - 203.5	625.4
21.	France - Belgium	304.0 - 299.3	603.3
22.	U.S. - Italy	475.6 - 121.9	597.5
23.	Switzerland - France	344.0 - 246.0	590.0
24.	France - Italy	298.0 - 266.3	564.3
25.	U.S. - Taiwan	379.1 - 174.3	553.3
26.	Germany - Turkey	377.4 - 172.5	549.9
27.	Ukraine - Russia	296.7 - 249.0	545.7
28.	Germany - Poland	353.7 - 190.0	543.7
29.	Belgium - Netherlands	266.1 - 254.5	520.6
30.	U.S. - Australia	383.5 - 123.5	507.0
31.	Switzerland - Italy	292.0 - 198.1	490.1
32.	U.S. - Dominican Republic	392.1 - 95.6	487.7
33.	U.K. - Spain	270.6 - 208.0	478.6
34.	U.K. - Italy	270.1 - 196.8	466.9
35.	Australia - U.K.	230.0 - 223.6	453.6
36.	U.S. - China	388.1 - 61.7	449.8
37.	U.S. - Philippines	417.2 - 32.2	449.4
38.	France - Spain	233.0 - 209.2	442.2
39.	Spain - Germany	212.5 - 209.4	421.9
40.	U.K. - Netherlands	223.2 - 198.3	421.4
41.	U.S. - Israel	216.5 - 161.7	378.2
42.	New Zealand - Australia	185.0 - 175.0	360.0
43.	Taiwan - China	198.1 - 150.0	348.1
44.	Japan - China	229.5 - 105.0	334.5
45.	U.S. - Switzerland	225.8 - 108.1	333.8
46.	U.K. - Canada	170.4 - 160.0	330.4
47.	U.S. - Colombia	260.5 - 68.7	329.2
48.	U.S. - Netherlands	222.3 - 105.8	328.1
49.	U.S. - Jamaica	262.6 - 50.2	312.8
50.	Japan - Rep. of Korea	156.0 - 150.0	306.0

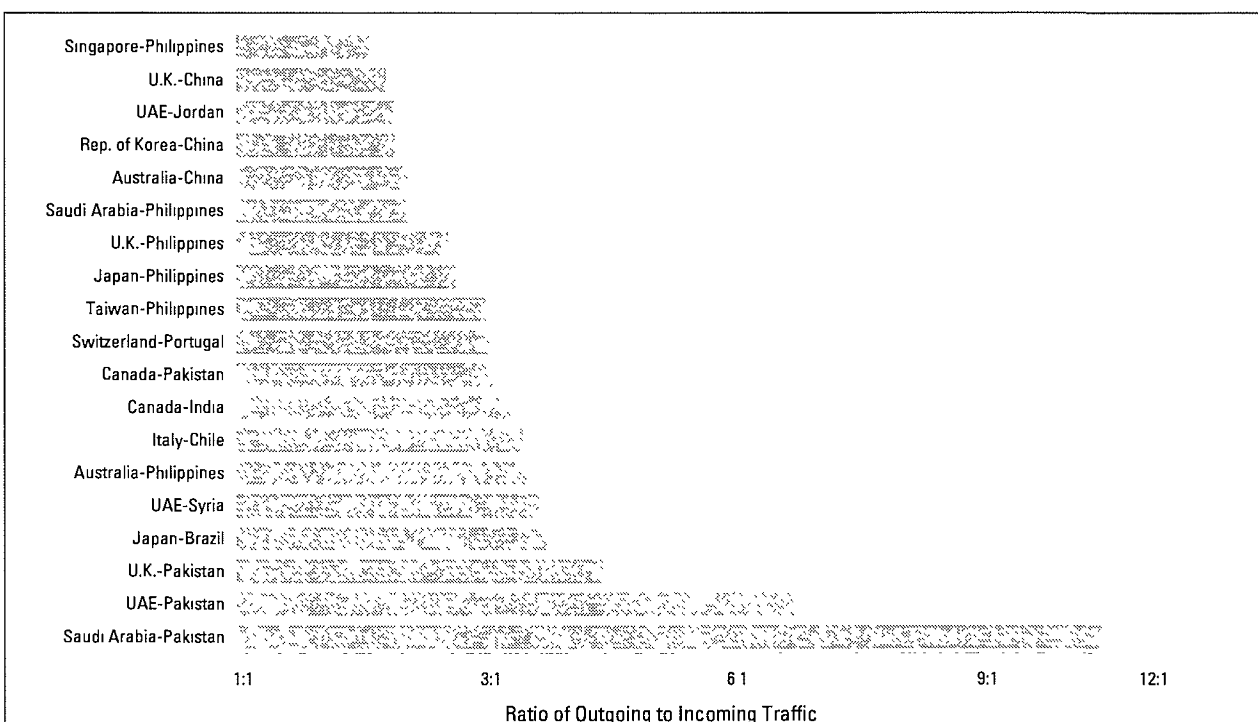
Note: All data in millions of minutes of telecommunications traffic (MiTT). The country which generates more traffic on each route is listed first. The routes listed above total 41.5 billion minutes, 51 percent of all international traffic. For routes to and from the United States, calls are measured by point of billing in both directions for calendar year 1997 On non-U.S. routes, data for Australia, Hong Kong, Ireland, Malaysia, New Zealand, Singapore, Taiwan, and the U.K. are for fiscal year 1997/98. International Simple Resale (ISR) traffic on non-U.S. routes is excluded.

Figure 14. Traffic Imbalances on U.S. Routes, 1997



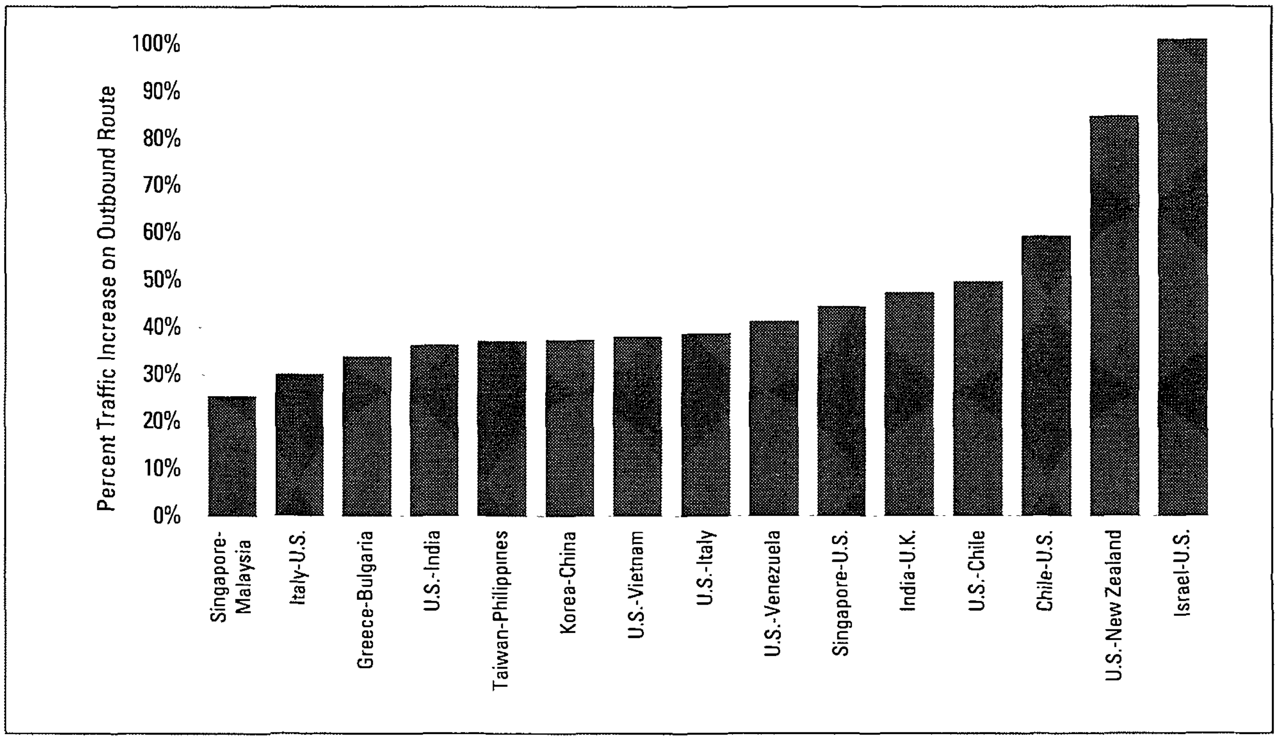
Note: Country with traffic deficit on route listed first. A ratio of 1:1 would indicate a perfect balance on a route. U.S. data based on billing point of call, and may not reflect actual call ratios due to call-back.

Figure 15. Traffic Imbalances on Non-U.S. Routes, 1997



Note: Country with traffic deficit on route listed first. A ratio of 1:1 would indicate a perfect balance on a route. Data for some countries based on billing point of call, and may not reflect actual call ratios due to call-back.

Figure 16. International Outbound Routes with Rapidly Growing Traffic, 1996-1997



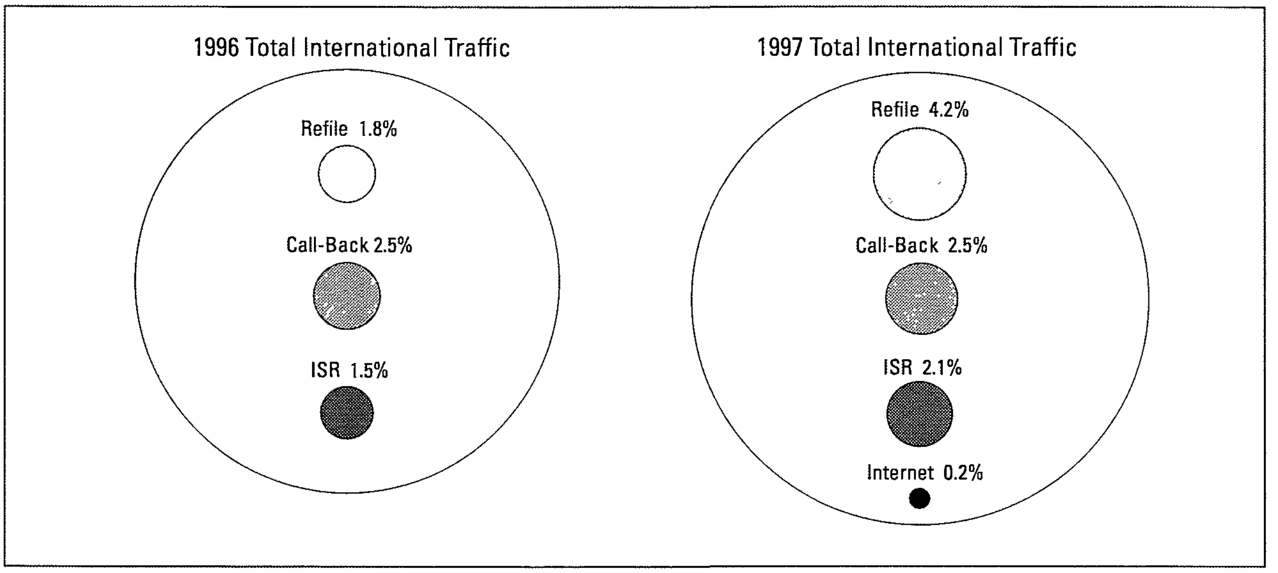
Note: Country originating traffic listed first; country terminating traffic listed second. Some data based on billing point of call, and may not reflect actual route growth rates due to call-back.

