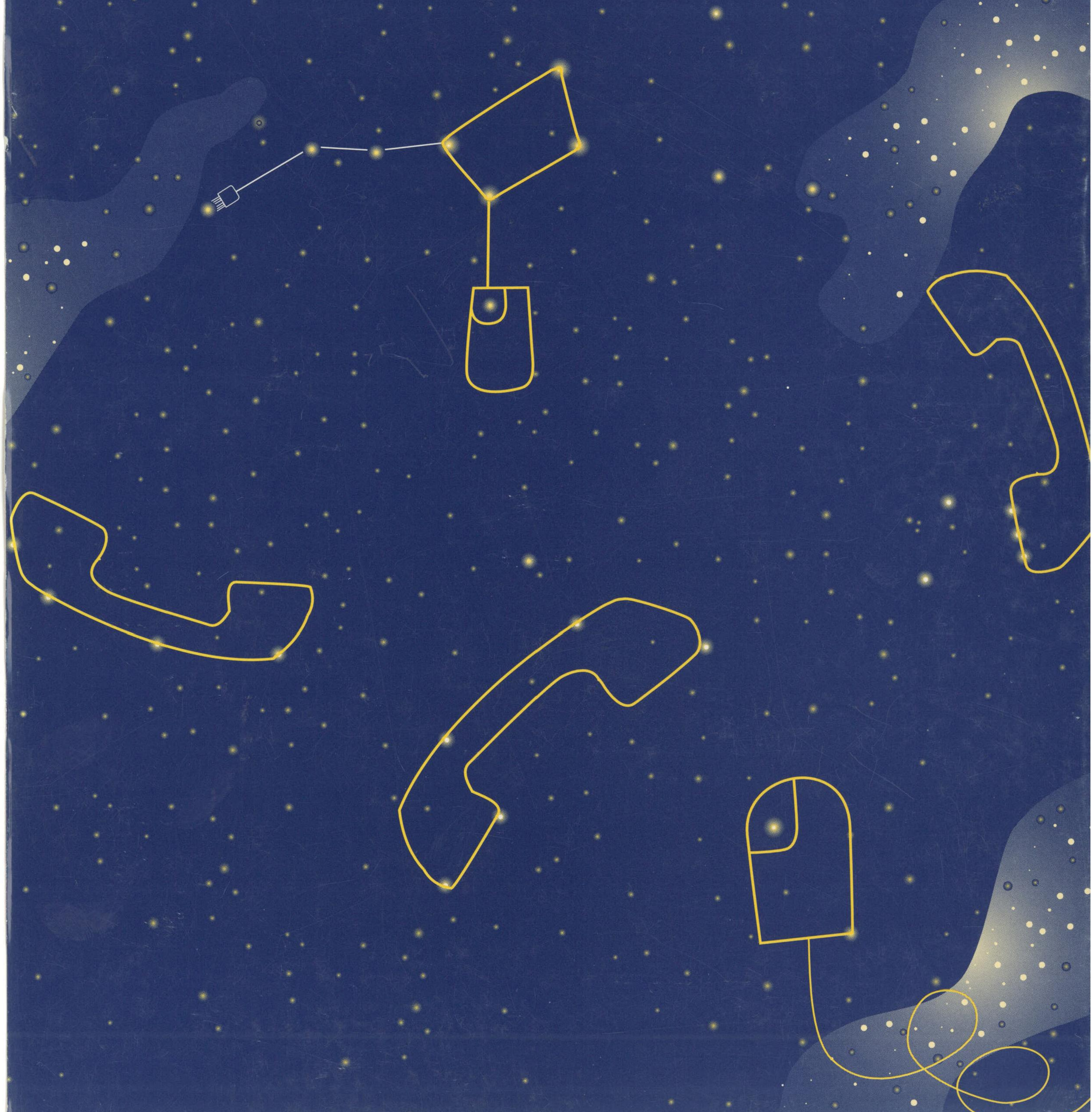
TeleGeography 1996/97

Global Telecommunications Traffic Statistics & Commentary

Gregory C. Staple, Editor



TeleGeography® 1996/97

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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*).

About the Cover

The Egyptian astronomer Ptolemy cataloged about 1,022 stars, grouped into 48 constellations, during the 2nd century C.E. Another 40 constellations were recognized beginning in the 16th century, as European navigators widened their explorations. Coelum (the chisel), Horologium (the clock), and Octants (the Octant, for John Hadley's 1730 invention), joined Orion; Ursa Major; and Leo in the heavens.

Times change. And, with them, the way we picture the night sky. Send us your favorite "digital" constellations and we'll send you a complimentary TGI publication.

TeleGeography, Inc.

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Other Tables and Figures
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Preface

As the dramatic transformation of the global telecommunications industry continues, a new wholesale market for trans-border services has emerged and is growing rapidly. Liberalization is releasing the regulatory brakes on the provision of international services, and the global alliances are developing their offerings to address this market, both within and outside of the traditional trading methods of the correspondent regime.

This new market is diverse, including the ever growing number of resellers and call-back operators, emerging "Second Operators" and the large numbers of as yet unaligned Telecommunications Operators (TOs) looking for lower cost international delivery. Then there are of course the behemoth "domestic players" such as the U.S. Regional Bell Operating Companies (RBOCs), who have yet to make clear their impact upon the international scene.

As the pace of change in the telecoms and related industries continues to increase, the importance of reliable information comes ever to the fore. *TeleGeography* has, since its launch in 1989, been hailed as the basic industry reference text on international traffic flows. It is a reliable information source that is essential for informed decision making by companies at all levels in the market, from those forming global alliances to those exploiting short term arbitrage opportunities as they arise around the globe.

In addition, this edition provides invaluable insights into the evolution of this market and the impact of new technologies and alliance developments, and it particularly focuses upon the development and implications of the Internet. *TeleGeography* continues to be an invaluable industry tool which MCI and BT are proud to co-sponsor.

Timothy F. Price
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MCI Telecommunications Corporation

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Managing Director
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This year's edition of *TeleGeography* was also supported, in part, by publication grants from MCI Communications Corporation and British Telecommunications plc. As in the past, however, these grants were made without any precondition; TeleGeography, Inc. is solely responsible for the report's editorial contents.

The Editors

Introduction

"People prefer that which is complicated, growing and sufficiently unpredictable to be interesting."
– E.O. Wilson, *Biophilia* (1984)

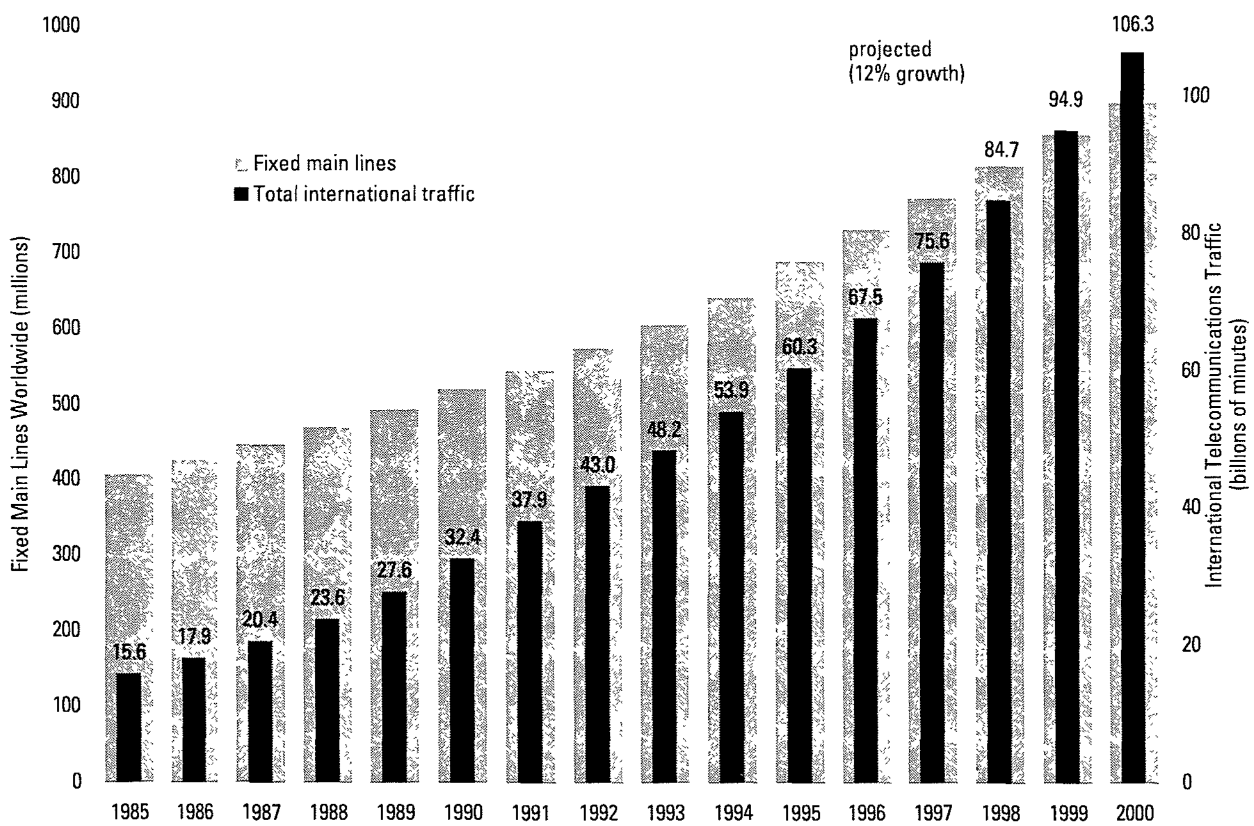
As an ecosystem, the global communications business has few peers either in size or complexity. Its networks span the earth offering services as different as facsimile and television, e-mail and mobile telephony. Electronic communication networks now touch our lives whether at work or at play, in our home or in our car. As in other ecosystems, the major subsystems are intimately related though the linkages may not be readily apparent. This edition of *TeleGeography* profiles two of these symbiotic worlds: the public telephone network and the world of international private lines.

The global telephone network is primarily used for voice communications. Private networks, by contrast, are mainly used for data communications. The Internet, for example, is the world's largest private data network. However, these two networks are marked by a type of reciprocal evolutionary change or co-evolution which affects us all. The price of international calls; the success of telecommunication trade talks; the future for Internet telephony; and access to multimedia services—these are but a few of the issues shaped by how the world's private and public networks interact.

The seeds of today's co-evolutionary cycle were planted in the early 1980s when regulators in the U.S. and several other countries began to free private data networks from the rules governing public telephony. As the regulatory environment for these two networks diverged, both networks entered a period of unprecedented growth even as they became more specialized.

International telephone traffic grew fivefold from 1985 to 1995 (see Figure 1) and the average price for overseas calls

Figure 1. International Traffic Continues to Grow Faster than the Number of Lines



Note: Data include outbound Minutes of Telecommunication Traffic (MiTT) on public telephone networks only.
Source: ITU, TeleGeography, Inc. © TeleGeography, Inc. 1996

Figure 2. Trends in the Global Information Economy

Traffic growth trends, 1986-1995 and projections, 1995-2000

	Historical trend			*10% growth*		*12% growth*		*14% growth*	
Indicator	**1986**	**1995**	**CAGR 1986-95**	**2000**	**CAGR 1995-2000**	**2000**	**CAGR 1995-2000**	**2000**	**CAGR 1995-2000**
Calls (Bn)	3.6	16.8	18.5%	33	14.5%	35.8	16.3%	39.1	18.4%
Estimated call length (mins)	4.6	3.6	-2.7%	3	-3.5%	3	-3.5%	3	-3.5%
Minutes (Bn)	16.7	60.3	15.4%	98.9	10.4%	107.3	12.2%	117.2	14.2%
Per main line subscriber	38.8	87.4	9.4%	109.9	4.7%	116	5.8%	123.4	7.1%
Per main line plus mobile	38.6	77.8	8.1%	82.4	1.2%	85.8	2.0%	90.1	3.0%
Revenue	21.7	55	10.9%	73.6	6.0%	75.5	6.5%	78.3	7.3%
Assumptions									
Price per MiTT ($)	1.3	0.91	-3.9%	0.74	-4.0%	0.7	-5.0%	0.67	-6.0%
Main lines (M)	430	690	5.4%	900	5.4%	925	6.0%	950	6.6%
Mobile subscribers (M)	1.4	85	58.1%	300	28.7%	325	30.8%	350	32.7%

Note: 1986-1995 based on reported data. 1995-2000 based on ITU forecasts. Scenarios are as follows
1. 10% growth: Continuing trend of last four years.
2. 12% growth: Assuming a faster network growth rate and faster rates of price-cutting.
3. 14% growth. Assumption that recent slowdown will be decisively reversed towards the end of the decade due to a combination of price cutting, demand stimulation and the development of new services. A significant component of this new demand would be traffic generated from mobile subscribers.