Figure 17. International Outbound Routes with Declining Traffic, 1996-1997

Note: Country originating traffic listed first; country terminating traffic listed second. Some data based on billing point of call, and may not reflect actual rates at which traffic flows are changing due to call-back.

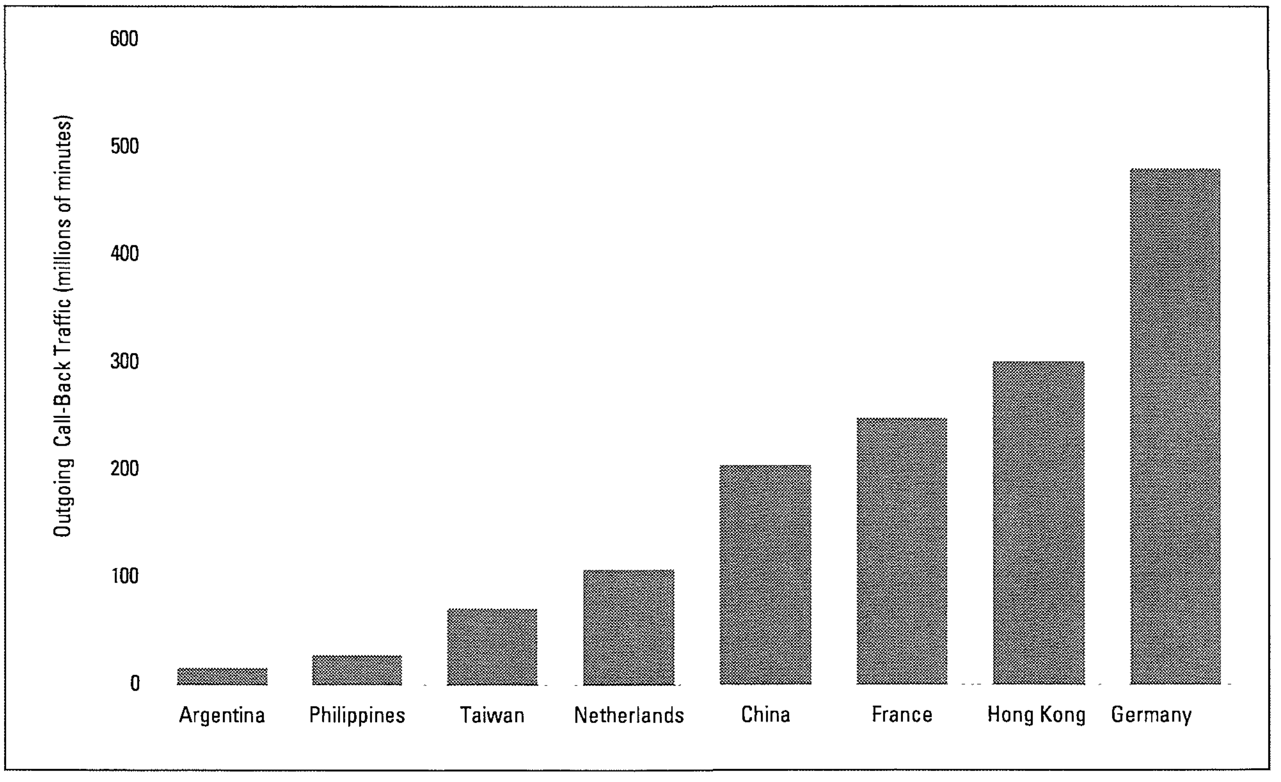
Alternative Traffic Arrangements

Figure 18. Alternative Traffic Arrangements as a Share of Global International Traffic, 1996-1997



Note: Area of circles proportional to total international traffic, which equaled 71.7 billion minutes in 1996 and 81.8 billion minutes in 1997.

Figure 19. Selected Origin Countries of Call-Back Traffic, 1997



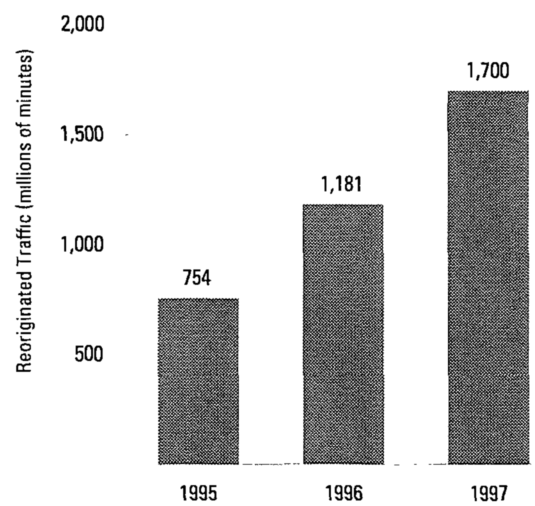
Source: M.J. Scheele & Associates (www.callbackinfo.com); Tel. +1 415 824 2400; Fax +1 415 824 2429

Figure 20. Reported U.S.-Hubbed Refile and Calling Card Traffic

Top Destinations for Calls Reoriginated via the U.S., 1996

Destination		Millions of MiTTS
1.	United Kingdom	159.1
2.	Germany	86.2
3.	Japan	60.8
4.	Italy	60.3
5.	Mexico	52.6
6.	France	50.0
7.	Canada	35.9
8.	Rep. of Korea	35.5
9.	Belgium	26.2
10.	Spain	25.5
11.	China	24.2
12.	Brazil	22.9
13.	Philippines	21.2
14.	Australia	20.9
15.	Hong Kong	20.8
16.	Israel	20.0
17.	Netherlands	17.9
18.	Guatemala	17.2
19.	Jamaica	16.2
20.	Switzerland	15.6

Total Traffic Reoriginated via the U.S., 1995-1997

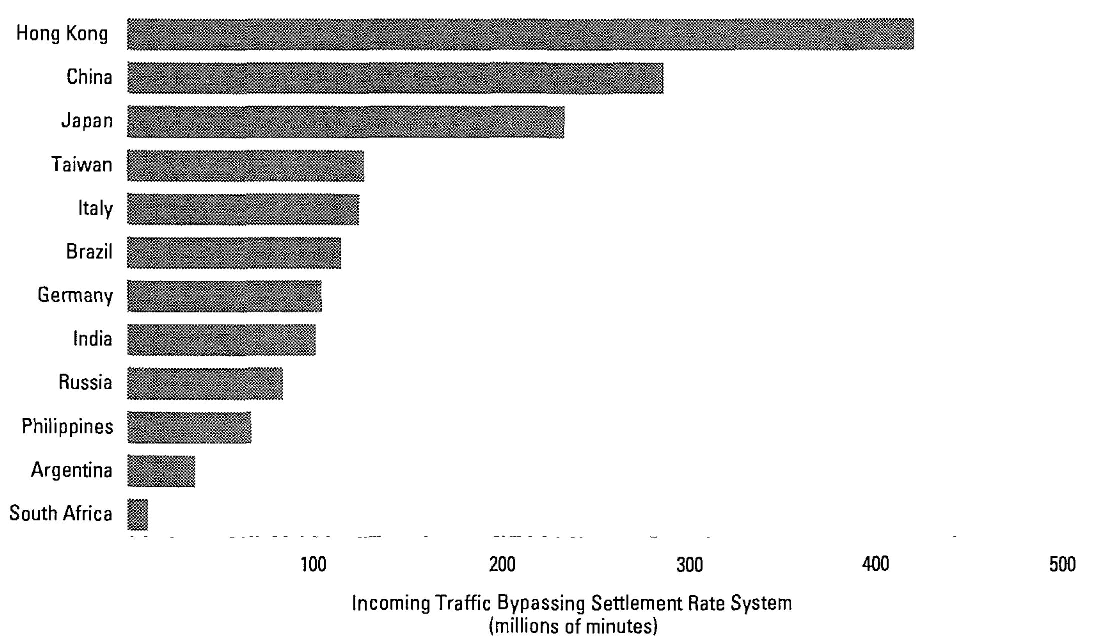


Note: U.S. call reorigination includes calls that are placed in non-U.S. countries, re-routed via the U.S., and terminated in a third country. The route totals include refile and calling card calls, but exclude call-back traffic. Data are based on U.S. carrier filings with the FCC, and may understate actual volume of reoriginated calls.

Source: FCC

Figure 21. Illicit Bypass Traffic, 1997

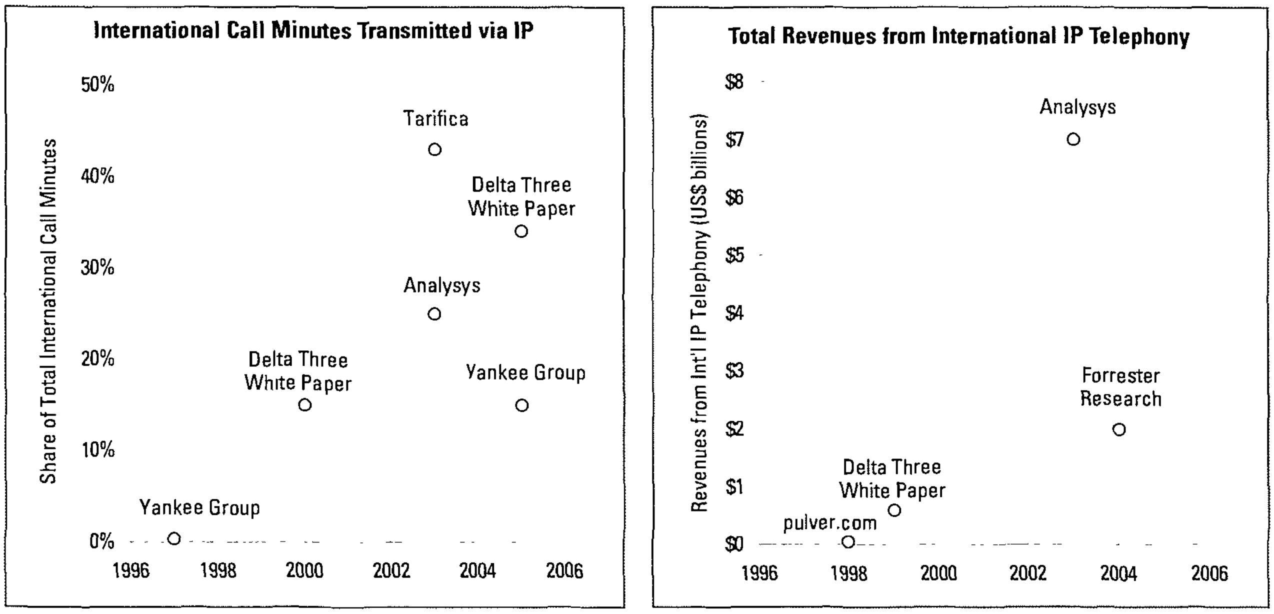
Estimated Traffic Bypassing Settlement Rate System to Selected Destinations, 1997



Note: Illicit bypass includes international calls that, through the use of extra-legal means by originating carriers, are not covered by traditional settlement payments to foreign PTTs. For example, an international carrier may send calls over an international private line directly to a foreign cellular service provider, which then switches the traffic onto the local wireline network.

Source: M.J. Scheele & Associates (www.mjscheele.com); Tel. +1 415 824 2400; Fax +1 415 824 2429

Figure 22. International IP Telephony Forecasts



Note: These estimates of Internet Protocol (IP) telephony call traffic and revenue include all voice traffic transmitted via IP, including calls carried on the public Internet, carrier-owned private lines, and the Public Switched Telephone Network (PSTN).

Sources: Analysys Ltd. (www.analysys.com), Delta Three Inc. (www.deltathree.com); Forrester Research Inc. (www.forrester.com); pulver.com (www.pulver.com); Tarifica, Ltd. (www.tarifica.com); The Yankee Group (www.yankeegroup.com)

Methodology

The traffic statistics in *TeleGeography 1999* were compiled primarily from an independent survey of telecommunications service providers by TeleGeography, Inc. (TGI). For some countries and carriers, traffic data have been estimated based upon annual reports, government publications and industry interviews. See the footnotes to each table for further information. The *Direction of Traffic* database, jointly compiled by TGI and the International Telecommunication Union (ITU), was also consulted.

To enable comparisons of countries' international traffic statistics, TGI has endeavored to apply a consistent methodology. When reviewing the traffic statistics in *TeleGeography 1999*, however, readers should keep in mind the following issues which may cause traffic data to appear inconsistent:

Public Switched Network vs. Private Line Traffic

Traffic volumes in *TeleGeography 1999* are generally reported in minutes or MiTT (Minutes of Telecommunications Traffic). In most cases MiTT refer to paid minutes of traffic on public switched voice circuits and thus include voice as well as non-voice (facsimile or data) traffic.

Unless otherwise stated, traffic carried by International Simple Resale (ISR) carriers is excluded. ISR carriers resell the capacity of international private lines (IPLs) for switched services by interconnecting their IPLs to the public switched network at one or both ends.

Traffic carried by "pure" resellers of international switched voice services is included in this report. These resellers do not own or lease their own international transmission facilities. Instead, they resell the traffic of other carriers; thus, pure resale traffic is counted as part of the MiTT for the facilities-based carrier whose services are resold.

Cross-Border Traffic

Neighboring countries may not classify local cross border traffic in the same way. That is, one country may treat some cross-border traffic as local, while its neighbor counts all such traffic as international.

Billing Point vs. Originating Point of Traffic

Unless otherwise stated in the notes to a table, the outbound MiTT reported for countries in *TeleGeography 1999* refers to outbound traffic originated in the reporting country even if it is billed in another country.

In the past, most international calls were billed at the point of origination. The number of billed minutes thus coincided with the volume of outgoing traffic. Billed minutes also included collect or reverse charge calls because the calls were set up by an operator in the originating country. However, the recent use of calling card and call-back services has shifted the billing point for many international calls. For example, calls from Italy to the United States (or a third country, such as Argentina) may now be set up and billed in the U.S.

Some countries, including the U.S., report international traffic data based solely on the location where the traffic is billed. Consequently, "outbound" traffic data for these countries can include traffic actually originating in another. Thus, incoming MiTT reported for one country may not match the outgoing MiTT on the same route by the correspondent country. Some double counting may also occur. For example, a call from Thailand to the U.S. which is billed to a U.S. calling card is reported by the U.S. carrier as outbound U.S. MiTT; the same call also is reported as outbound MiTT by Thailand.

Accordingly, in countries where calling card and call-back services are widely used, a year-to-year comparison of national MiTT also requires examining the statistics of countries, such as the U.S. and the U.K., where the calls are hubbed.

Transit Traffic

Unlike calling card and call-back traffic, *TeleGeography 1999* excludes from country totals transit traffic—that is, traffic which merely passes through a given country, but is not refiled via the switched network in the reporting country.

Rounding

Rounding may cause the figures on total national incoming and outgoing traffic to appear inconsistent with other national data.

Revised Data

Some differences exist between the historical statistics (1996 or earlier) reported in *TeleGeography 1999* and data stated in prior TGI reports or *Direction of Traffic*. The variations reflect corrections and/or revised data subsequently provided to TGI.

Global Reference: Blue Pages

National Telecommunications Indicators (A-K)

Countries	GDP 1997 (US$billions)	Population 1997 (millions)	Main Lines 1997 (thous.)	Lines Per 100 (thous.)	Cellular Users 1997 (thous.)	PCs (thous.)	Internet Users 1997 (thous.)
Albania (a,c)	n.a.	3.3	87	2.6	n.a.	n.a.	n.a.
Andorra	n.a.	0.1	32	50.0	10	n.a.	1.0*
Argentina (d)	323.2	35.7	6,750	18.9	2,013	1,400	170.0
Armenia (d)	1.6	3.4	n.a.	n.a.	n.a.	n.a.	n.a.
Australia (b)	346.3	18.4	9,350	50.7	4,893	6,700	1,600.0
Austria (a,c)	206.2	8.1	3,969	48.8	1,160	1,700	650.0
Bahamas	2.5	0.3	96	34.9	6,152	n.a.	5.0
Bahrain (a)	5.4*	0.6	152	25.2	59	40	2.0*
Bangladesh	30.9	125.3	297*	0.2*	n.a.	n.a.	n.a.
Belarus (a,d)	13.5	10.4	2,313	22.2	8	n.a.	0.7*
Belgium (a)	242.4	10.2	4,769	46.9	974	2,400	300.0*
Bolivia	7.8	7.7	535	7.0	116	n.a.	3.0*
Botswana	4.9	1.5	84	n.a.	n.a.	n.a.	n.a.
Brazil (a)	688.1*	164.5	15,106*	10.0*	4,400	4,200	1,310.0
Brunei	n.a.	0.3	79*	25.7*	n.a.	n.a.	3.4*
Canada (a)	617.6	30.3	18,460	60.8	3,420*	8,200	4,500.0
Chile	77.1	14.5	2,600	17.9	410	790	2,000.0*
China	917.7	1,221.6	70,310	5.8	13,233	7,500	400.0
Colombia (a)	76.1*	37.4	5,334	14.3	1,265	1,214	130.0*
Costa Rica (a)	9.5	3.5	584	16.5	64	n.a.	30.0*
Cyprus (a,c)	8.9	0.8	385	51.1	92	n.a.	5.0*
Czech Republic (a)	52.0	10.3	3,275	31.8	526	850	200.0*
Denmark (a,d)	169.7	5.3	3,339	62.9	1,450	1,900	300.0*
Dominican Republic	14.9	7.9	709	9.0	130	n.a.	6.2
El Salvador (a)	11.3	5.7	325	5.7	40	n.a.	2.6
Estonia (a)	4.7	1.4	469	32.6	144	n.a.	n.a.
Finland	119.8	5.1	2,866	55.8	2,147	1,600	1,000.0*
France	1,392.9	58.6	33,700	57.5	5,817	10,200	500.0*
French Polynesia	3.1*	0.2	52	22.4	5	n.a.	0.1
Germany (a,c)	2,102.7	82.1	45,200	55.1	8,170	21,000	2,500.0*
Greece	120.9	10.6	5,328*	51.0*	938	470	150.0*
Guyana	0.7	0.7	50*	6.0*	1*	n.a.	0.5
Hong Kong (a,b)	172.3	6.5	3,647	55.7	2,230	1,500	675.0
Hungary (a)	43.7	10.2	2,660	26.6	265*	500	107.7*
Iceland (a)	7.4	0.3	168	62.1	66	n.a.	40.0*
India (a,c)	324.1	966.8	17,802	1.8	882	2,000	300.0
Indonesia (a)	214.6	209.8	4,982	2.4	916	1,600	250.0
Iran	132.9	67.5	6,513	9.6	239	2,000*	30.0
Ireland (a,b,d)	73.2	3.6	1,500	41.6	533	520	80.0
Israel (a)	97.9	5.5	2,656	48.0	1,672	1,100	300.0
Italy (c)	1,145.4	56.8	25,698	45.2	11,738	6,500	585.0
Japan (b)	4,192.7	125.7	60,381	48.0	38,254	25,500	8,500.0
Jordan (b)	3.6	4.3	403	9.3	n.a.	40*	2.0
Kazakhstan (d)	2.1	16.9	1,917*	11.4*	10*	n.a.	6.0
Korea, Rep. of	442.5	45.9	20,422	44.4	6,910	6,931	800.0
Kuwait (a)	26.7*	1.8	412	22.4	210	125*	15.0*

Source: International Telecommunication Union, International Monetary Fund, Central Intelligence Agency, and TeleGeography, Inc.

International Telephone Traffic (A-K)

Outgoing MiTT (millions)			Incoming MiTT (millions)			Traffic Balance		
1996	1997	% Change	1996	1997	% Change	1996	1997	Countries
20.6	40.8	98.2%	46.0	n.a.	n.a.	25.4	n.a.	Albania (a,c)
37.8	42.2	11.6%	27.3	30.1	10.3%	-10.5	-12.1	Andorra
181.3	223.4	n.a.	390.7	444.2	n.a.	209.4	220.7	Argentina (d)
48.1	48.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Armenia (d)
1,305.0	1,510.0	15.7%	n.a.	1,250.0	n.a.	n.a.	-260.0	Australia (b)
960.0	995.5	3.8%	n.a.	957.7	n.a.	n.a.	-37.8	Austria (a,c)
56.7	62.7	10.5%	n.a.	n.a.	n.a.	n.a.	n.a.	Bahamas
92.2	106.6	15.6%	69.4	85.4	23.1%	-22.8	-21.2	Bahrain (a)
38.3	46.9	22.5%	129.2	187.0	44.7%	90.9	140.2	Bangladesh
104.9	148.6	n.a.	n.a.	185.2	n.a.	n.a.	36.6	Belarus (a,d)
1,228.4	1,340.0	9.1%	1,289.1	1,420.0	10.2%	60.7	80.0	Belgium (a)
21.4	22.7	6.1%	53.9	69.3	28.6%	32.5	46.6	Bolivia
30.8	n.a.	n.a.	22.7	n.a.	n.a.	-8.1	n.a.	Botswana
366.9	459.1	25.1%	624.4	761.3	21.9%	257.5	302.2	Brazil (a)
35.2	35.6	1.1%	n.a.	22.0	n.a.	n.a.	-13.6	Brunei
3,519.8	4,286.3	21.8%	4,313.3	4,635.1	7.5%	793.5	348.7	Canada (a)
173.8	242.0	39.2%	n.a.	n.a.	n.a.	n.a.	n.a.	Chile
1,433.2	1,631.8	13.9%	n.a.	n.a.	n.a.	n.a.	n.a.	China
135.5	n.a.	n.a.	384.2	n.a.	n.a.	248.7	n.a.	Colombia (a)
55.0	66.9	21.6%	87.8	111.6	27.1%	32.8	44.7	Costa Rica (a)
128.6	154.4	20.1%	92.0	115.2	25.2%	-36.6	-39.2	Cyprus (a,c)
281.2	306.1	8.9%	324.4	355.0	9.4%	43.2	48.9	Czech Republic (a)
573.2	628.0	n.a.	600.0	682.0	n.a.	26.8	54.0	Denmark (a,d)
126.6	142.0	12.2%	450.9	476.9	5.8%	324.3	334.9	Dominican Republic
28.6	34.3	20.0%	160.5	168.2	4.8%	131.9	133.9	El Salvador (a)
58.5	66.3	13.4%	60.1	67.0	11.5%	1.6	0.7	Estonia (a)
332.0	371.7	12.0%	n.a.	n.a.	n.a.	n.a.	n.a.	Finland
3,273.0	3,545.0	8.3%	3,283.0	3,609.0	9.9%	10.0	64.0	France
7.9	9.1	15.2%	n.a.	n.a.	n.a.	n.a.	n.a.	French Polynesia
5,100.0	5,333.1	4.6%	n.a.	5,206.0	n.a.	n.a.	-127.1	Germany (a,c)
515.6	593.7	15.2%	557.3	634.6	13.9%	41.7	40.9	Greece
29.8	24.1	-19.1%	162.8	142.4	-12.6%	133.0	118.2	Guyana
1,738.6	1,718.0	-1.2%	1,940.8	2,100.3	8.2%	202.2	382.3	Hong Kong (a,b)
265.0	287.1	8.4%	n.a.	324.6	n.a.	n.a.	37.5	Hungary (a)
32.5	n.a.	n.a.	32.0	n.a.	n.a.	-0.5	n.a.	Iceland (a)
384.2	420.5	9.5%	1,000.0	1,256.6	25.7%	615.8	836.1	India (a,c)
280.2	351.6	25.5%	356.4	456.0	27.9%	76.2	104.4	Indonesia (a)
183.2	160.7	-12.3%	n.a.	130.2	n.a.	n.a.	-30.5	Iran
580.0	695.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Ireland (a,b,d)
319.7	n.a.	n.a.	468.1	n.a.	n.a.	148.4	n.a.	Israel (a)
2,124.0	2,351.9	10.7%	2,253.5	2,475.1	9.8%	129.5	123.2	Italy (c)
1,710.6	1,771.7	3.6%	1,519.1	1,635.0	7.6%	-191.5	-136.7	Japan (b)
74.6	91.9	23.2%	133.1	145.0	8.9%	58.5	53.1	Jordan (b)
102.5	114.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Kazakhstan (d)
699.3	885.0	26.6%	740.6	n.a.	n.a.	41.3	n.a.	Korea, Rep. of
140.7	160.5	14.1%	131.2	n.a.	n.a.	-9.4	n.a.	Kuwait (a)

Notes:
a. International MiTT based on billing point of traffic.
b. International traffic for year ending 31 March (30 June for Australia, Pakistan)
c. Traffic data exclude some carriers or routes.
d. 1996 and 1997 traffic data are not directly comparable. See country pages for details.
* Data for 1996.