Source: *Direction of Traffic 1996* (ITU/TeleGeography, Inc.)

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fell to $0.75 per minute or less on many routes. Data networking by multinational companies grew even more rapidly. By the early 1990s, a vast consumer market also developed for the Internet as new protocols allowed multimedia information to be transmitted with other data on private computer networks.

Although these two networked worlds often seemed separate—one public, the other private, one for voice, the other for data—they were (and are) engaged in a tightly coupled evolutionary dance. Public telephone operators (PTOs) own the principal undersea cable and satellite facilities which provide the backbone circuits for the world's data networks, including the Internet. Private line customers provide a substantial portion of the demand for this transmission capacity, much of which is currently under-subscribed (see e.g., Figure 4). PTOs and private network operators thus have a shared interest in the terms on which international circuits may be leased and connected to the public switched telephone network (PSTN).

PTOs depend on their private line customers in other respects. The multinational companies which lease most private lines also generate large volumes of public telephone traffic. If these customers are not well served, they may shift traffic to their own networks. PTOs also rely on private networks to trial next generation technologies. The residential market for high speed packet-switched networks, for example, is obviously very small. Consequently, private line customers are essential testing grounds for new technologies which will later become part of carriers' public network offerings.

Still for much of the last decade, co-evolution has depended on the fact that private and public networks primarily offered different services. Cooperation rather than competition was the rule. But it is now evident that the environment is changing again. The evolutionary strategies which allowed both networks to flourish in the past may no longer work. This time, though, in contrast to the early 1980s, regulation and technology are bringing the landscape occupied by these two networks closer together.

For instance, today more and more of the PTOs' international private line customers also directly compete in providing public switched telephone services. Some are merely service resellers and are new to the market; others are PTOs which seek to use private lines as an inexpensive means of access to foreign markets. In addition, one of the largest new sources of demand for international private line circuits is from Internet service providers (ISPs). And though the Internet was built for e-mail, tomorrow it may carry telephony too.

Technological innovations also have led PTOs themselves to compete directly with their private line customers. As the public network becomes more and more digital, telephone companies are seeking to provide a range of end-to-end data services, wooing small and medium sized customers who might otherwise lease their own lines. Many PTOs are also actively marketing Virtual Private Networks (VPNs) using "smart" switching and call routing technologies to partition the public networks on an as-needed basis for private customers. Some PTOs have become Internet service providers themselves and others are keen to join them; witness WorldCom's proposed acquisition of MFS/UUNet, now one of the largest ISPs in the U.S. and Europe.

The data and articles presented in the body of this report are intended to flesh out the story of this co-evolutionary process. Will the current cycle of change lead to the end of public networks as we know them? Or will private networks begin to die out as PTOs bring their greater marketing power and facilities to bear? Or will we see a third scenario—hybrid networks—as often occurs in nature when environmental changes force two major species to compete side-by-side in the same territory?

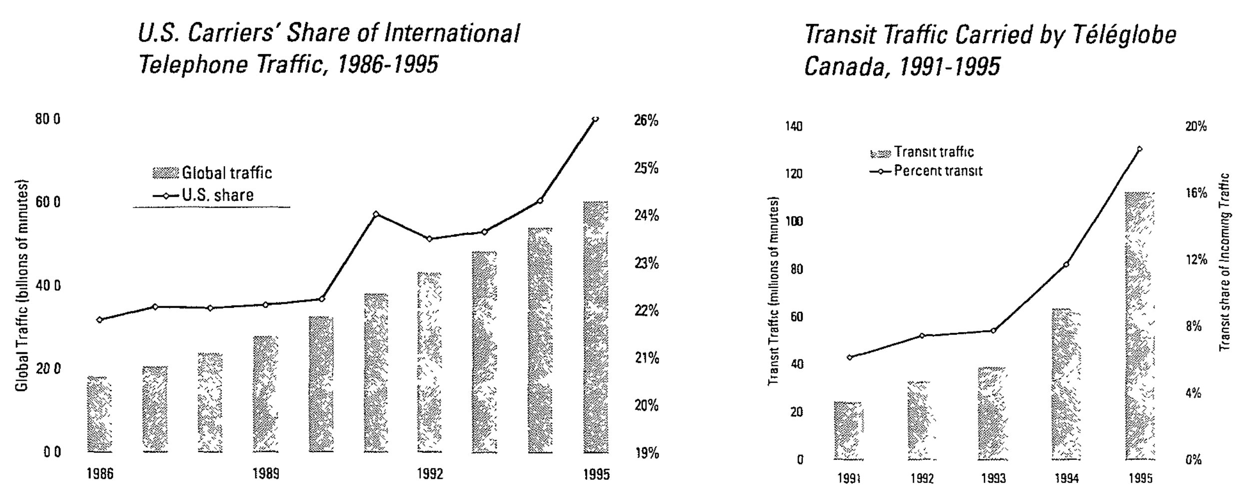
Of course, these ecological metaphors are inexact. They are intended to suggest the dynamic process of change that is now underway within the international telecommunications business rather than to define it precisely. Other scenarios are also possible. Moreover, the process of change will be uneven, with significant variation from region to region and sometime even from country to country, although in the age of telephone call-back services and the Internet, no country can easily prevent its citizens from taking advantage of telecommunications services available elsewhere. These cautions should be kept in mind in reviewing the trends highlighted below.

Industry Trends

• *Volume*—The volume of international traffic on the public telephone network continues to grow much faster than the global economy with traffic volumes up 13 percent from 1994 to 1995 (see Figure 1). We expect traffic to grow at a similar rate (12 percent or more) in the next three to five years, generating over 106 billion minutes of international traffic by the year 2000. This expansion will be driven, in part, by the addition of over 425 million new telephone customers which, by 2000, will raise the base of telephone subscribers to 1.2 billion, including approximately 300 million mobile subscribers (see Figure 2).

• *Competition*—More and more national PTOs face global competition for their international telephone services, even where additional facilities-based carriers are not permitted. Telephone call-back and credit-card based services provided by carriers outside their home market generated at least three billion minutes of traffic in 1995. Most of this traffic was handled by U.S. carriers—even AT&T offers call-back services from Europe—which increased their share of the global market to over 25 percent in 1995 (see Figure 3). This was due in part to a large jump in resale traffic. U.S. resellers of international switched services increased their 1995 traffic base to 2.3 billion minutes from 1.3 billion in 1994.

Figure 3. Eat or Be Eaten: North American Carriers are at the Top of the Global Food Chain



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The impact of this U.S. assault is striking. For example, in 1995, on the U.S.-India route, the volume of telephone traffic billed by India's overseas carrier, Videsh Sanchar Nigam, was essentially unchanged from 1994 at 52 million minutes whereas the volume of traffic billed by U.S. carriers increased over 50 percent to approximately 285 million minutes. The statistics tell a similar story on many other routes to and from the U.S. Traffic billed by U.S. carriers accounted for over 85 percent of the volume increase over 1994 on the Hong Kong, Japan and Argentina routes.

• *Toward Bill and Keep*—New billing and routing arrangements for telephone traffic (e.g., call-back and home country direct services) suggest that carriers which originate international calls are gaining the upper hand over carriers which terminate calls.

To put it in another way, there is a new global call origination business which is more and more independent from the call termination business. In the old world, these two businesses were largely symmetrical and cooperative: the same carriers picked up and delivered calls. Routing and financial arrangements were mutually agreed; and carriers at each end of a route were paid the same amount for terminating a call.

In the new world, call origination—control over the customer—is all important, and routing and settlement arrangements follow from there. This plainly calls into ques-

Figure 4. How Do U.S. Carriers Use Their International Facilities?

International Circuit Status of U.S. Carriers on Selected Routes, December 1995

Route (to/from U.S.)	IPLs	PSTN	Percent IPL	Idle circuits	Percent idle
Canada	5,543	44,172	11%	1,936	4%
Mexico	1,653	23,416	7%	800	3%
Hong Kong	860	742	54%	1,036	39%
Japan	2,241	4,619	33%	16,259	70%
Singapore	521	306	63%	593	42%
United Kingdom	6,048	8,317	42%	27,001	65%
All routes	26,497	126,150	17%	118,343	44%

Note: Circuit figures stated in 64 Kbps units "Percent IPL" indicates the share of total active circuits that are privately leased and "Percent Idle" indicates the share of available circuits that remain unused PSTN refers to the public switched telephone network

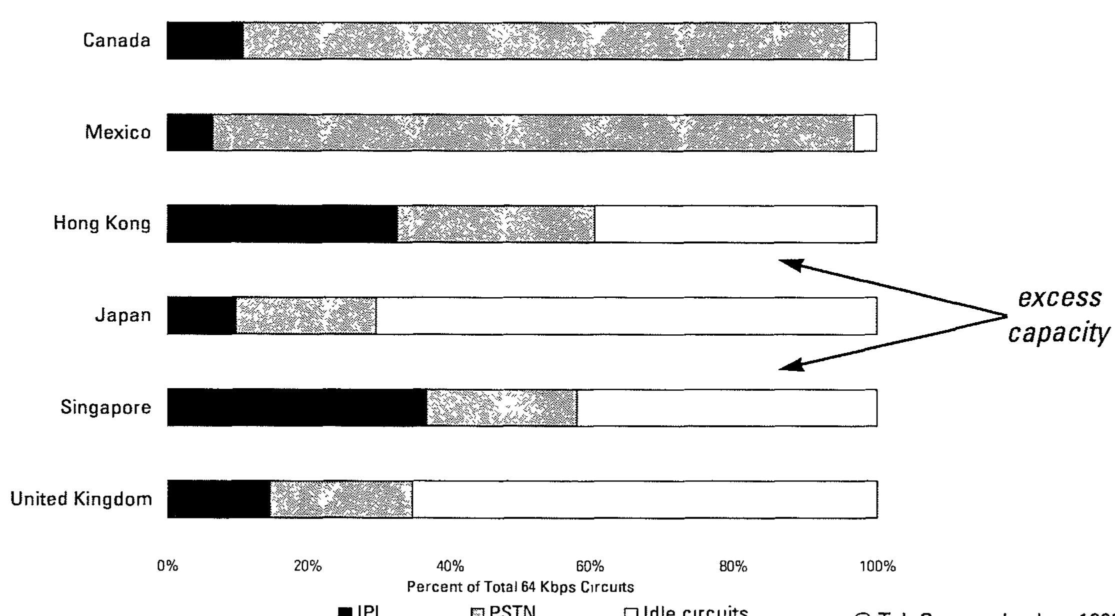

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Figure 5. The Top 20 Carriers: Traffic Growth

Company	Country	1993	Outgoing Traffic 1994	1995	CAGR 93-95
1. AT&T	United States	7129	7947	8482	9.1%
2. Deutsche Telekom	Germany	4680	5147	5244	5.9%
3. MCI	United States	2839	3517	4458	25.3%
4. BT	United Kingdom	2310	2489	2909	12.2%
5. France Télécom	France	2576	2603	2805	4.4%
6. Telecom Italia	Italy	1610	1708	1908	8.9%
7. Swiss PTT	Switzerland	1572	1649	1778	6.4%
8. Sprint	United States	1175	1471	1765	22.6%
9. Hongkong Telecom	Hong Kong	1377	1578	1692	10.8%
10. Stentor	Canada	1552	1525	1467	-2.8%
11. KPN	Netherlands	1238	1346	1459	8.6%
12. China MPT	China	870	1090	1339	24.1%
13. Mercury	United Kingdom	820	1018	1107	16.2%
14. Belgacom	Belgium	979	1049	1106	6.3%
15. KDD	Japan	952	1011	1086	6.8%
16. Telefónica	Spain	847	948	1025	10.0%
17. Telmex	Mexico	625	844	950	23.3%
18. Austrian PTT	Austria	767	819	901	8.4%
19. Téléglobe	Canada	808	861	898	5.4%
20. Telstra	Australia	640	690	807	12.3%

International traffic in MiTT. CAGR is the compound annual growth.
See page 64 for additional carriers and information.
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tion the survival of carriers which depend heavily on settlement revenue to make ends meet (i.e., from terminating more traffic than they send out).