National Telecommunications Indicators (L-Z)

Countries	GDP 1997 (US$billions)	Population 1997 (millions)	Main Lines 1997 (thous.)	Lines Per 100 (thous.)	Cellular Users 1997 (thous.)	PCs (thous.)	Internet Users 1997 (thous.)
Luxembourg	12.9*	0.4	245	58.4	67	n.a.	23.0*
Macau (a)	n.a.	0.5	170	33.8	51	n.a.	3.0*
Macedonia	n.a.	2.0	n.a.	n.a.	n.a.	n.a.	n.a.
Malaysia (a,b,c)	98.5	20.5	4,223	20.6	2,461	1,000	600.0
Malta	0.5	0.4	187	49.6	18	n.a.	n.a.
Mexico (a)	402.8	97.6	9,264	9.5	1,745	3,600	520.0
Moldova (a,d)	1.9	4.5	627	14.1	2	11*	0.2
Namibia	3.2	1.7	101	5.9	13	n.a.	1.0
Netherlands (a,c,d)	360.5	15.6	8,860	56.6	1,717	4,400	900.0*
New Zealand (b)	57.1	3.6	1,840	51.3	565	1,000	550.0
Nicaragua (a)	2.0	4.4	128	2.9	8	n.a.	n.a.
Norway	153.4	4.4	2,325	52.8	1,677	950*	500.0*
Oman (a)	16.2	2.3	201	8.9	60	25*	n.a.
Pakistan (b,c)	60.9	132.2	2,557	1.9	110	n.a.	4.0
Panama (a)	8.1	2.7	320*	12.0*	0	n.a.	6.0
Papua New Guinea	n.a.	4.4	47*	1.1*	3*	n.a.	0.1
Paraguay	7.7	5.7	181*	4.0*	33*	n.a.	1.0*
Peru (a)	65.2	25.6	1,646	6.4	436	n.a.	60.0*
Philippines (a,b)	82.2	76.1	2,078	2.7	1,302	970	100.0
Poland (a)	135.6	38.6	7,510	19.4	857	1,400	800.0
Portugal (a)	102.3*	9.9	3,819	38.5	1,507	740	500.0
Romania	12.8	22.5	n.a.	n.a.	n.a.	n.a.	n.a.
Russia (c)	449.8	147.3	26,875	18.2	485	4,700	600.0*
Saudi Arabia	125.5*	20.1	2,285	11.4	332	700*	20.0
Singapore (a,b)	83.7*	3.4	1,685	49.0	849	1,270	500.0
Slovak Republic (a)	19.5	5.4	1,392	25.8	200	1,000*	100.0*
Slovenia	18.6*	2.0	722	36.6	93	n.a.	100.0*
South Africa	129.1	42.3	4,646	11.0	1,600	1,800	800.0
Spain (a)	531.3	39.1	15,854	40.5	4,338	4,800	525.0
Sri Lanka	15.1	18.7	315	1.7	112	60*	2.5
Sweden (a)	227.8	8.9	6,010	67.8	3,169	3,100	800.0*
Switzerland	255.0	7.2	4,688	64.7	1,044	2,800	370.0*
Syria (a)	59.9*	16.1	1,312	8.1	0	20*	n.a.
Taiwan (b)	n.a.	21.7	10,862	50.1	1,492	2,570	1,500.0
Thailand (a,c)	152.6	59.5	4,815	8.1	2,003	1,200	150.0
Turkey	191.9	63.5	15,744	24.8	1,610	1,300	120.0*
Ukraine (d)	49.7	50.4	9,410	18.7	57	n.a.	50.0*
United Arab Emirates	39.1*	2.3	835	36.9	309	160	9.7*
United Kingdom (a,b,d)	1,288.2	57.6	30,292*	51.8	8,993	11,200*	2,500.0*
United States (a)	8,079.9	268.0	170,568*	64.0*	55,312	109,000	40,000.0
Uruguay (a)	20.0	3.3	761	23.3	150	n.a.	75.0*
Uzbekistan (d)	21.6	23.5	1,814*	7.8*	4	n.a.	1.0
Venezuela (a)	87.5	22.4	2,804	12.5	1,072	850	35.0
Vietnam (a)	20.4*	75.1	1,587	2.1	134	250*	0.1
Yugoslavia (c)	n.a.	11.2	2,082	20.0	87	n.a.	20.0*

Source: International Telecommunication Union, International Monetary Fund, Central Intelligence Agency, and TeleGeography, Inc.

International Telephone Traffic (L-Z)

Outgoing MiTT (millions)			Incoming MiTT (millions)			Traffic Balance		
1996	1997	% Change	1996	1997	% Change	1996	1997	Countries
248.5	n.a.	n.a.	189.8	n.a.	n.a.	-58.8	n.a.	Luxembourg
112.5	119.0	5.8%	92.1	92.2	0.2%	-20.4	-26.7	Macau (a)
51.0	51.7	1.4%	81.9	85.2	4.1%	30.9	33.5	Macedonia
570.5	588.5	3.1%	581.9	592.0	1.7%	11.4	3.5	Malaysia (a,b,c)
31.7	34.4	8.6%	34.0	n.a.	n.a.	2.3	n.a.	Malta
1,070.7	1,200.0	12.1%	2,489.7	n.a.	5.0%	1,419.0	n.a.	Mexico (a)
50.2	56.8	n.a.	n.a.	80.2	n.a.	n.a.	23.3	Moldova (a,d)
51.4	52.3	1.8%	n.a.	47.0	n.a.	n.a.	-5.3	Namibia
1,534.1	1,535.0	n.a.	1,584.6	1,712.2	n.a.	50.5	177.2	Netherlands (a,c,d)
353.0	407.0	15.3%	380.0	n.a.	n.a.	27.0	n.a.	New Zealand (b)
n.a.	40.4	n.a.	n.a.	52.5	n.a.	n.a.	12.1	Nicaragua (a)
443.5	481.0	8.5%	422.3	n.a.	n.a.	-21.2	n.a.	Norway
62.6	74.3	18.7%	58.0	70.4	21.4%	-4.6	-3.9	Oman (a)
77.0	84.1	9.2%	488.4	557.8	14.2%	411.4	473.7	Pakistan (b,c)
41.2	41.4	0.5%	97.7	95.1	-2.6%	56.5	53.7	Panama (a)
26.9	23.4	-13.0%	n.a.	20.6	n.a.	n.a.	-2.8	Papua New Guinea
24.9	n.a.	n.a.	49.4	n.a.	n.a.	24.5	n.a.	Paraguay
66.7	79.4	19.1%	226.5	256.9	13.4%	159.7	177.5	Peru (a)
240.0	295.0	22.9%	767.0	930.0	21.3%	527.0	635.0	Philippines (a,b)
437.2	n.a.	n.a.	725.5	n.a.	n.a.	288.3	n.a.	Poland (a)
340.0	393.3	15.7%	571.4	628.8	10.1%	231.4	235.5	Portugal (a)
91.5	110.8	21.1%	237.5	278.6	17.3%	146.0	167.8	Romania
851.3	939.3	10.3%	1,037.6	1,035.6	-0.2%	186.3	96.3	Russia (c)
584.4	660.0	12.9%	n.a.	n.a.	n.a.	n.a.	n.a.	Saudi Arabia
942.0	1,161.0	23.3%	n.a.	n.a.	n.a.	n.a.	n.a.	Singapore (a,b)
134.1	144.7	7.9%	159.0	174.4	9.7%	24.9	29.8	Slovak Republic (a)
105.3	113.5	7.8%	113.9	118.9	4.4%	8.6	5.4	Slovenia
353.0	368.8	4.5%	n.a.	343.2	n.a.	n.a.	-25.6	South Africa
1,189.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Spain (a)
29.3	33.2	13.2%	96.0	124.3	29.5%	66.7	91.1	Sri Lanka
1,026.0	1,140.0	11.1%	n.a.	n.a.	n.a.	n.a.	n.a.	Sweden (a)
1,935.5	2,164.0	11.8%	1,562.8	1,723.0	10.3%	-372.7	-441.0	Switzerland
78.9	89.3	13.2%	156.0	173.3	11.1%	77.1	84.0	Syria (a)
674.0	789.0	17.1%	736.8	842.2	14.3%	62.8	53.2	Taiwan (b)
247.4	278.4	12.5%	376.2	408.5	8.6%	128.7	130.1	Thailand (a,c)
473.4	557.5	17.8%	755.0	836.0	10.7%	281.6	278.5	Turkey
340.8	486.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Ukraine (d)
589.3	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	United Arab Emirates
4,569.2	6,600.0	n.a	4,360.0	n.a.	n.a.	-209.2	n.a.	United Kingdom (a,b,d)
19,119.1	22,700.1	18.7%	8,194.9	9,219.3	12.5%	-10,924.1	-13,480.8	United States (a)
54.5	68.4	25.5%	80.1	93.7	17.0%	25.6	25.3	Uruguay (a)
54.2	63.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Uzbekistan (d)
139.0	159.2	14.5%	228.8	286.9	25.3%	89.8	127.7	Venezuela (a)
52.4	50.2	-4.2%	n.a.	294.6	n.a.	n.a.	244.4	Vietnam (a)
237.2	217.0	-8.5%	325.7	332.0	1.9%	88.5	115.0	Yugoslavia (c)

Notes:
a. International MiTT based on billing point of traffic.
b. International traffic for year ending 31 March (30 June for Australia, Pakistan)
c. Traffic data exclude some carriers or routes.
d. 1996 and 1997 traffic data are not directly comparable. See country pages for details.
* Data for 1996.