As yet, the redirection of customer traffic from one PTO to another is only marginally related to competition from International Simple Resale (ISR) carriers which lease dedicated international circuits in bulk and then break them down to provide retail telephone service (see generally pp. 15 to 21 below). However, our companion directory, *New International Carriers*, updated as of July 1996, shows that liberalized markets are now served by at least 150 ISR providers. We expect major incumbent carriers (e.g., AT&T, BT, Telia, Téléglobe, Sprint) to begin using ISR facilities soon too, redirecting some traffic to affiliated carriers and "hubbing" other traffic streams in a more cost-effective way to third countries.

The distinction between originating and terminating carriers is also being driven by the Internet. Because the Internet is a connectionless service (data packets are sent from switch to switch without the need for a dedicated end-to-end circuit), most Internet operators do not have close economic ties. Each commercial operator is responsible for funding its piece of the network regardless of the costs (or benefits) these investments bestow on the network as a whole.

This is at once the beauty and bane of the Internet today—beauty, because central planning and traffic settlement regimes have been avoided—and bane, because without economic agreements between the Internet's myriad access providers, there is little incentive to conserve the Internet commons for all. More on this below.

• *Network Capacity*—There is still substantial idle transmission capacity on major trans-Atlantic and trans-Pacific telecommunication routes. Circuit status data compiled by U.S. international carriers show that at December 1995 approximately 44 percent of the carriers' available capacity was unused. On key routes, where new fiber optic cables are available (e.g., to the U.K. and Japan) unused capacity is even greater, averaging 65-70 percent (see Figure 4). The next generation of mega-cables now being planned for these routes will probably keep cable fill ratios at 50 percent or less well into the twenty-first century (see p. 63).

These facts suggest that incumbent carriers (i.e., cable owners) will have more and more flexibility in the pricing and scope of their international offerings. Indeed, the magnitude of the current gap between supply and demand for transmission facilities suggests that if international private lines (IPLs) were repriced a host of new international carriers and services—for Internet telephony, on-line music, catalog shopping—could be accommodated almost overnight.

• *Private Lines*—The foregoing circuit status reports also suggest that private networks have quietly become the largest users of international bandwidth on major routes. Simply put, data, not voice, is already driving the global network much more than many people realize. For example, 50 to 60 percent of the circuits between the U.S. and major Asian points (e.g., Singapore and Hong Kong) are privately leased and over 40 percent of the circuits between the U.S. and U.K. are now dedicated to private customers. The preferences of these private users—whether it be transmission protocols or service suites, back-up capacity or pricing arrangements—are thus likely to have a large impact on the evolution of the public network. This can already be seen at the margins as major networking protocols, first used to interleave voice and data traffic on private networks, are now being offered to the general public. The commercial initiatives of SITA, the network owned by the world's airlines, form a case in point (see p. 12).

• *Internet Traffic*—The mix of traffic on the Internet has swung decisively toward multimedia. Since early 1995, World Wide Web traffic has risen from 20 to 75 percent of total Internet packets (as measured by traffic over a major U.S. backbone network). The change is dramatic, and similar, in some ways, to the early years of radio, which rapidly changed from a ship-to-shore communications device to a mass broadcast entertainment medium.

The new dominance of Web traffic on the Internet is probably good news for PTOs. Though a multimedia Internet with real-time audio and video service presents a clear challenge to telephony, PTOs have the bandwidth and, in some cases, the networking skills and switching facilities to accommodate it. Moreover, because the Internet is largely deregulated, the more popular it becomes, the more support PTOs are likely to gain for a more liberal approach to regulating plain old telephone service. This is especially true to the extent that the Internet provides an alternative dial tone. A viable Internet phone service must, however, surmount a number of hurdles (see pp. 37 to 40).

• *Internet Metrics*—Though the Internet works much of the time, performance is highly variable. Frequent users must now put up with dropped packets, unpredictable routing and even network brownouts. In fact, some experienced Internet engineers, such as Robert Metcalfe, founder of 3Com and the father of Ethernet, contend that the Internet's unchecked growth may well lead to a catastrophic "crash." Though Metcalf's forecast is flatly rejected by others (see p. 28), there is little question that the Internet's service quality now falls short of that expected by telephone users.

What is to be done? There are probably as many answers as there are Internet engineers. To all we have but one response: whatever is done, the metrics may matter most. Without a cooperative method of traffic measurement, many technical solutions are likely to be ineffective or problematic as users, ISPs and PTOs continue to argue over the results. Moreover, metrics are the key to developing pricing mechanisms that will help transform the Internet from an *ad hoc* private network of networks to a robust end-to-end communication service for the general public.

Final Thoughts: the Language of Tomorrow

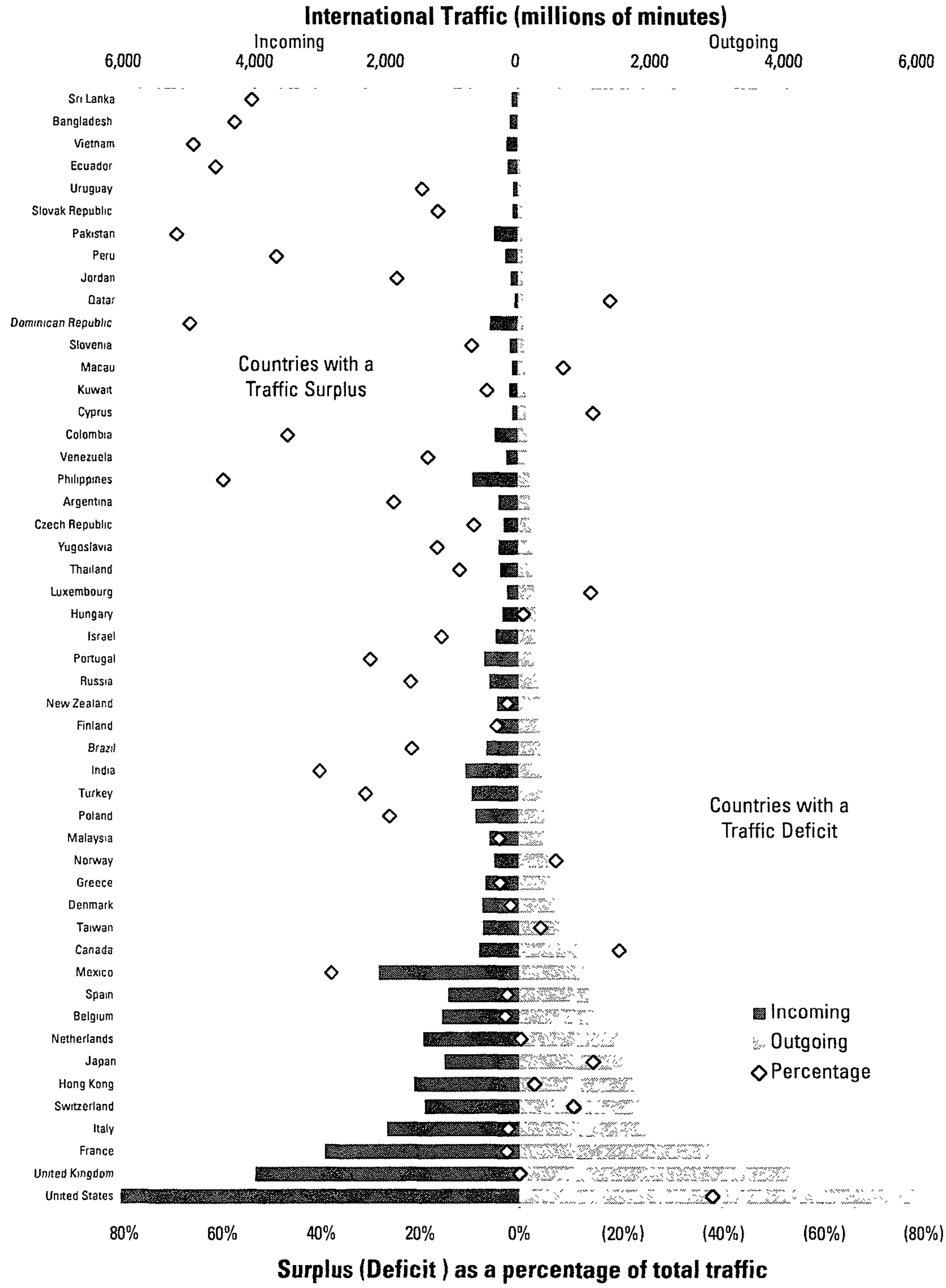
No evolutionary survey would be complete without some attention to the language we use to describe the networked world. How we talk about communications networks—whether we use organic metaphors (ecosystems) or geographic ones (highways)—often reflects how we think about them (e.g., as in flux or relatively fixed). In turn, how we think about networks affects our expectations—what we want them to do today and in the future.

Since the early 1960s, we have been constantly told that satellite communications and computer networks will make the world ever smaller—"a global village," in the words of of the late Canadian media scholar, Marshall McLuhan. Yet, as we first argued in *TeleGeography 1993*, instantaneous global communication has not led to the end of geography so much as the explosion of place. This is largely a matter of economics. As the price of getting on the telecoms map has fallen, the demand for places has mushroomed. The global telephone network is now populated by hundreds of millions of people from Mexico to Malaysia and Finland to Fiji. In this bewildering new landscape, McLuhan's metaphor has had a continuing appeal because of the way it evokes home and community.

We have also used metaphors to tame the most unruly communications place of our time, the Internet. Although cyberspace is anything but one-dimensional (see the End Page to this report), it is popularized as a hybrid form of real estate—an "electronic frontier," to be developed and marketed much like a new housing subdivision or shopping center. Cyberspace may be a "land of bits" but it is a real, material one. And eminently bankable. Just ask the folks at Netscape, Yahoo!, Excite, Spyglass or the dozen or so other Internet companies whose initial public offering of stock sold out in the last year.

Despite our sympathies for this digital property boom (our Web site—http://www.telegeography.com—is for rent too!) there are competing, non-material metaphors for the Internet which may well be more illuminating in the longer term. For example, some writers, such as Finland's Leena

Figure 6. Richer Countries Call Out, Poorer Countries Have a Traffic Surplus



Note: Countries with a surplus receive more international traffic than they send.

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Krohn, have depicted the Net as an "electronic *oceanos*" of words and thoughts, like literature.

The fact that precious few Web pages have literary merit does not make the metaphor inapt. Taken as a whole, the Web, like literature, makes the world bigger and smaller at the same time; it is also at once intensely intimate and incredibly public; part body, part mind, a parallel space for reflection and evolution.

We live in a world of readers as well as builders and merchants. The inventors of Netscape Navigator™, the most popular software for "browsing" the World Wide Web, borrowed as heavily from the literary metaphor as they did from the real estate one. Navigator™ starts at a "home page" and allows users to mark their way not by "road signs" but with "book marks." And why not? The hypertext transfer protocol (http) which underlies the Web was designed by Tim Berners-Lee in large measure to permit the collaborative review and creation of documents.

So what? Why should we care about these metaphorical divides? Does it matter whether we talk about the Net as literature or as part of a ecosystem rather than as a market or a highway? Isn't the Internet all these things and more?

Perhaps. But, language does have consequences. If material views of the Net dominate our vocabulary, as seems true today, then many communication businesses are likely to flesh out the metaphor in their investment plans. The infrastructure installed, the look and feel of the access points, the types of services which are provided—all these are likely to reflect their investors' preferred vocabulary. Geographical metaphors are likely to bring us more geography: wider and wider highways; ever faster modems and any number of electronic cars to drive. Yet, for most people, to borrow from Microsoft's ads, the question will still be: "Where do you want to go today?" And "why"?