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1	Canada
	Guam
	Northern Marianas
	United States
	Caribbean
20	Egypt
212	Morocco
213	Algeria
216	Tunisia
218	Libya
220	Gambia
221	Senegal
222	Mauritania
223	Mali
224	Guinea
225	Ivory Coast
226	Burkina Faso
227	Niger
228	Togo
229	Benin
230	Mauritius
231	Liberia
232	Sierra Leone
233	Ghana
234	Nigeria
235	Chad
236	Central African Republic
237	Cameroon
238	Cape Verde Islands
239	Sao Tome and Principe
240	Equatorial Guinea
241	Gabon
242	Congo (Brazzaville)
243	Congo (Kinshasa)
244	Angola
245	Guinea-Bissau
246	Diego Garcia
247	Ascension Island
248	Seychelles
249	Sudan
250	Rwanda
251	Ethiopia
252	Somalia
253	Djibouti
254	Kenya
255	Tanzania
256	Uganda
257	Burundi
258	Mozambique
260	Zambia
261	Madagascar
262	Reunion Island
263	Zimbabwe
264	Namibia
265	Malawi
266	Lesotho
267	Botswana
268	Swaziland
269	Comoros & Mayotte
27	South Africa
290	St. Helena
291	Eritrea
297	Aruba
298	Faroe Islands
299	Greenland
30	Greece
31	Netherlands
32	Belgium
33	France
34	Spain
350	Gibraltar
351	Portugal; Azores
352	Luxembourg
353	Ireland
354	Iceland
355	Albania
356	Malta
357	Cyprus
358	Finland
359	Bulgaria
36	Hungary
370	Lithuania
371	Latvia
372	Estonia
373	Moldova
374	Armenia
375	Belarus
376	Andorra
377	Monaco
378	San Marino
379	Vatican City
380	Ukraine
381	Yugoslavia
385	Croatia
386	Slovenia
387	Bosnia-Hercegovina
389	Macedonia
39	Italy
40	Romania
41	Switzerland
41-75	Liechtenstein
420	Czech Republic
421	Slovak Republic
43	Austria
44	United Kingdom
45	Denmark
46	Sweden
47	Norway
48	Poland
49	Germany
500	Falkland Islands
501	Belize
502	Guatemala
503	El Salvador
504	Honduras
505	Nicaragua
506	Costa Rica
507	Panama
508	St. Pierre & Miquelon
509	Haiti
51	Peru
52	Mexico
53	Cuba
54	Argentina
55	Brazil
56	Chile
57	Colombia
58	Venezuela
590	Guadeloupe
591	Bolivia
592	Guyana
593	Ecuador
594	French Guiana
595	Paraguay
596	Martinique
597	Suriname
598	Uruguay
599	Netherlands Antilles
60	Malaysia
61	Australia
62	Indonesia
63	Philippines
64	New Zealand
65	Singapore
66	Thailand
672	Australian Territories
673	Brunei
674	Nauru
675	Papua New Guinea
676	Tonga Islands
677	Solomon Islands
678	Vanuatu
679	Fiji
680	Palau
681	Wallis & Futuna
682	Cook Islands
683	Niue
684	American Samoa
685	Western Samoa
686	Kiribati
687	New Caledonia
688	Tuvalu
689	French Polynesia
690	Tokelau
691	Micronesia
692	Marshall Islands
7	Kazakhstan
	Russia
	Tajikistan
	Uzbekistan
800	International Freephone
81	Japan
82	South Korea
84	Vietnam
850	North Korea
852	Hong Kong
853	Macau
855	Cambodia
856	Laos
86	China
870	Inmarsat Special
871	Inmarsat East Atlantic
872	Inmarsat Pacific
873	Inmarsat Indian
874	Inmarsat West Atlantic
880	Bangladesh
881x	Global Mobile Satellite Systems
886	Taiwan
90	Turkey
91	India
92	Pakistan
93	Afghanistan
94	Sri Lanka
95	Myanmar
960	Maldives
961	Lebanon
962	Jordan
963	Syria
964	Iraq
965	Kuwait
966	Saudi Arabia
967	Yemen
968	Oman
971	United Arab Emirates
972	Israel
973	Bahrain
974	Qatar
975	Bhutan
976	Mongolia
977	Nepal
98	Iran
992	Tajikstan
993	Turkmenistan
994	Azerbaijan
995	Georgia
996	Kyrgyzstan

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- **Afghanistan** 93
- **Albania** 355
  - Tirana 42
- **Algeria** 213
  - Algiers 2
- **American Samoa** 684
- **Andorra** 376
- **Angola** 244
  - Luanda 2
- **Anguilla** 1-264
- **Antigua & Barbuda** 1-268
- **Argentina** 54
  - Buenos Aires 1
- **Armenia** 374
  - Yerevan 2
- **Aruba** 297
- **Ascension Island** 247
- **Australia** 61
  - Melbourne 3
  - Sydney 2
- **Australian Territories** 672
- **Austria** 43
  - Vienna 1
- **Azerbaijan** 994
  - Baku 12
- **Bahamas** 1-242
- **Bahrain** 973
- **Bangladesh** 880
  - Dhaka 2
- **Barbados** 1-246
- **Belarus** 375
  - Minsk 172
- **Belgium** 32
  - Brussels 2
- **Belize** 501
  - Belmopan 8
- **Benin** 229
- **Bermuda** 1-441
- **Bhutan** 975
- **Bolivia** 591
  - La Paz 2
- **Bosnia** 387
  - Sarajevo 71
- **Botswana** 267
- **Brazil** 55
  - Brasilia 61
  - Rio de Janeiro 21
  - São Paulo 11
- **British Virgin Islands** 1-284
- **Brunei** 673
  - Bandar Seri Begawan 2
- **Bulgaria** 359
  - Sofia 2
- **Burkina Faso** 226
- **Burma** 95
- **Burundi** 257
- **Cambodia** 855
- **Cameroon** 237
- **Canada** 1
  - Montreal 514/450
  - Ottawa 613
  - Toronto 416
  - Vancouver 604
- **Cape Verde** 238
- **Cayman Islands** 1-345
- **Central African Republic** 236
  - Bangui 61
- **Chad** 235
- **Chile** 56
  - Santiago 2
- **China, People's Republic of** 86
  - Beijing 1
  - Guangzhou 20
  - Shanghai 21
- **Colombia** 57
  - Bogota 1
- **Cocos Islands; Norfolk & Christmas Islands** 672
- **Comoros** 269
- **Congo** 242
  - Brazzaville 81/82/83
- **Congo** 243
  - Kinshasa 12
- **Costa Rica** 506
- **Croatia** 385
  - Zagreb 1
- **Cuba** 53
  - Havana 7
- **Cyprus** 357
  - Nicosia 2
- **Czech Republic** 420
  - Prague 2
- **Denmark** 45
- **Diego Garcia** 246
- **Djibouti** 253
- **Dominica** 1-767
- **Dominican Republic** 1-809
- **Ecuador** 593
  - Quito 2
- **Egypt** 20
  - Cairo 2
- **El Salvador** 503
- **Equatorial Guinea** 240
- **Eritrea** 291
- **Estonia** 372
  - Tallinn 2
- **Ethiopia** 251
  - Addis Ababa 1
- **Falkland Islands** 500
- **Faroe Islands** 298
- **Fiji** 679
- **Finland** 358
  - Helsinki 9
- **France** 33
  - Paris 1
  - Marseille 4
- **French Antilles** 596
- **French Guiana** 594
- **French Polynesia** 689
- **Gabon** 241
- **Gambia** 220
- **Georgia** 995
  - Tbilisi 8832
- **Germany** 49
  - Berlin 30
  - Bonn 228
  - Frankfurt 69
  - Munich 89
- **Ghana** 233
  - Accra 21
- **Gibraltar** 350
- **Global Mobile Satellite Systems**
  - Globalstar 8818/8819
  - ICO Global Comm. 8810/8811
  - Iridium 8816/8817
- **Greece** 30
  - Athens 1
- **Greenland** 299
- **Grenada** 1-473
- **Guadeloupe** 590
- **Guam** 1-671
- **Guatemala** 502
- **Guinea** 224
- **Guinea-Bissau** 245
- **Guyana** 592
  - Georgetown 2
- **Haiti** 509
- **Honduras** 504
- **Hong Kong** 852
- **Hungary** 36
  - Budapest 1
- **Iceland** 354
- **India** 91
  - Bombay 22
  - Calcutta 33
  - New Delhi 11
- **Indonesia** 62
  - Jakarta 21
- **Inmarsat**
  - Special 870
  - East Atlantic 871
  - Pacific 872
  - Indian 873
  - West Atlantic 874
- **International Freephone** 800
- **Iran** 98
  - Tehran 21
- **Iraq** 964
  - Baghdad 1
- **Ireland** 353
  - Dublin 1
- **Israel** 972
  - Jerusalem 2
  - Tel Aviv 3
- **Italy** 39
  - Rome 06
  - Milan 02
- **Ivory Coast** 225
- **Jamaica** 1-876
- **Japan** 81
  - Osaka 6
  - Tokyo 3
- **Jordan** 962
  - Amman 6
- **Kazakhstan** 7
  - Almaty 3272
- **Kenya** 254
  - Nairobi 2
- **Kiribati** 686
- **Kuwait** 965
- **Kyrgyzstan** 996
  - Bishkek 3312
- **Laos** 856
- **Latvia** 371
  - Riga 2
- **Lebanon** 961
  - Beirut 1
- **Lesotho** 266
- **Liberia** 231
- **Libya** 218
  - Tripoli 21
- **Liechtenstein** 41-75
- **Lithuania** 370
  - Vilnius 2

Luxembourg .352
Macau .853
Macedonia .389
- Skopje .91

Madagascar .261
Malawi .265
Malaysia .60
- Kuala Lumpur .3

Maldives .960
Mali .223
Malta .356
Marshall Islands .692
Martinique .596
Mauritania .222
Mauritius .230
Mayotte .269
Mexico .52
- Guadalajara .36
- Mexico City .5
- Monterrey .83

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Moldova .373
- Chisinau .41

Monaco .377
Mongolia .976
- Ulaanbaatar .1

Montserrat .1-664
Morocco .212
- Casablanca .2
- Rabat .7

Mozambique .258
- Maputo .1

Namibia .264
- Windhoek .61

Nauru .674
Nepal .977
- Kathmandu .1

Netherlands .31
- Amsterdam .20

Netherlands Antilles .599
New Caledonia .687
New Zealand .64
- Auckland .9
- Wellington .4

Nicaragua .505
- Managua .2

Niger .227
Nigeria .234
- Lagos .1

Niue .683
North Korea .850
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- Saipan .322

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- Oslo .2

Oman .968
Pakistan .92
- Islamabad .51

Palau .680
Panama .507
Papua New Guinea .675
Paraguay .595
- Asuncion .21

Peru .51
- Lima .14

Philippines .63
- Manila .2

Poland .48
- Warsaw .22

Portugal .351
- Lisbon .1

Puerto Rico .1-787
Qatar .974
Reunion Island .262
Romania .40
- Bucharest .1

Russia .7
- Moscow .095
- St. Petersburg .812

Rwanda .250
St. Kitts & Nevis .1-869
St. Lucia .1-758
St. Pierre & Miquelon .508
St. Vincent & the Grenadines .1-809
San Marino .378
São Tome and Principe .239
Saudi Arabia .966
- Riyadh .1

Senegal .221
Seychelles .248
Sierra Leone .232
- Freetown .22

Singapore .65
Slovak Republic .421
- Bratislava .7

Slovenia .386
- Ljubljana .61

Solomon Islands .677
Somalia .252
- Mogadishu .1

South Africa .27
- Johannesburg .11
- Pretoria .12

South Korea .82
- Seoul .2

Spain .34
- Madrid .91
- Barcelona .93

Sri Lanka .94
- Colombo .1

Sudan .249
- Khartoum .11

Suriname .597
Swaziland .268
Sweden .46
- Stockholm .8

Switzerland .41
- Berne .31
- Zurich .1

Syria .963
- Damascus .11

Tahiti .689
Taiwan .886
- Taipei .2

Tajikistan .7
- Dushanbe .3772

Tanzania .255
- Dar Es Salaam .51

Thailand .66
- Bangkok .2

Togo .228
Tokelau .690
Tonga .676
Trinidad & Tobago .1-868
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- Tunis .1