On the other hand, if we think about the Internet (and other networks), in a more organic way, a far more cautious approach may be indicated. A highway is not a habitat nor is a book literature; each comes into its own in relation to the community or the society in which it was created. Few successful networks are autonomous; they are a piece of something greater than themselves and rarely blossom without the right social fertilization.

A contrarian view of the information landscape—for example, as one shaped by browsers as much as by drivers—also suggests that the most successful communication businesses five years from now may be distinguished less by how many customers they have wired than by how many people they have taught to use the wires that others have installed. Companies that answer the "where" and the "why" for their clients may be treasured more than those which simply lay the asphalt or build the home sites. And when it comes to the "where" and "why," engineers may be less important than educators, and marketing skills less important than mentoring.

Gregory Staple
October 1996
Washington, D.C.

Beyond the Public Switched Network

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Sizing the Market for International Private Lines

by Graham Finnie and Melanie Stockwell

Though sometimes regarded as a distraction by telecommunications operators (TOs), the market for international private lines is by any measure large, growing, and profitable.

In 1995, telecoms customers spent approximately $2.1 billion on international private lines (IPLs), representing roughly four percent of all international telecommunications revenues (see Table 1).

Of this, retail demand from private corporations for their own use accounted for approximately $1.5 billion. The rest came from wholesale buyers, such as Internet Service Providers (ISPs), perhaps the fastest growing source of demand for dedicated international capacity, and from other resellers, global alliances and managed data network providers. (Details on the growth of global Internet backbones can be found at pp. 53-55 below.)

We estimate that the international private line market by capacity has grown at between 15 and 20 percent annually for the past five years, roughly paralleling the growth in international switched minutes. However, prices for IPLs are falling faster than the switched network—at approximately 10 percent a year on major routes. Thus, IPL revenue is lagging circuit expansion, though there are regional variations.

More importantly, despite the absolute growth of the IPL market, the proportion of corporate traffic traveling on private circuits is beginning to decline. We expect that relative decline to gather pace in the next few years as users make greater use of public services, including virtual private networks (VPNs) for voice, and frame relay and managed Internet Protocol (IP) services for data. Initially, the decline in IPL usage have been confined to data communications, but it is now spreading to voice communications as well.

However, this decline is relative: the explosion in data communications, brought about in large part by the shift to client-server computing, is benefitting all telecom services, including private lines. Traditionally, computing architectures were based on dumb terminals linked to smart mainframe computers that were easily (and most often strictly) controlled by centrally located information technology (IT) staff. By contrast, client-server computing, using personal computers (PCs) with off-the-shelf software, is largely driven at the departmental and divisional level. The new networks have created a near-anarchic situation: corporate IT staff in some big companies now have only the barest idea of who is transmitting what data and where.

Table 1. 1995 International Telecommunications Revenue

Service	Revenue	
PSTN	$55 billion	96.3%
Private Lines	$2.1 billion	3.7%

Note: Revenues for Managed Data, VPN and resale have been excluded since this would result in "double counting" of revenues. Private lines are used for all three services, and the PSTN is also used by some resellers

As we note in our two case studies, (see pp. 12 and 13 below), client-server computing has helped create unprecedented demand for all forms of wide area communications, and now the Internet and its associated technologies are adding to the swelling rivers of data. Applications that were formerly confined within buildings and departments have spilled out across national boundaries; and those applications themselves are continually evolving in ways that quickly turn bit streams into torrents.

For example, e-mail (once a very modest consumer of bits) has been replaced by client-server-derived e-mail with attachments (e.g., Lotus Notes), an increasingly large consumer of bits, and an increasing problem for telecoms managers. The same can be said for Internet software which initially allowed little more than plain text to be communicated and now allows users to send almost anything that can be digitized. The fact that individual workers can themselves download application software off the Internet adds to IT woes.

For providers, the result is a continuing data communications bonanza. The client-server revolution was driven from the bottom up, and its implications for wide area communications are still being worked through; the related boom in Internet communications has only just started.

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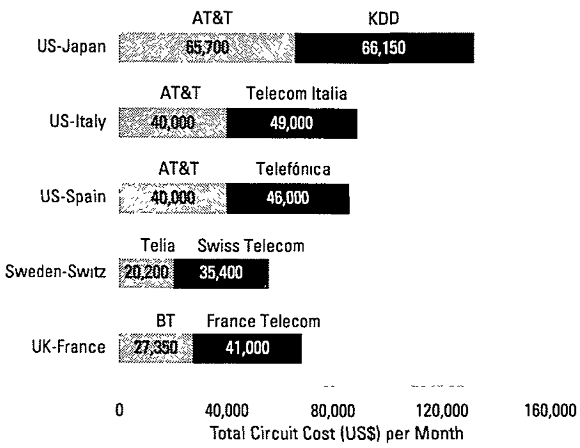
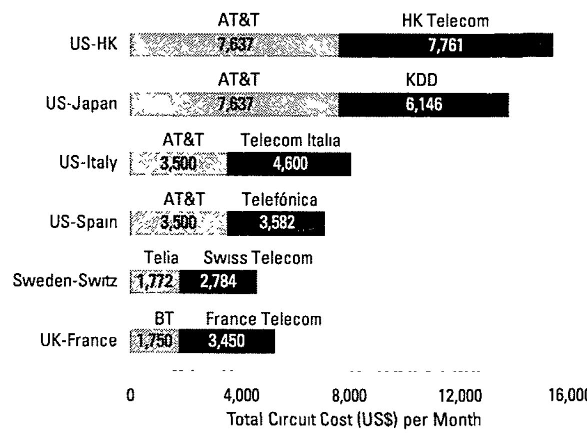
Box 1. How Much Do Leased Circuits Cost?

2 Mbps International Circuit Prices



64 Kbps International Circuit Prices



Generally speaking, prices have fallen by about 30 percent since mid-1993, continuing a trend that has persisted for at least six years. However, this generalization conceals a great deal of local variation; for example, Deutsche Telekom and Telenor (Norway) have cut tariffs by up to two-thirds since 1993, but France Telecom and Telecom Finland have maintained pricing at 1993 levels.

In a few instances, tariff structures have changed: Deutsche Telekom, for instance, now charges separately for national extensions on a case by case basis (unlike most other carriers), so the precipitous fall in pricing shown in the table is a little misleading.

These differences also often reflect underlying commercial or political strategies. Telecom Finland, for instance, has placed heavy emphasis on managed data services, and may have retained relatively higher prices to encourage migration of users to this service.

There may also be very wide variations in pricing. While OPT of Austria and Telefonica make little differentiation between the cost of a circuit to the nearest European country and to Japan, the differential for Telenor is 15:1.

The following table provides indicative figures on the decline, in real terms, of IPL prices from 1993 to 1996.

Monthly rental for a 64Kbps half-circuit in 1996 as a percentage of the 1993 price (1993 price = 100). All prices are in US$

Country	to near Europe	to far Europe	to USA	to Japan
Austria	64.1	63.2	58.8	44.1
Belgium	53.1	84.0	51.3	70.1
Denmark	94.9	94.9	90.7	NA
Finland	86.8	94.3	89.6	96.0
France	94.3	94.3	81.6	NA
Germany	37.3	37.3	39.2	47.4
Greece	56.1	58.9	45.5	45.5
Ireland	39.2	65.2	74.5	93.1
Italy	75.0	68.5	79.6	71.8
Netherlands	52.7	59.5	59.7	63.0
Norway	23.9	36.0	41.7	68.5
Portugal	84.4	80.2	71.5	76.7
Spain	64.6	64.6	74.2	74.2
Sweden	68.3	76.7	81.8	NA
Switzerland	80.5	76.2	80.0	72.0
U.K. (BT)	84.2	44.7	87.9	88.1
Average	66.2	68.6	69.2	70.0

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What are International Private Lines?

Private lines are ordinary telephone circuits that are leased for a flat fee to a particular customer and thus always "open." A private line, in industry jargon, is "nailed up" by the TO and bypasses standard switching equipment. Originally, circuit cross-connections were hand-wired; since digitization, this is usually accomplished electronically using digital cross-connect equipment.

An international private line requires the lease of two matching national circuits for the provision of through service. Typically, the customer must deal with two different national carriers although, as discussed below, a number of joint marketing arrangements and carrier alliances now permit customers to provision whole circuits through a single carrier contact point. Customers pay a connection charge (though this is increasingly waived in competitive markets for all but the shortest contracts) and a monthly fee for use of private lines, but no volume charges.

The use of private lines by private corporations—as well as presidents and prime ministers—has a long history. The first private lines were installed soon after the telegraph was invented, and before public monopolies were created, by companies such as Reuters (a leading news wire service). Over the past two to three decades, the use of IPLs has spread rapidly as companies have sought reliable connections between remote computers.

For most of the 1980s, many TOs, especially in continental Europe and Asia, tried to persuade corporations to stop using private lines and use instead the TOs' public service alternatives, which included X.25 packet switching. TOs argued that IPLs were a crude historical legacy which made wasteful use of scarce capacity (since they often go unoccupied for long periods). In a digital age, they reasoned, where network capacity can be allocated flexibly, public service is both more reliable and more efficient.

In some countries such as Germany, the TO began to charge for volume and usage on leased circuits; Germany and one or two others also prohibited outright the transmission of voice on leased circuits, while most European and Asian TOs prohibited any breakout of voice—and

Box 2. Five Percent of the World's Telephone Traffic is Carried by Private Networks

How many minutes of international voice traffic travel over private networks, as compared to the public network?

We know the latter figure to a high degree of accuracy: totalling the statistics in this report we reach a total of 60.3 billion minutes for 1995. Resellers using IPLs (i.e., international simple resale (ISR) carriers), rather than carriers reselling switched minutes, probably account for another 800 million minutes. The bulk of ISR traffic travels to and from the U.K. or on the U.S./Canada route (see p. 19 below). However, calculating minutes of voice traffic on private lines used by private organizations is much harder.

Most suppliers don't know how their customers use private lines—and, worse, many network managers don't monitor line usage in detail. Nor are industry-wide statistics available on how "full" those lines are; though we know that private lines usually are not cost-effective for voice alone unless they are used three to five hours a day. But for IT managers, voice often "rides free" on networks installed to handle vital data traffic. Equipment can route voice over the private network when there is surplus capacity, but this is rarely measured in detail. Moreover, where voice is compressed to 8Kbps or less (as it routinely is on many private circuits), the crossover point for using a leased circuit may be much lower than three to five hours daily.

Lesser but significant problems include the absence of precise information on exactly how many private lines there are (see main article), and how many of these are used by private corporations.

Our estimate thus makes the following assumptions:

- *25,000 international private lines (whole circuits) in use by private corporations (out of a global total of 36,000—see Table 4), with an average capacity of 64Kbps (this takes account of the fact that there are a significant number of analogue lines with lower capacity and a small but important proportion with higher capacity; our margin of error on this figure is 10 percent either way);*
- *Five voice channels per 64 Kbps circuit, reflecting standard compression to 8 or 16 Kbps (the true figure may be anywhere between four and six channels in our view);*
- *Four hours average utilization per circuit, of which an average 1.5 hours is voice (the actual figure may be as low as one hour and as high as two hours);*
- *circuits are utilized 240 days per year.*

This yields the following calculation: $25{,}000 \times 5 \times 90 \times 240 = 2.7$ *billion minutes, or 4.5 percent of all telephone traffic (give or take one percent).*

This calculation does not exclude fax. As we note in the main article, the proportion of fax traffic in the international PSTN is thought to range between 30 and 60 percent, depending on the route. The share of fax traffic is much lower in private networks—no more than ten percent. Conventionally, fax traffic is routed even by large corporations on dedicated PSTN circuits because it is difficult for technical reasons to route it via the PBXs and multiplexers that feed into leased circuits.

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sometimes data—into the public network. But corporations stuck doggedly to their view that, in many situations, a private line the made most business sense.

The Demand for IPLs

Corporations lease international lines for three main reasons:

- First, if the volume of traffic between two points—two major corporate sites, for example—is sufficiently high, then it is cheaper to use a private line because there are no volume charges on private lines. Historically, this crossover point has been three to five hours a day, though it has varied. TOs have often raised prices to discourage IPL use. Conversely, others have lowered rates to encourage companies to route private lines through their TO's national hub, which may provide an opportunity for the TO to transit and refile (to off-net locations) a portion of the corporation's traffic.

- Second, corporations use private lines because they have historically been more reliable than switched connections (the service quality can be directly monitored and maintained), and for certain applications this has been paramount. Two examples are: the links between financial trading rooms, where failure can be disastrously expensive; and links between computers, which on many routes until this decade could only be realized reliably over private lines. For critical applications, users built meshed networks in which there were two alternate routes to key sites.

- Third, some applications simply cannot be operated over switched facilities. A good example is remote front-end processor (FEP) operation, whereby a front-end processor—which is normally situated within a few meters of a mainframe—is situated in another country and connected via a "channel-connect" facility. The bandwidth required exceeds anything that can be provided continuously by any dial-up services, and often the delays inserted by managed services are too great to ensure proper operation. For users, the benefits of operating a remote FEP include the cost reduction associated with the removal of mainframe computers in remote countries, and the economy of centralized IT control.

Table 2. Top Ten IPL Routes

Number of lines, all types of circuits; all estimates

Route	Lines
U.S.-Canada	7,000
U.S.-Mexico	1,500
U.S.-U.K.	1,500
U.K.-France	1,000
Germany-France	800
Germany-Switzerland	700
U.K.-Germany	700
U.S.-Japan	700
U.K.-Netherlands	650
Netherlands-Germany	500

Note: These estimates are for circuits of varying capacity (see also Box 5 on p 19 for 1995 data on 64 Kbps IPL circuits on selected U.S routes). Source: the Yankee Group Europe, 1996

Competition among equipment vendors such as Micom, NET, Newbridge Networks, Stratacom, Tellabs and Timeplex (now Ascom Timeplex) has generated a wider and wider variety of high quality equipment for economic utilization of private lines. Multiplexing equipment, for example, makes it possible for a user to obtain up to eight voice channels from a given 64 Kbps circuit. Corporations may now compress voice to 8 Kbps or less, lowering the crossover point at which it becomes economically attractive to shift traffic from the public network.

At the same time, however, the service offered by IPL suppliers has greatly improved. Many now offer guarantees on their half of the circuit, with stiff penalties if they are not met. BT, for instance, pays a rebate of 30 percent of the line cost if it is out of service for six hours or more per month. And the time for provisioning circuits, a big problem in the past, is gradually improving. IPL prices are falling too. The price of a 64 Kbps half-circuit has fallen about 30 percent in the past three years, and fell 30 percent in the previous three years as well; greater savings are possible if new discount schemes are taken into account (see Box 1).

As a result, private lines now are very widely used by major corporations: in a survey of 50 large users undertaken in mid-1996 for this article, the Yankee Group found that 54 percent were using IPLs; and among large international corporations, all were using IPLs. In a larger survey of 150 users in 1995, a similar proportion (51 percent) said they used private circuits.

We estimate that there are approximately 36,000 IPLs (whole circuits) in use worldwide by private corporations, totaling perhaps 2.2 Gbps of total capacity. As a proportion of all telecommunications capacity, this is relatively insignificant, representing approximately 5 percent of voice traffic (see Box 2). But for the corporations concerned, this capacity has been a vital asset in their effort to create more cost effective and more reliable communications among far-flung sites.

Indeed, according to suppliers and our own user survey data, many corporations are adding further sites to existing networks, or increasing the bandwidth used on exist-

Table 3. Corporate Demand for International Services (1996)

Based on YGE telecom manager opinion poll

1. How is your international voice traffic carried?	
Reseller	4%
Private Network	9%
IVPN	14%
PSTN	73%
2. How is your international data traffic carried?	
Public Network	16%
Managed Data Network Service	36%
Private Network	48%

Note: Figures represent average percentage of aggregate traffic, not percentage of users using each service. Source. Yankee Group Europe.

ing routes. As multinationals expand, traffic to remote sites increases, justifying the installation of private lines on cost grounds; elsewhere, the relentless increase in data traffic (typically 20 percent or more a year in the average corporate network) drives the need for more capacity on major routes.

Most large international corporate networks were based on 64 Kbps lines until very recently; now, the use of fractional T-1 and E-1 lines—unavailable on most routes until recently—has become widespread. A few major corporations are using full T-1 (1.544 Mbps) or E-1 (2 Mbps) lines. The Yankee Group estimates that there are about 200 to 300 T-1 or higher capacity IPLs in use today by private corporations. Where traffic justifies it, these lines can be quite cost effective: E-1 lines, for instance, which carry 30 64 Kbps circuits, are priced at nine to 15 times the cost of a 64 Kbps circuit, depending on the supplier.

Meanwhile, a very small number of corporations have made the move to even higher-speed lines, and others are considering it. This year, for instance, Hewlett Packard, a major corporate network operator (see Box 4), issued a request for tender for multiple T-1 capacity on the trans-Pacific route. However, few corporations can yet justify such high speed lines, and most of the demand at these upper levels is coming from Internet and other on-line service providers.

How IPLs Are Used

Table 3 shows the proportion of international corporate traffic carried by different TO services based on our survey of approximately 50 major companies.

TO estimates and our own data on the split between data and voice on IPLs is somewhat contradictory. It is clear that data predominates, but it is not clear by how much. Our own view is that about 65 percent of traffic by circuit occupancy is data, about 35 percent voice.

The most important routes for private circuits roughly track those for switched minutes (see Table 2). For example, routes between the U.S. and Canada, Mexico and the U.K. occupy the top three positions just as they do for switched minutes.

However, there are some important quirks. As Table 4 shows, for example, Germany and France lag well behind the U.K. in total circuits installed, though Germany generates significantly more public international traffic than the U.K. The reasons for this are primarily historical; the U.K. has always been an important hub for international private line traffic; it is the most important financial center in Europe; and the use of private lines has never been discouraged there, as it was in many continental European countries. Prices have generally been much lower too.

In other cases, a concentration of large corporations or financial services companies makes for a large market, as in Switzerland. Countries like Belgium are important hubs and transit points. Another obvious difference is that private line traffic is business traffic, whereas public

Table 4. Estimated IPLs, by Country

IPLs for all users as of January 1996

Country	Lines
Australia	1000
Belgium	2200
Canada	8000
Denmark	500
France	3500
Germany	6000
Hong Kong	1500
Ireland	600
Italy	1600
Japan	1800
Netherlands	1400
Singapore	1000
Spain	1000
Sweden	750
Switzerland	1700
U.K.	11000
U.S.	17000
Rest of World	10450
Total	71000

Note: Data are for all circuits leased to private corporations and resellers, including analogue. Higher speed circuits (eg 512Kbps, 2Mbps) are counted as one circuit. Note that total number of whole circuits is approximately 36,000, since two half circuits are required to provide through service (see also Figure 4 at p xiv for 1995 data on 64 Kbps IPL circuits on selected U.S. routes). Source: Yankee Group Europe

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Table 5. Major IPL Suppliers

Estimated 1995 Earnings

Carrier	IPL Earnings (US$)
Cable & Wireless	200m
AT&T	200m
MCI	150m
Deutsche Telekom	130m
Stentor	125m
WorldCom	120m
KDD	110m
BT	110m
France Telecom	65m
Sprint	45m

Source: Yankee Group Europe, 1996

network traffic measures business and residential traffic; where access to IPLs is limited, more business traffic will flow over the public network.

IPL Market Trends

Despite the evidence that the demand for IPLs is still rising, the market is a mature one and, relatively speaking, it's on the slide. The long effort by suppliers to woo users onto public or "virtual public" alternatives is at last beginning to pay off. Carriers are lukewarm about private lines for a variety of commercial reasons, as well as the engineering prejudices mentioned above.

First, the flat rate tariffing used for private lines runs counter to TO prejudices in favor of usage-based tariffing. When traffic is rising and the meter is running, TO's reason, tariffing by use equals big margins. A related reason is that IPL traffic bypasses the accounting rate system. Thus, instead of receiving a per minute charge for landing traffic, the TO only receives a flat monthly fee. That is why, of course, TOs have tried to limit customers from reselling the capacity of IPLs to third parties for switched services (known as International Simple Resale or ISR) so as to stem a wholesale diversion of settlement revenues.

Second, most suppliers believe that the margins on ordinary IPLs could soon decline to a point where it will be difficult to make much money. The reason: it's hard to differentiate or add value to such a simple product. "Private lines are as close to a commodity as you can get in telecommunications," a senior manager with Cable & Wireless told us.

On most routes, margins are actually very good, because providers still monopolize or effectively control the installation of cross-border capacity. But on the biggest and most competitive route, across the Atlantic, where there is considerable excess undersea cable capacity, margins are already under pressure. Although no TO will reveal financial figures, several told us that if prices dropped much further, they would be making a loss on IPLs, especially at higher speeds. That claim must, perhaps, be taken with a pinch of salt.

According to the U.K. regulatory agency Oftel, the estimated annual cost to BT of providing 2Mbps circuits for wholesale use is £160,000, but this takes into account all BT's historic costs; for a new operator self-providing circuits by buying ownership rights in a cable (so-called IRUs), Oftel estimates the cost would be £94,000 (see Box 3).

In the table, Oftel calculates the cost in two ways: (1) the cost to a new operator of self-providing a circuit by buying an IRU, plus maintenance costs and local access circuit costs; and (2) the cost to BT based on fully allocated costs, overheads and so forth.

By comparison, BT's retail price for the circuit without any discounting is £244,000 (see also Box 3). This suggests there is still quite a bit of room for prices to fall, especially as new players and infrastructure providers begin to size up the market.

All three major alliances (Concert, Global One and Unisource/Uniworld) as well as Cable & Wireless have launched "managed bandwidth" offerings, in which they take responsibility for end-to-end supply of leased lines. In principle at least, this removes the administrative hassle from the user of having to buy from two or more suppliers. Most managed bandwidth providers also offer some level of guarantee on provisioning time and circuit up-time, with more or less severe financial penalties if they fail to deliver.

TOs are not keen on these offerings and often don't advertise them. Apparently it's hard to make much money supplying managed bandwidth. Suppliers must lease the access line wherever they don't directly supply such lines, usually at retail prices, and this often wipes out profit on the line. Some local operators deliberately structure pricing to discourage managed bandwidth providers, whom they see as a threat. Carriers under pressure from competitors have in many cases widened the differential between 64 Kbps and 2 Mbps circuits so that it's more difficult for competitors to buy wide band circuits, split them up for customers and still make a profit.

In 1989, before competition began in Europe, the ratio between 64 Kbps and 2 Mbps circuit tariffs was about 1:10; today it is about 1:12, even though most cost data suggests that the ratio should be falling. Making matters worse, the belief among suppliers that they could charge more for managed bandwidth than for leased circuits has been largely proved wrong. Most users will not pay more for managed bandwidth, and according to Global One, many actually want to pay less.

Among customers, meanwhile, there is a growing desire to move to public offerings, driven in large part by senior management pressure to outsource everything that is not considered core to the business. This means that there has been strong pressure on telecommunications managers to justify the existence of a private network, which requires staff and management; in the Yankee Group's 1995 user survey, we found that only one-quarter of users said they would definitely not outsource their corporate network.

Whereas leased lines are effectively neutral as to traffic type, managed or public services are usually specifically designed for particular types of traffic. The next two sections, therefore, look separately at developing demand for voice and data public network alternatives to IPLs.

The Rise of Managed Data Services

In data communications, there has already been a strong move to managed data offerings, and we expect that to continue. Our 1996 survey found that users expected to move away from private lines and towards managed data offerings, confirming a trend shown in a similar survey taken in 1995.

Suppliers say that the trend is a long-term one. Cable & Wireless, for instance, estimates that, while its revenue from IPLs has grown by about six percent per annum over the last six years, revenue from managed data offerings (including X.25, IP, and frame relay) has grown by 30-40 percent per annum. Other suppliers report similar changes.