Turkey .90
- Ankara .312
- Istanbul .212

Turkmenistan .993
- Ashkhabad .12

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- Kampala .41

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- Kiev .44

United Arab Emirates .971
- Abu Dhabi .2
- Dubai .4

United Kingdom .44
- Cardiff .1222
- Glasgow .141
- London .171/181
- Manchester .161

United States .1
- Chicago .312/773
- Houston .713/281
- Los Angeles .213/323
- Miami .305/786
- New York .212/917
- Washington .202

U.S. Virgin Islands .1-340
Uruguay .598
- Montevideo .2

Uzbekistan .7
- Tashkent .3712

Vanuatu .678
Vatican City .379
Venezuela .58
- Caracas .2

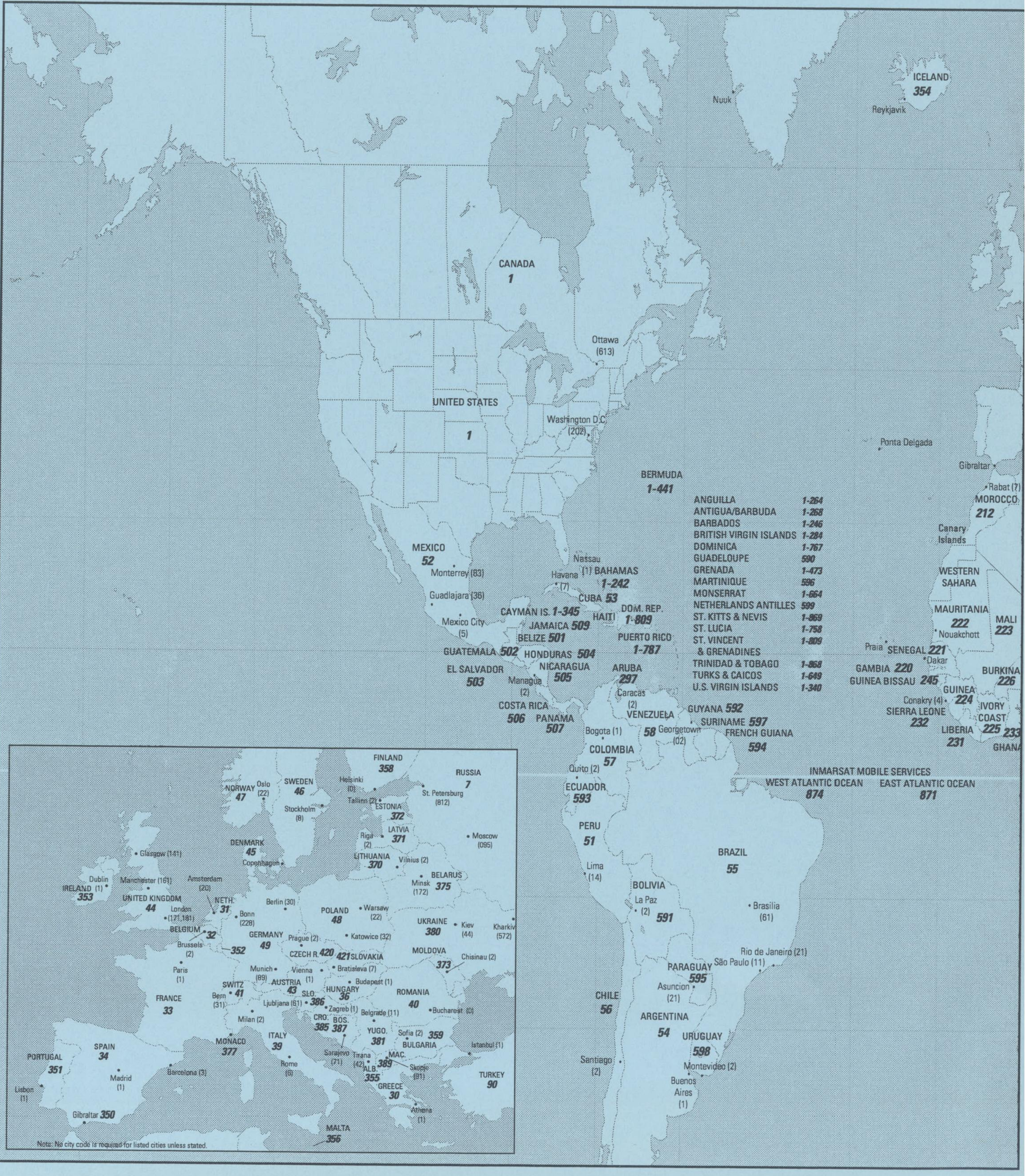
Vietnam .84
Wallis & Futuna .681
Western Samoa .685
Yemen .967
- Sanaa .2

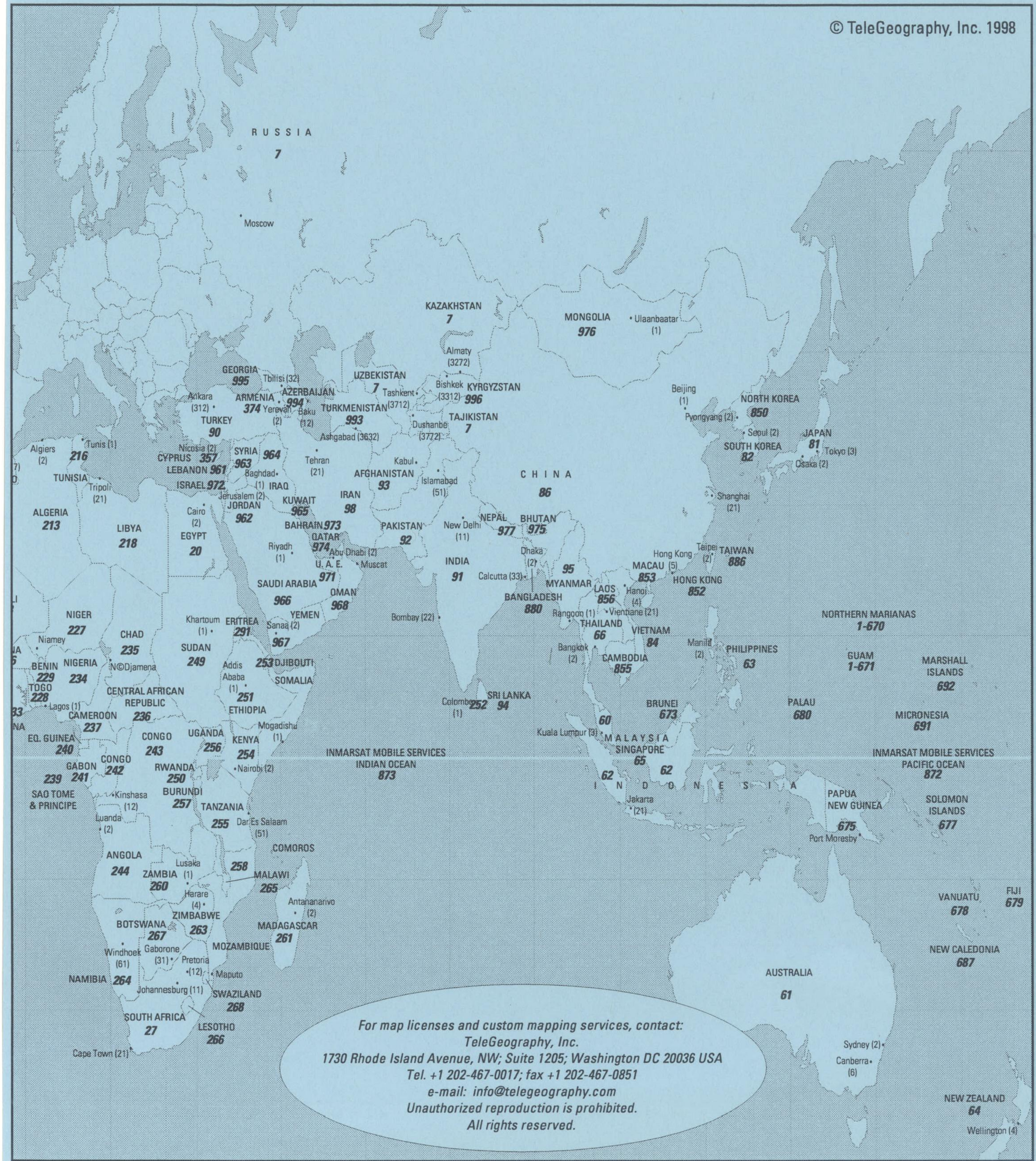
Yugoslavia .381
- Belgrade .11

Zambia .260
- Lusaka .1

Zanzibar (Tanzania) .255
Zimbabwe .263
- Harare .4

World Dialing Codes

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RUSSIA
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Moscow
KAZAKHSTAN
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Ulaanbaatar (1)
Almaty (3272)
GEORGIA
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Tbilisi (32)
UZBEKISTAN
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Bishkek (3312)
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Seoul (2)
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Kinshasa (12)
Luanda (2)
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Dar Es Salaam (51)
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1-671
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North American Area Codes, by Jurisdiction

Alabama
- Birmingham ... 205
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- Montgomery ... 334

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- Milwaukee ... 414
- Eau Claire ... 715

Wyoming ... 307

Note: Two codes separated by a slash (e.g., in Houston, Texas) indicate an overlay; multiple codes are used for the same geographic area.