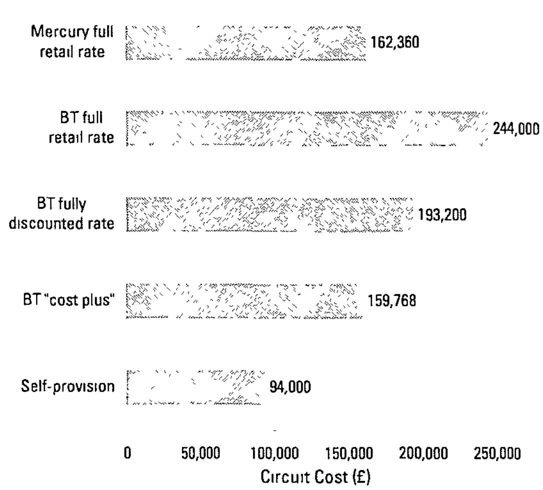
There are several reasons why the move to managed offerings is happening first in data communications:

- The market was deregulated earlier. In most of Europe and Asia, deregulation of data communications service took place at least five years ago, meaning that the supply industry (and its offerings) is now relatively mature. For example, there are at least a half-dozen operators offering international frame relay services that reach ten or more countries (AT&T/Unisource, CompuServe, Concert, Global One, IDB Worldcom, Infonet).

- The pattern of corporate traffic and demand is changing. In the past two years, the rapid spread of client-server networks and LANs has spilled over into the wide area where it is now the main source of new demand (see also Box 5 regarding the rise of traffic in SITA's global network). This type of traffic differs in two ways from traditional data traffic. First, it is more "bursty" (i.e., there are more peaks and troughs in bandwidth demand) which means that it is not very well-suited to leased lines where capacity is permanently assigned.

Second, wide area networks (WANs) are less hierarchical

Box 3. Oftel's Cost Equation



Data on the true cost to operators of providing telecommunications services is notoriously controversial, since cost data is often not available and few economists agree on how costs should be allocated.

Nevertheless, virtually everyone agrees that the cost of supplying capacity is still much lower than the price charged.

One of the few independent agencies that has attempted to assess the true costs is Oftel, the U.K. regulatory agency. As part of a consultative document issued in July 1996, Oftel came up with the estimates shown here.

Oftel has proposed that the second cost calculation or "BT cost plus" wholesale rate be available to relevant connectable systems. These systems include resellers and managed network providers but not ordinary private line carriers.

Note: BT "cost plus": includes fully allocated costs, relevant overheads and an (unspecified) rate of return on capital employed. Self-provision based on IRU cost + maintenance + retail 2 Mbps backhaul circuit charges (i.e., national extensions). Source: adapted from Oftel data.

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Box 4. The World's Largest Private Networks

Who has the biggest IPL networks and how big are they? The problems start with definitions—and there are as many as you like. What counts as a private network? SITA is a consortium that sells its services back to its airline owners. SWIFT has a similar identity in the financial services industry. In the end, we included in the listing here only those companies that built networks for their own use. SITA, however, which runs the largest non-TO network, is profiled in Box 5.

And just how do you define "biggest"? One way is by measuring traffic, but few users have anything but the most rudimentary idea of how much traffic they generate, or whether it's voice or data. And different networks (e.g. circuit and packet switched networks) measure traffic in different ways (in this case, by minutes and data segments, a variable and rather esoteric measure). Indeed, poor auditing of network traffic is one reason why corporations often find it difficult to issue outsourcing tenders. Often there may be good information locally, but it is not consolidated globally.

Budgets are a more objective measure which usually yield more reliable data—but there are almost insuperable obstacles here too. The biggest is deciding what's included and what's excluded. Do you include some or all domestic communications or segments (some corporations don't segment that out)? And all PSTN communications? What about equipment and depreciation? Even if you can establish an "objective" measure, most companies have their own way of assessing spending, and won't have the figures you want. Moreover, many regard telecoms spending as a commercial secret.

Taking into account the above reservations, the Yankee Group drew up a tentative list of the 30 largest IPL networks using the following information:

- YGE aggregate data on corporate global telecom spending by industry sector and size;
- published information on spending by sector and size;
- published information on IT spending by individual companies;
- published information on major multinational companies (i.e., identifying how "multinational" or transnational they were);

Principal secondary sources were *Communications Week, Communications Week International, Datamation, Information Week* and the United Nations Conference on Trade and Development (UNCTAD). Some additional information was drawn from the U.K. regulatory agency, Oftel, and from European Commission databases. Thus this list is not the 30 biggest private network operators; but we do think it includes the top 12 spenders.

How extensive are their networks? Some are very extensive. In the Yankee Group's 1995 User Survey, we asked 143 users how many countries were connected to their private wide area network. Of the 75 who actually had an international WAN, 19 connected 20 or more countries, and six connected 50 or more. The largest connected 100 countries.

Such networks don't come cheap. With 64 Kbps IPLs averaging approximately $30,000 per annum per half-circuit, a large private network with aggregate capacity of, say, 10Mbps will cost around $10 million; management, manpower, multiplexers and other gear will at least double that figure.

The largest network owners, including all those on this list, spend at least $50 million a year on telecommunications, of which at least one-quarter is spent on IPLs.

It's worth noting that all these companies are dwarfed by the largest customer for international bandwidth, SITA. They will also likely be dwarfed in the near future, at least in terms of bandwidth, by Internet service providers, who are the fastest-growing consumers of international private lines.

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Box 4. (continued)

Who is most likely to have a big private network? Our list can be divided into five major categories:

Major financial services companies—As we have noted elsewhere, these companies drove the early demand for private circuits, and they remain the most important category of IPL customer. Anecdotal information suggests that Citicorp and American Express, for instance, have among the largest international private networks. However, their importance has declined relative to other sectors:

IT companies—It's perhaps not surprising that IT companies should feel comfortable with large computer networks. Companies like Hewlett Packard, IBM and Siemens run among the very largest corporate networks; all three are almost certainly among the top dozen private network operators worldwide.

Multinational conglomerates—A good example here is ABB, a company that drew together the disparate elements of Sweden's ASEA and Switzerland's Brown Boveri. ABB spends close to $300 million on communications per annum.

Oil companies—Oil companies have large networks partly by virtue of their sheer size, but also because they are highly globalized. As a proportion of revenues, their spending on telecommunications is generally no higher than average, but their dominance of the upper echelons of the *Fortune 500* ensures their appearance here.

Automotive companies—Again, size and global reach are major factors here. Some auto companies such as Ford have consciously globalized functions such as design engineering, greatly increasing network traffic.

Some companies that might have been expected to creep into our list, such as the giant consumer goods concerns Nestle and Unilever, are absent because they do not operate private networks (both companies outsourced several years ago).

Also missing are the world's major airlines, which of course depend heavily on SITA for their network needs.

30 Major International Corporate Networks

ABB	Switz./Swed.
Alcatel	France
American Express	U.S.
BP	U.K.
Citicorp	U.S.
Daimler Benz	Germany
Deutsche Bank	Germany
Digital Equipment	U.S.
Dow	U.S.
Du Pont	U.S.
Elf	France
Exxon	U.S.
Fiat	Italy
Ford	U.S.
General Electric	U.S.
General Motors	U.S.
Glaxo	U.K.
Hewlett Packard	U.S.
HSBC	U.K./H.K.
IBM	U.S.
Merrill Lynch	U.S.
Motorola	U.S.
Philips	Netherlands
Schlumberger	U.S.
Shell	U.K./Neth.
Siemens	Germany
Texas Instruments	U.S.
TRW	U.S.
UBS	Switzerland
Volkswagen	Germany

Note: This listing is intended to be indicative, not definitive We believe that the top 12 private networks are all on this list, but do not claim that it includes all the top 30 private networks. Source: the Yankee Group Europe.

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than traditional dumb terminal networks that drove earlier demand. In such a network, data from one or several terminals is collected and transmitted to some central site for processing, and is both predictable and controllable. Whereas traditional networks have a star topology linking a head office or data centre with subsidiaries which is well-suited to leased lines, newer networks have many more point-to-point routes which are less heavily loaded—lending themselves to public solutions.

In the last two years, demand for frame relay offerings has been especially buoyant. Frame relay is a variant on packet switching which is beginning to replace the public X.25 services widely used for international data communications, especially in Europe. Frame relay gives users a so-called "Committed Information Rate" (e.g., 64 Kbps) for little more than the price of a leased circuit solution, but at off-peak periods, users may get a lot more than 64Kbps. IPL veterans say that actual throughput is not as high as advertised, and say that it's not as

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Box 5 -The Big Network: SITA's 1200-Node Monster

The SITA network is a network of superlatives. With a total of 1200 nodes in 220 countries, it is the world's most extensive private network, and with an aggregate network capacity of over 350 megabits per second, it is also probably the largest.

More surprisingly, it may also be among the fastest-growing: in 1995, network traffic quadrupled, and in 1996 it was expected to triple—an extraordinary rate of growth for such a large and relatively mature network.

Owned by the world's airlines and headquartered in Paris, the Société Internationale de Télécommunications Aéronautiques (SITA) was constituted as a cooperative in 1949 to meet the airlines' growing need for international communications. It has 600 airline members, and had a turnover in 1995 of over $1 billion.

Huge Growth

Today, network managers are grappling with a growth in demand that took nearly everyone by surprise. In the early 1990s, network traffic growth per annum was a relatively steady 30-50 percent; then in 1994, demand doubled, and it reached 400 percent in 1995. It's a testament to the skill and experience of SITA's management that it did not fold under the pressure; careful use of compression and better network optimization (achieved in part through the use of more "intelligent" routing equipment) meant that capacity requirements only doubled, for instance.

The key reason for traffic growth is the same for SITA as for everyone else: the spread of client-server LANs and the proliferation of bandwidth-hungry applications running over them and out into the wide area. Originally, the SITA network was unique, carrying a mix of proprietary airline protocols and applications that had their own particular characteristics. Now, the network looks much like everyone else's—except, of course, in its reach. Little voice is carried, but following deregulation on major routes, even that is now changing.

Meanwhile, the network has been steadily snaking up river and inland; where before it was largely a one-node-to-one-country affair, the number of nodes has tripled over the past five years, and in the past 12 months, SITA has taken over large domestic networks previously operated by British Airways, Lufthansa (Germany) and American Airlines, among others.

For those running the network, therefore, life has been dominated by the need to get new capacity into service as quickly and reliably as possible. Between the 15 major nodes in the network, capacity is now at least 1.544 megabits per second (known as T1); most other links are now digital 64Kbps or multiple 64Kbps lines, though certain less-developed regions—most of Africa, for instance—are still largely analog.

With capacity demand eating up more and more of the operational budget, a major objective of SITA has been to achieve better utilization of existing lines. Its working objective is that at any time 70 percent of circuits will be "normally loaded"; this is defined as 40-60 percent full on average, meaning they will be fully loaded at peak periods. In mid-1996, 60 percent of lines were normally loaded. Given that network traffic has become inherently more unpredictable and "bursty" due to the supersession of airline protocols by generic LAN applications and protocols, that is an especially noteworthy achievement.

Growing Cost

SITA does not publish figures on the cost of its network, but a conservative estimate would be that it costs up to $100 million for lines alone; with 5,000 staff worldwide, ongoing operational costs will be higher, and it is also spending heavily on new capital equipment The workhorses of the network are DPN100 packet switches from Nortel, which also provides DMS 100 voice switches and Magellan switches. Cisco provides routers.

In an ever-changing network environment, SITA often appears a beacon of stability; but under pressure from its owners it's being forced to change fast. Because of the replacement of airline protocols by generic communications and computer protocols, it is now implicitly competing against every other provider of data communications services—one reason why it decided to fight back and start providing services to non-airline users itself. In 1990, it established a subsidiary, Scitor, which sells services to all comers, including, most recently, VPNs for voice. Though Scitor remains small, it is growing very fast Recently SITA received a $300 million cash injection from Morgan Stanley, helping to boost its commercial expansion.

Box 6. Westinghouse: A Middle Sized Corporate Network

Ten years ago, the giant American energy and manufacturing conglomerate Westinghouse had a single 9.6 Kbps private line linking its U.S. and European offices. In the European morning, when U.S. staff were still in bed, it carried data between IBM mainframes, along with a little e-mail. In the afternoon, it switched to voice.

Today, the company has ten sites connected at speeds ranging from 64 Kbps to 256 Kbps, making it a fairly typical medium-sized international private network. Traffic is balanced approximately 50-50 between voice and data, with data applications dominated by e-mail, groupware, Internet access, and various engineering applications, often with a high graphical content.

Each big project (e.g., a new power station) creates a large graphical library that must be replicated at several sites, requiring that large files be routinely sent to synchronize these libraries.

The Westinghouse network has followed a classic trajectory; higher speed analog links were followed in 1989 by the first digital circuits, which were exploited using time division multiplexers that offered a lower cost per bit.

Like many other major corporations, especially those based in the U.S., Westinghouse had simply extended a model that had been widely established in its domestic network, in which newly available digital leased lines were rented to improve the reliability of data transfer and, in some cases, cut the cost of voice communications between major corporate sites. With traffic largely flowing between the two headquarters sites in Pittsburgh and Brussels and out to regional offices—a classic "double star" network—the use of leased circuits was especially attractive.

Furthermore, leased circuits became increasingly reliable, which was a key concern for vital corporate data traffic. Westinghouse looks for 99.7 percent reliability on its international links, equivalent to 15 minutes loss of service or less per month; it rarely achieved that in 1990, but today it routinely does.

The relatively smooth evolution from analog to digital was disrupted by the LAN and client-server computing explosion of the early- to mid-90s which left Westinghouse struggling to keep up with the surge in demand for wide area bandwidth. Client-server applications and files washed over into the wide area networks, often in ways that could not be anticipated. For example, new releases of software such as Microsoft Mail and cc:mail made it much easier for users to attach large "documents" (which could in fact be anything from a corporate manual to a large binary image file) to a short e-mail message, leading to big increases in wide area communications wherever e-mail was already widely used—as it was at Westinghouse. New related applications like Lotus added to the "attachment explosion"; and an imminent decision to allow wider access by Westinghouse staff to the Internet in late 1996 was expected to trigger yet another bandwidth explosion.

Like others, Westinghouse is making maximum use of compression techniques to try and get the most out of existing bandwidth. It compresses data at a ratio of about 3 to 3.5:1, and runs voice at 8 Kbps (compared to 16 or 32 Kbps in most international public networks).

At the same time, the bandwidth surge has been a key driver for it to examine alternatives, especially frame relay. On many routes, leasing more capacity means doubling capacity (eg from 64 Kbps to 128 Kbps) with a big hike in cost. The relative lack of granularity in highly expensive international bandwidth (even worse higher up the scale where, e.g., users must usually leap from 2 to 34 Mbps) has forced users to look at alternatives. Westinghouse implemented its first frame relay link (from Infonet) between its Pittsburgh head office and Brussels last year.

On the voice side, the company may make greater use of virtual private networks (VPNs) Westinghouse is continually adding new sites to its corporate network. As well as the 10 sites linked to the private network, Westinghouse has a further 10-12 international sites which must also be connected. With new digital network services, such as VPN, it's much easier to route and consolidate traffic in ways that bring bigger discounts.

More unusually, Westinghouse sells systems integration on its network to third parties, and has created a separate company, Westinghouse Communications, to sell services both internally and externally. In the U.S., Westinghouse already carries more external than internal traffic on its network, but in Europe it has only a couple of token contracts, basically extensions to domestic U.S. contracts. Westinghouse's decision to sell services does not seem to affect its attitude to the question of outsourcing bandwidth, where it expects to do more business. Rather, it wants to customize its offerings to compete with the big players.

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reliable. But for new users especially, frame relay is proving hard to resist.

Virtual nets: virtually here?

On the voice side, the move to public solutions is much less pronounced. The market is only just being deregulated. Consequently, supplier offerings are not mature. Typically, these offerings do not take in many countries. Soundings taken by the Yankee Group Europe have shown a steady trend away from the PSTN, but no clear trend to VPNs.

Yet it's clear that virtual private networks or resold switched minutes—the distinction between the two is often hazy—are going to be the solution of choice for most corporations in the next few years. This is largely because of cost: the price-per-minute is falling rapidly under pressure from competition, shifting the crossover point and making it more difficult for corporations to justify the use of private lines for voice. Initially, most international VPN suppliers actually priced their offerings above the retail PSTN rate (there were few takers). Now, good negotiation will likely yield discounts of 40 percent on the PSTN, or even more.

On the transatlantic route, big users often get a price of 15 cents a minute on VPNS between the U.K. and the U.S., against a published retail rate of 60 cents a minute. In contrast, the price per minute of compressed voice traffic on a fully loaded 2 Mbps circuit between the U.S. and the U.K. is in the region of $0.06 per minute. (This estimate is derived from the current 2 Mbps prices quoted by major suppliers, see Box 1.) To that, managers must add the cost of breakout at either end, which may add another 15 cents, and the cost of managing the circuit.

On the face of it, therefore, it may already be impossible to justify a 2 Mbps transatlantic circuit purely for carrying voice traffic. Since many corporations are already moving (or thinking about moving) data onto public services, the economics of private voice networks become less compelling.

On other routes, though, voice-over-IPL still makes a lot of sense for some companies, and especially where the networks already exist and have been very well-optimized. Suppliers report great difficulty matching the price-per-minute achieved in the best-run corporate voice networks, and often end up only winning business for peripheral sites.

More importantly, perhaps, much private line voice is traveling on networks set up originally to carry data. Modern multiplexers can dynamically route voice on the private network if the volume of data is low and, in this sense, the voice is said to be carried free—a somewhat misleading view, but enough to make an across-the-board move to VPNs more complex.

Conclusion

Despite the many factors driving corporations to put more of their international traffic on public network offerings, the market among private corporations for IPLs is stubbornly buoyant.

Inertia is one major reason: while international net newbies go for managed offerings and existing net managers do the same when they are bringing up new routes, the old networks are there, are reliable, are often highly cost-effective, and there seems no good reason to tear them down. When demand increases, managers often find it easier to add another circuit, boosting the installed base of lines. And the capital equipment may not have been fully depreciated, making it harder to justify changing the financial structure of the corporate network.

Private lines are also often still justified for the same reasons that they were justified 20 years ago: they are often cost-effective and very reliable. So long as that continues to be the case, corporations will continue to use them.

As the great sea of bits flows back and forth between public, private and various intermediary networks, the one certainty is that no orthodoxy lasts forever; and in the febrile world of networking, forever means more than five years. This year, for instance, U.K. and U.S. authorities relaxed rules on the ownership of international circuits between the two nations, making it possible for new operators to lay their own cables or to acquire IRUs as needed. In continental Europe, too, new legislation this year ended the TO monopoly over construction of infrastructure. The potential savings from building it yourself are vast: it costs $250,000 to buy outright a 2 Mbps half-circuit in a transatlantic cable. It costs at least as much to lease one for a year. You don't need a degree in mathematics to see the opportunity.

For the time being, public network solutions are clearly on the rise. Yet, if new services, technologies and ownership options emerge, this paradigm could shift, and quickly. Remember, you read it here first. ◆

A PRIMER ON INTERNATIONAL SIMPLE RESALE

The End Game Has Barely Begun

by Gregory C. Staple

International Simple Resale (ISR) is an obscure term even in the telecommunications industry. Yet, since 1992, when the U.S. and the U.K. first authorized ISR, it has become a powerful strategic weapon for carriers in a complex game for traffic and revenues.

For example, using ISR circuits, a U.K. carrier, such as Mercury, can pick up and land traffic directly in the U.S., bypassing current correspondents, such as AT&T and MCI. But these U.S. carriers can retaliate in kind by using their own ISR facilities to enter the U.K. Thus, ISR may not immediately lead to more competition; major carriers, each armed with ISR, may act cautiously, first launching ISR forays to probe their counterparts' reactions. To understand the context for this new game, some background may be helpful.

What is ISR?

Broadly defined, ISR refers to the wholesale purchase 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 public switched telephone network (PSTN) at one or both ends of the international route. ISR thus may be defined simply as an IPL interconnected to the PSTN at one or both ends.

Customers can usually access an ISR carrier's service on a dial-up basis. But if a customer has a substantial volume of international traffic, it may hire a domestic leased line so as to connect directly to the ISR carrier's national switch.

ISR carriers are often confused with companies reselling international switched services. Although some ISR carriers may also be switched resellers, there are several important distinctions:

• An ISR carrier pays a flat monthly rate for its transmission capacity (i.e., the IPL). This rate typically reflects the cost of acquiring one-half of the IPL from a carrier in Country A and a "matching" half circuit from a carrier in Country B. (Due to national licensing rules, few international carriers own end-to-end "whole" circuits.) In contrast, a carrier reselling international switched services does not have its own dedicated capacity; it resells the switched service of a facilities-based international carrier, typically acquiring the service in bulk under a volume-sensitive discount.

• ISR carriers do not pay settlement charges to the underlying facilities-based carriers. Traffic handled by ISR carriers therefore bypasses the international accounting rate regime. (For an explanation of this regime, see Box 1. Current accounting rates on major routes are listed in the tables following this essay.) In contrast, the international traffic handled by switched service resellers, such as call-back companies, is subject to international settlement payments because this traffic is bundled with the switched traffic of the underlying carrier for foreign termination.

• ISR carriers are able both to originate and terminate international traffic because they can interconnect their IPLs at both ends. By comparison, switched resellers can only originate service, although some switched resellers may operate in more than one country and thus appear to offer two-way services.

The Economics of ISR

ISR is economically attractive to two types of carriers: (1) entrepreneurs which cannot acquire their own international facilities for regulatory or economic reasons (e.g., if the government will not issue additional facilities-based international licenses); and (2) incumbent facilities-based carriers, especially those with a payment deficit to major correspondents (i.e., carriers which send out more traffic than they receive) (see Table 1).

For entrepreneurial carriers, ISR is primarily an arbitrage business. The profitability depends upon the ISR carrier's ability to exploit the differential between the current retail prices for international telephony and the price of the underlying components—that is, the IPL circuits plus the domestic access charges. The larger the price spread, the greater the ISR carrier's potential profits (see Box 2). Regulation of IPL prices and domestic access charges are thus of prime importance to ISR carriers who live in constant fear of a "price squeeze."

The economics of ISR are not so clear cut for an incumbent facilities-based carrier. ISR provides such carriers an opportunity for reducing foreign settlement pay-

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Box 1. Accounting Rates and How they Work

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 rate is agreed per minute for landing traffic in either direction 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.

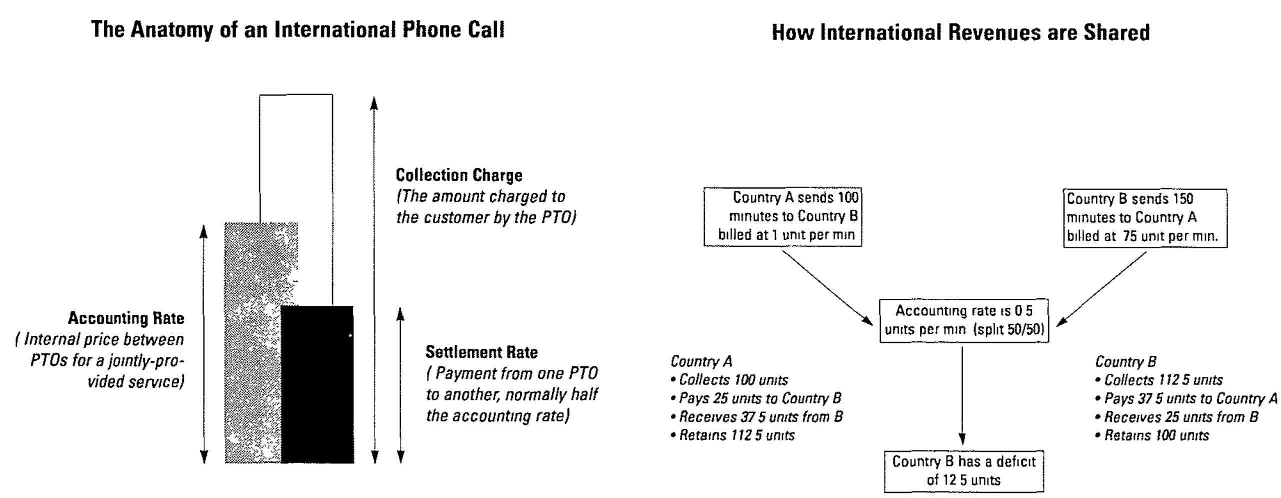
2. On any given route, one carrier pays settlements to another carrier only to the extent that there is a traffic imbalance—that is, one carrier has terminated a greater volume of telephone minutes than the other carrier. The originating and terminating carrier usually divide the accounting rate 50/50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

5. Carriers which have relatively lower collection charges (often due to the competition from other carriers) and a net traffic deficit are dissatisfied with the current accounting rate regime: it tends to subsidize high cost monopoly carriers at the expense of lower cost carriers and end-users from competitive regimes. That is also why carriers with a net traffic outflow tend to favor ISR. If ISR is legal, such carriers can land their traffic overseas without paying foreign settlement charges. Some carriers which dislike the status quo also want the right to establish their own foreign affiliates so that they can provide end-to-end service and "settle" with themselves.