North American Area Codes, by Number

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202	District of Columbia
203	Connecticut
204	Manitoba
205	Alabama
206	Washington
207	Maine
208	Idaho
209	California
210	Texas
212	New York
213	California
214	Texas
215	Pennsylvania
216	Ohio
217	Illinois
218	Minnesota
219	Indiana
225	Louisiana
228	Mississippi
240	Maryland
242	Bahamas
246	Barbados
248	Michigan
250	British Columbia
252	North Carolina
253	Washington
254	Texas
256	Alabama
264	Anguilla
267	Pennsylvania
268	Antigua & Barbuda
281	Texas
284	British Virgin Islands
301	Maryland
302	Delaware
303	Colorado
304	West Virginia
305	Florida
306	Saskatchewan
307	Wyoming
308	Nebraska
309	Illinois
310	California
312	Illinois
313	Michigan
314	Missouri
315	New York
316	Kansas
317	Indiana
318	Louisiana
319	Iowa
320	Minnesota
323	California
330	Ohio
334	Alabama
336	North Carolina
340	U.S. Virgin Islands
345	Cayman Islands
352	Florida
360	Washington
401	Rhode Island
402	Nebraska
403	Alberta
404	Georgia
405	Oklahoma
406	Montana
407	Florida
408	California
409	Texas
410	Maryland
411	Directory Assistance
412	Pennsylvania
413	Massachusetts
414	Wisconsin
415	California
416	Ontario
417	Missouri
418	Quebec
419	Ohio
423	Tennessee
425	Washington
435	Utah
440	Ohio
441	Bermuda
443	Maryland
450	Quebec
473	Grenada
484	Pennsylvania
500	Personal Comm.Serv. (PCS)
501	Arkansas
502	Kentucky
503	Oregon
504	Louisiana
505	New Mexico
506	New Brunswick
507	Minnesota
508	Massachusetts
509	Washington
510	California
512	Texas
513	Ohio
514	Quebec
515	Iowa
516	New York
517	Michigan
518	New York
519	Ontario
520	Arizona
530	California
540	Virginia
541	Oregon
559	California
561	Florida
562	California
570	Pennsylvania
573	Missouri
580	Oklahoma
601	Mississippi
602	Arizona
603	New Hampshire
604	British Columbia
605	South Dakota
606	Kentucky
607	New York
608	Wisconsin
609	New Jersey
610	Pennsylvania
611	Repair Service
612	Minnesota
613	Ontario
614	Ohio
615	Tennessee
616	Michigan
617	Massachusetts
618	Illinois
619	California
626	California
630	Illinois
649	Turks & Caicos
650	California
651	Minnesota
660	Missouri
661	California
664	Montserrat
670	Northern Marianas
671	Guam
678	Georgia
701	North Dakota
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705	Ontario
706	Georgia
707	California
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709	Newfoundland
710	U.S. Government Emergency
712	Iowa
713	Texas
714	California
715	Wisconsin
716	New York
717	Pennsylvania
718	New York
719	Colorado
720	Colorado
724	Pennsylvania
727	Florida
732	New Jersey
734	Michigan
740	Ohio
757	Virginia
758	St. Lucia
760	California
765	Indiana
767	Dominica
770	Georgia
773	Illinois
775	Nevada
780	Alberta
781	Massachusetts
784	St. Vincent/Grenadines
785	Kansas
786	Florida
787	Puerto Rico
800	Toll-free services
801	Utah
802	Vermont
803	South Carolina
804	Virginia
805	California
806	Texas
807	Ontario
808	Hawaii
809	Dominican Republic
809	St. Vincent
810	Michigan
812	Indiana
813	Florida
814	Pennsylvania
815	Illinois
816	Missouri
817	Texas
818	California
819	Quebec
828	North Carolina
830	Texas
831	California
843	South Carolina
847	Illinois
850	Florida
860	Connecticut
864	South Carolina
867	Northern Territories
868	Trinidad & Tobago
869	St. Kitts/Nevis
870	Arkansas
876	Jamaica
877	Toll-free services
880	Toll-free services
881	Toll-free services
882	Toll-free services
888	Toll-free services
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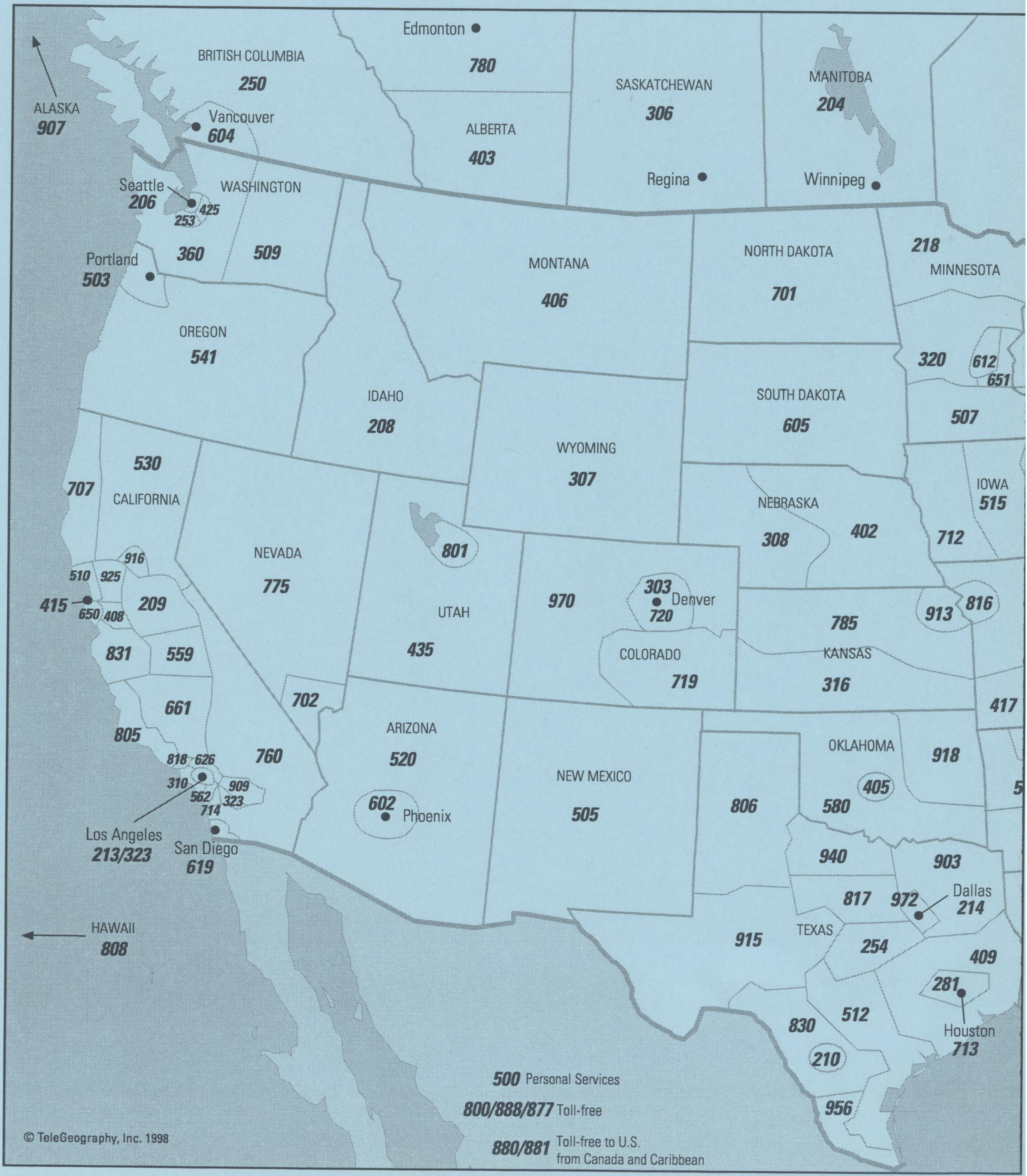
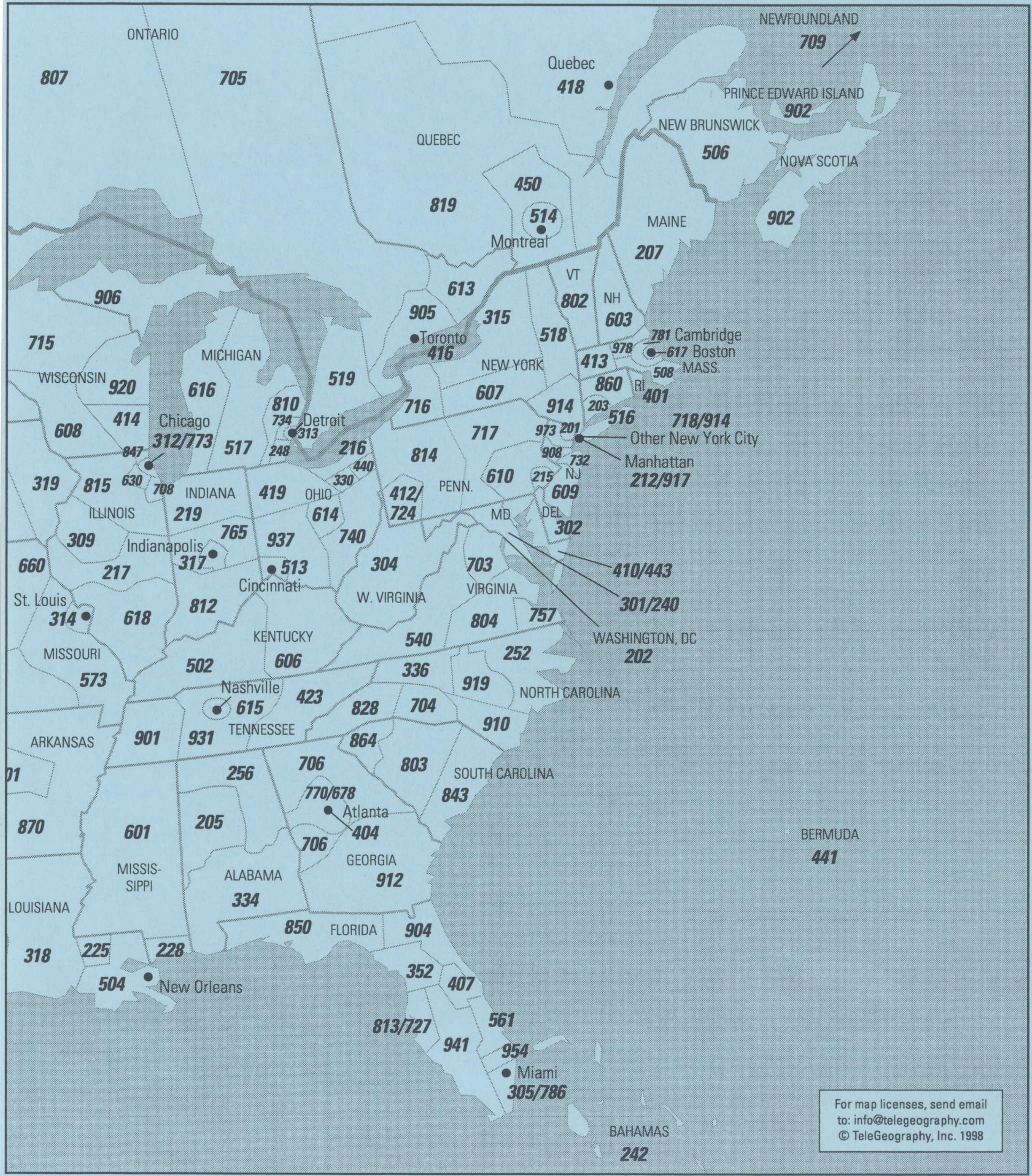
915	Texas
916	California
917	New York
918	Oklahoma
919	North Carolina
920	Wisconsin
925	California
931	Tennessee
937	Ohio
940	Texas
941	Florida
949	California
954	Florida
956	Texas
970	Colorado
972	Texas
973	New Jersey
978	Massachusetts

North American Area Codes




ONTARIO
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NEW BRUNSWICK
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NOVA SCOTIA
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BAHAMAS
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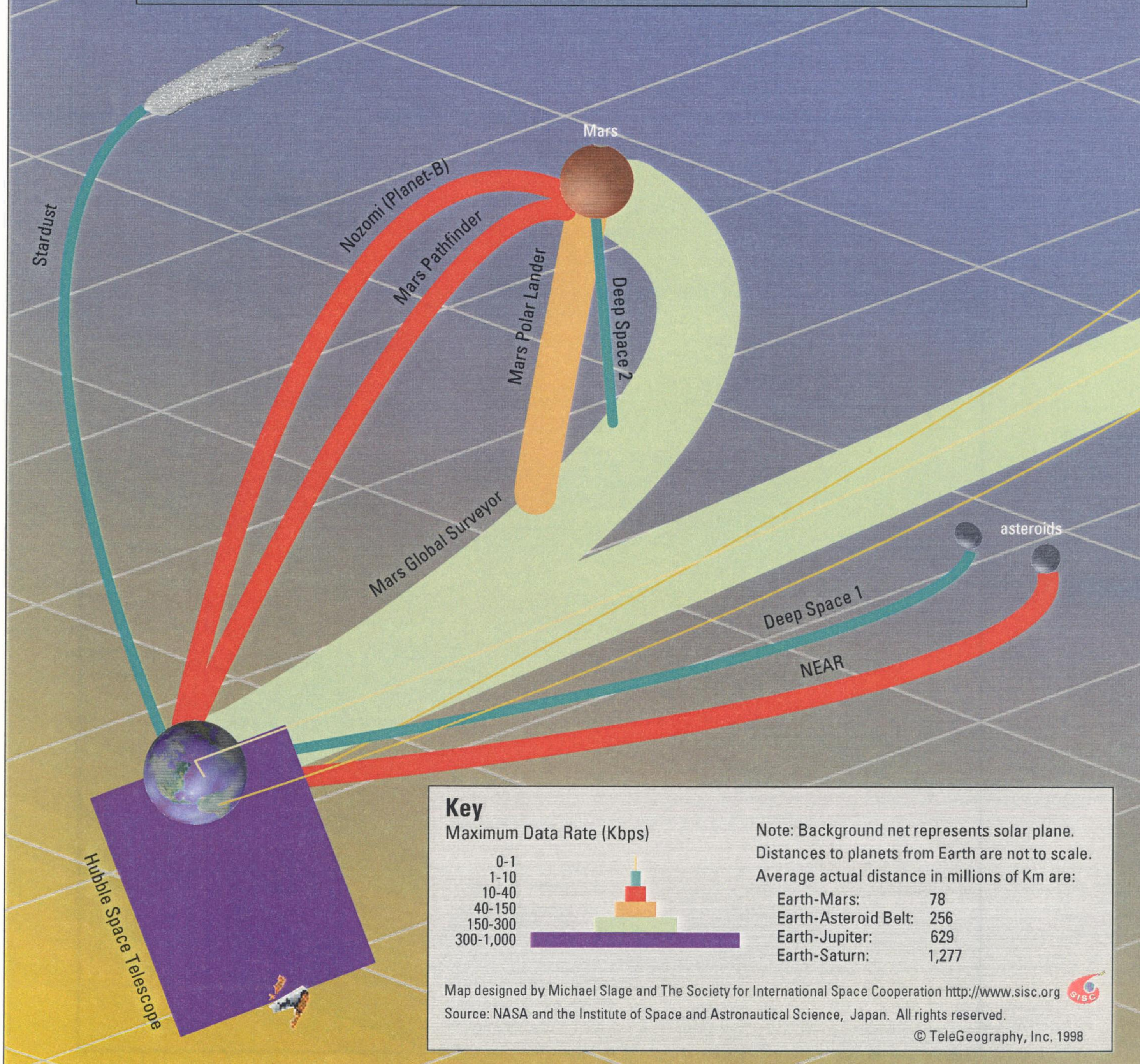
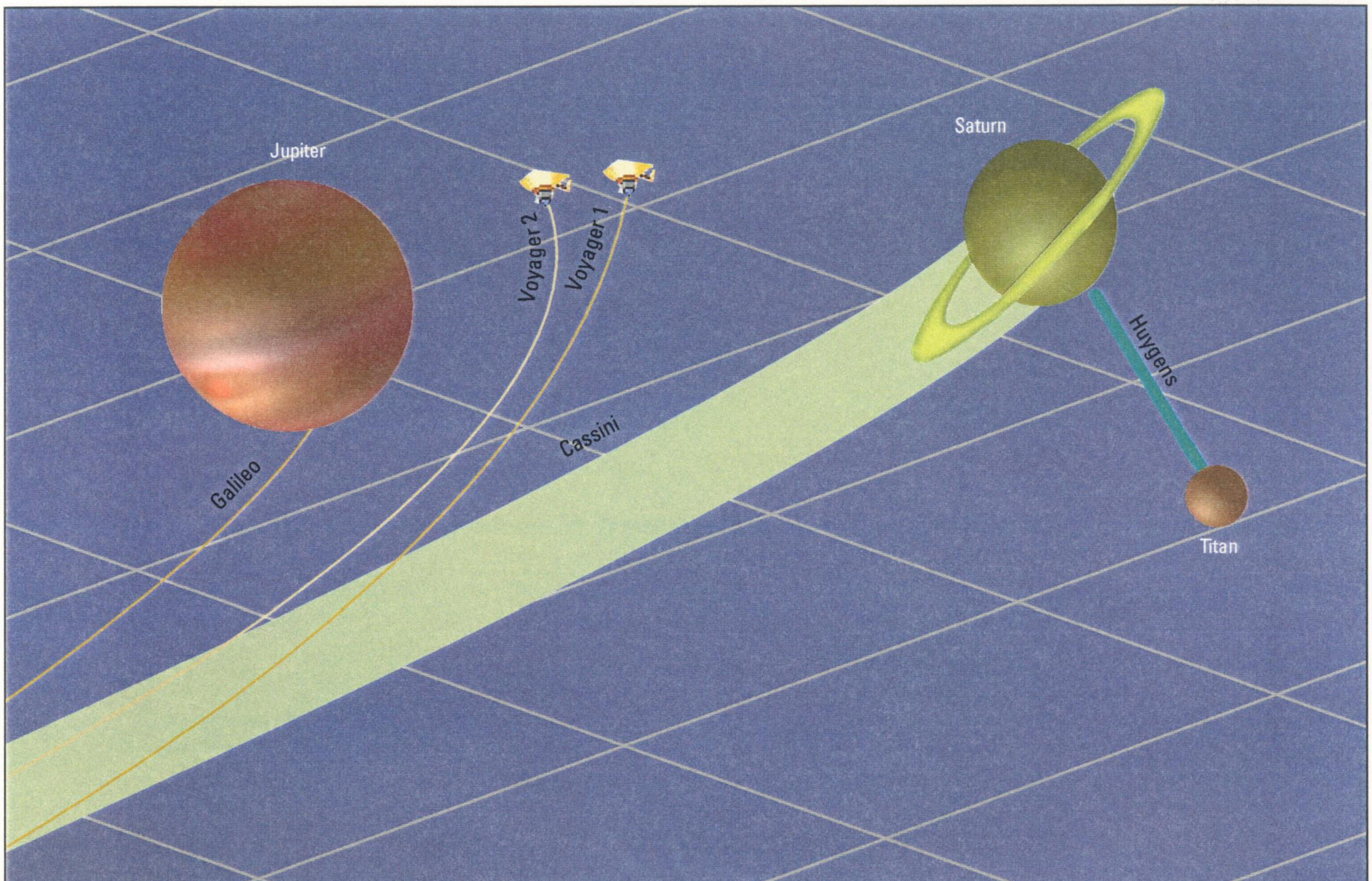
End Pages

Calling The Planets

The Internet's power to make the Earth smaller will soon reach to other parts of our Solar System. This map shows the communications capacity of major interplanetary space vehicles, including planned missions. The map highlights the increased bandwidth of recent space probes compared to those launched in the 1970s and 80s. The new high data rate networks of the Cassini Class Deep Space mission to Saturn and Mars should be the first step in laying the communications network necessary for human exploration of the planets. Eventually these bright spots in the night sky may be just another address on the World Wide Web.





Mission Histories and Bandwidth

Mission	Year Launched	Transmitter Power	Band Type	Hz	Max Kbps	Min Kbps
Cassini	1997	20 Watt	X-Band	8GHz	249.0	20.0
Deep Space 1	1998	15 Watt	X-Band	8GHz	8.0	2.0
Deep Space 2	1999	*	*	*	7.0	1.0
Galileo**	1989	20 Watt	S-Band	2294 MHz	0.16	0.04
Hubble Space Telescope	1990	†	S-Band	2294 MHz	1,000.0	0.5
Huygens	1997	10 Watt	S-Band	2295 MHz	8.0	0.001
Mars Climate Orbiter	1998	15 Watt	X-Band	8GHz	249.0	20.0
Mars Global Surveyor	1996	25 Watt	X-Band	8GHz	85.0	21.33
Mars Pathfinder	1996	13 Watt	X-Band	8GHz	25.0	2.0
Mars Polar Lander	1999	††	††	††	128.0	2.0
NEAR	1996	5 Watt	X-Band	8GHz	27.0	6.0
Nozomi(Planet-B)	1998	2.5 Watt	S-Band (X-Band)	2294 MHz (8 GHz)	32.0	0.064
Stardust	1999	15 Watt	X-Band	8GHz	8.0	2.0
Voyager 1 ‡	1977	23 Watt	S-Band (X-Band)	2294 MHz (8 GHz)	0.16	0.16
Voyager 2 ‡	1977	23 Watt	S-Band (X-Band)	2294 MHz (8 GHz)	0.16	0.16

* Data will be stored on-board the NM-DS-2 probe and then transmitted to the orbiting Mars Global Surveyor spacecraft for relay back to the Deep Space Network (DSN) on Earth.

** Originally 8.415 GHz X-Band at 134 Kbps.

† The Hubble Space Telescope was the first scientific spacecraft designed to utilize the full capabilities of the Earth-orbiting Tracking and Data Relay Satellite System (TDRSS), communicating over either multiple-access or single-access channels at any of the supported transmission rates.

†† The orbiter overflies the lander for typically 5 - 6 minutes about 10 times a Martian day. During this brief time the lander communicates with the orbiter at high speed: 128,000 bits/second vs. 2,000 bits/second with conventional X-band telecommunications systems.

‡ Maximum data return during active mission phase was 115.2 Kbps. The Deep Space Network continues to receive daily Ultra Violet and fields/particles data. The imaging cameras, photopolarimeter and IR spectrometer were turned off on both spacecraft after Voyager 2's 1989 Neptune flyby. The remaining seven instruments (UV spectrometer, cosmic ray telescope, low energy charged particle expt., magnetometer, plasma and plasma wave subsystems and the planetary radio astronomy unit) continue to return data at a combined rate of 160 bps. Their data return and communications could continue to 2017 when power levels go critical.

About TeleGeography, Inc.

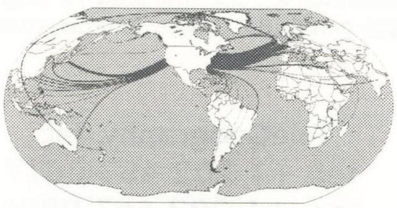
telegeography \tĕl´ə-jē-ŏg´rə-fē\ *n* (1990) abbrv. of telecommunications geography [fr. Gk *tele,* far off, at a distance and L. *communicatus,* pp. of communicare to impart + fr. Gk *geo* (earth) + *graphein,* (to write)] 1. a new branch of geography that maps the pattern of telephone traffic and other electronic communication flows; 2. places created by or perceived solely via telecommunications (e.g., a computer network address); 3. the telecommunications artifacts (radio antennae, terminals, signs) on a site; 4. the balance of telecommunications power in one country or region vis-à-vis another (cf. geopolitics, *archaic*).

The old geography of countries and coast lines is giving way to a new geography marked by telephone codes, satellite "foot prints" and Internet addresses. Electronic networks have made the world smaller. But they also have created countless new places where people work and play. This expanding electronic terrain—call it telegeography—demands a new cartography.

That is the *raison d'etre* of TeleGeography, Inc. (TGI). Founded by Washington, D.C. lawyer Gregory C. Staple, TGI is the world's leading publisher of reports on international telecommunications flows. It also is an authoritative source of data on the ownership of information-communication companies worldwide. In addition, the company provides customized mapping and consulting services. TGI's flagship report—*TeleGeography*—has been published annually since 1989 in cooperation with the London-based International Institute of Communications (IIC).

Other TGI publications include *New International Carriers*, a three volume directory of competing international telephone companies, and the *Telecommunications Map of the World*, a poster-sized map of world telecommunications. TGI's directories are used by leading communication companies, consultancies, governments and financial institutions in over 60 countries.

To learn more, please visit us at http://www.telegeography.com.



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PREPARATION OF THIS REPORT WAS SUPPORTED,
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THIS REPORT IS PUBLISHED ANNUALLY BY TELEGEOGRAPHY, INC.

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ISBN 1-886142-15-7