Figure 1. Accounting Rate Monetary Flows



Note: This box adapted from *Direction of Traffic 1996* © ITU/TGI

Box 2. Sample Break-Even Calculation for ISR Carrier

ISR Route	IPL Capacity	IPL Cost Origin. End[1]	IPL Cost Term. End[1]	IPL Cost/Min.[2]	Switch Term. Cost /Min.[3]	ISR Cost/Min.[4]	Téléglobe Tariff/Min.[5]
Canada-U.K.	E-1 circuit (30x64 Kbps)	$35,000	$42,699	$0.052	$0.023	$0.075	$0.24
Canada-Australia	766 Kbps	$42,800	$52,374	$0.157	$0.044	$0.201	$0.42

Note: All figures in Canadian dollars (as of September 1996, C$1 00=US$0.73).
1. Prices before discounts.
2. Based on 50,000 minutes per 64Kbps circuit per month and assumes 5 voice paths per 64Kbps circuits
3. U.K. and Australian switched terminating cost/minute figures are based on BT and Telstra tariffs converted to Canadian dollars and an estimated distribution of traffic by time of day and destination.
4. Local access and contribution costs are not included as they are common to both ISR and GAT scenarios
5. The Téléglobe Global Access Tariff (GAT) provides a wholesale switched rate for large customers and resellers. Tariff here is based on a GAT rate of $0 217/minute; a surcharge of $0.20/call, and a diversity discount of 1% An average call duration of 7.5 minutes/call was used.

Source: Bell Canada, Téléglobe

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ments but may provoke carriers' foreign correspondents as well as its domestic competitors. Thus, for incumbent carriers, ISR may be characterized as a non-cooperative game where the welfare of each carrier is linked; information about other player's preferences is limited; and hence the optimal strategy and payoffs are not easily calculated in advance.* This has made most carriers careful in playing the ISR game, with many preferring merely to mirror the moves of their principal competitors (i.e., to adopt a "tit-for-tat" strategy).

Learning the Game

A numerical example may clarify the reasons why most incumbents have been reluctant to take a more aggressive tack towards ISR. Assume, for instance, that in 1995 Incumbent #1 in Country A sent 100 million minutes to Incumbent #2 in Country B and received back only 75 million minutes, generating a net deficit of 25 million minutes or $12.5 million (i.e, the accounting rate was $1 and the settlement rate was $0.50). Assume also that Country A and B both permit ISR, and that there is at least one other incumbent in each country.

In 1996, if Incumbent #1 decides to send 25 million minutes to Country B over ISR facilities, thus bypassing the accounting rate system and clearing its deficit, Incumbent #2 might respond by doing likewise, in which case the deficit would remain the same.

Alternatively, Incumbent #2 might retaliate by shifting a greater volume of outbound traffic to ISR facilities; routing traffic to a competing carrier in Country A; or by establishing (or buying) its own affiliate in Country A so as to "self correspond." To make things even more complex, Incumbent #2 also could seek to divert Country A's inbound traffic from Countries C, D and E via its own ISR facilities, thus depriving Country A of inbound settlement payments from third countries and worsening its current deficit situation. (There are non-traffic related countermoves that many carriers could initiate, of course.)

Table 1. Who Cares Most About ISR?

Estimated Balance of Settlements for Public Switched Services (1995)

Traffic in millions of minutes and settlements in millions of US$

Country	Traffic Surplus (Deficit)	Settlement Surplus (Deficit)
Argentina	120	85
Australia	n.a.	(25)
Brazil	176	135
China	n.a.	480
Germany	(1266)*	(801)
Hong Kong	(93)	(78)
India	464	254
Japan	(384)	(151)
Korea	115	110
Mexico	1164	444
Philippines	517	235
Poland	268	111
Portugal	241	148
Russia	161	183
Saudi Arabia	n.a.	(135)
Singapore	n.a.	(41)
Sweden	n.a.	(40)
Switzerland	(339)	(135)
Turkey	331	173
U.K.	5	(158)
U.S.	(8623)	(4500)

*Data for 1994

Note: Settlements based on estimates in *Direction of Traffic 1996*

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* For a general introduction to cooperative and non-cooperative games, see H. Scott Bierman and Luis Fernandez, *Game Theory With Economic Application* (Addison-Wesley, Reading, MA, 1993).

Faced with such scenarios, most countries have adopted some basic legal ground rules for ISR to make the game more manageable. These rules typically have been designed to reduce the risk for incumbent carriers subject to potential competition from foreign-affiliated ISR providers.

The Law of ISR

The legal regimes for ISR fall into two main groups: "protectionist" and *laissez faire*. (see Box 3). Protectionist countries typically require prior authorization for ISR carriers or permit ISR service only on those routes where "equivalent" opportunities exist at the foreign end. This group of countries currently includes the U.S. and Canada. The free market group, which includes Australia, New Zealand, Sweden and the U.K., permits ISR carriers to enter the market upon completing a simple notification process (the U.K. requires a license) and allow service on any route even though similar opportunities may not exist at the foreign end (i.e., a company may connect an IPL with the public network at one end only, known as "one-ended ISR"). Some countries, notably Denmark and Finland, fall somewhere in between these two regimes.

Hubbing rules for ISR also distinguish the protectionist and *laissez faire* camps, although the line is more blurred. As used here, hubbing refers to the indirect routing of switched traffic from Country A to Country B using ISR facilities connecting Country A to a third country where traffic is landed and then refiled to Country B either via the PSTN or another ISR link.

Box 3. Legal Rules for ISR in Selected Countries

Country	Entry	Foreign Ownership	Hubbing
Australia	Requires enrollment with Australian Telecommunications Authority (Austel) under the International Service Providers Class License (ISPCL). One-ended and two-ended ISR permitted without "equivalence" test but Austel retains power to intervene where a foreign-affiliated ISR carrier is misusing its market power or offshore regulatory status to substantially lessen competition.	No limits.	No restrictions but subject to Austel oversight.
Canada	Letter notification required to Canadian Radio-television Commission (CRTC) ISR permitted only to countries providing "equivalent" opportunities (i.e., only two-ended ISR is lawful) but CRTC does not review equivalence. Facilities-based local exchange carriers (i.e., Bell Canada and other Stentor companies) may not provide ISR but policy is under review.	No limits.	Only with the consent of all concerned parties (i.e., hub and destination countries). Policy under review.
Sweden	Open entry. License only required from the National Post and Telecom Agency (NPTA) if resale activity is of a "considerable extent" There is no "equivalency" requirement, i.e., one-ended and two ended ISR is lawful.	No limits.	Unlimited
U.K.	Requires grant of Public Telecommunications Operator (PTO) license by Department of Trade and Industry (DTI). Prior "equivalency" rules lifted in June 1996 so that ISR is now permissible on any route, but government retains power to prevent abuses by foreign-affiliated ISR carriers. Where foreign carrier has a monopoly, proportionate return is required for ISR and non-ISR traffic; parallel accounting rates are also required on such routes.	No limits.	No limits but government retains power to intervene to prevent discriminating practices.
U.S.	Requires prior authorization of Federal Communications Commission (FCC) under Section 214 of the Communications Act. Authority granted route-by-route to countries where Effective Competitive Opportunities (ECO)—i.e., substantially similar opportunities—exist. Thus, one-ended and two-ended ISR only permitted to countries meeting ECO test.	No limits, but foreign affiliated ISR carriers must show that they lack market power to serve home country.	Switched hubbing only, i.e., traffic from U.S. to Country B may be routed via ISR facilities in Country C provided it is refiled to Country B via Public Switched Telephone Network (PSTN) in Country C and not via an IPL.

Note: At September 1996, ISR was also lawful, in principle, in Denmark, Finland, Germany, the Netherlands and New Zealand, subject to local licensing requirements

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Box 4. The Impact of ISR: Carriers, Traffic and Accounting Rates

Country	Number of ISR Carriers (6/96)	1995 Total Outbound ISR Traffic (million minutes)	Telephone Accounting Rate Per Minute (SDR)		
			Route	Before (1991)	After (1995)
Australia	> 50	40-80	AU-U.K. AU-U.S.*	0.70 0.68	0.39 0.308**
Canada	> 20	250-300	CN-U.K.	~0.40	0.20
Sweden	~ 10	20-30	SW-U.K. SW-U.S.	0.40 0.50	0.23 0.25
U.K.	> 40	~250	U.K.-U.S.	0.53	0.25 (1996)
U.S.	> 50	200-250	U.S.-CN	0.20	0.15

* U.S. ISR applications on this route were still pending at September 1996
** This is a 1996 average for the route reflecting different Australian rates for terminating traffic in urban, rural or mobile networks.
Note: Accounting rates are for the largest carrier on each route (AT&T or BT). 1 SDR =$1.4585 at Sept. 1, 1996.

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If unlimited hubbing is permitted, an ISR carrier may be able largely to supplant the role of existing facilities-based carriers in a given country even on routes where ISR is not permitted. This can be done by collecting outbound or inbound traffic to or from closed markets at one or more off-shore "hubs" and then linking the hubs to the target country by ISR facilities. Further, if there are no limits on foreign ownership of the ISR carrier, such hubbing arrangements may lead to the *de facto* market entry by facilities-based foreign carriers.

Canada is instructive in this regard. In Canada, ISR carriers need not obtain route-by route approval although, in principle, ISR is permitted only where "equivalent" opportunities exist at the foreign end. This lax regulatory regime has led some domestic long distance carriers, such as Unitel and Sprint Canada, to use ISR facilities to hub or "refile" Canada-overseas traffic to third countries via the facilities of affiliated U.S. carriers (AT&T owns 33 percent of Unitel, recently renamed AT&T Canada Long Distance; Sprint owns 25 percent of Sprint Canada). Inbound Canadian traffic is said to be hubbed in reverse fashion, in some cases with the aid of off-shore foreign

Box 5. How do U.S. Carriers Use Their International Facilities?

Total Private Line, Public Switched and Idle 64 Kbps Circuits by Region, December 1995

Routes	Private Line	Public Switched Network	Total In Use	Idle Circuits	Total Available
North America	7,196	67,588	74,784	2,736	77,520
C. & S. America	1,776	6,955	8,731	6,274	15,005
Caribbean	517	5,349	5,866	1,779	7,645
Western Europe	9,997	22,389	32,386	54,593	86,979
Eastern Europe	241	2,886	3,127	1,470	4,597
Middle East	506	2,560	3,066	266	3,332
Africa	199	2,051	2,250	181	2,431
Asia	5,067	13,185	18,252	26,605	44,857
Oceania	998	3,125	4,123	24,439	28,562
Other	0	60	60	N/A	60
Total	26,497	126,148	152,645	118,343	270,988

Note: Data based on FCC circuit status reports filed by U S. carriers and are for AT&T, MCI, Sprint and WorldCom only Data are for circuits originating in continental U.S "Idle" circuits are circuits owned by a carrier at year end but not in use Totals are for all circuits to all countries within a region. Limited idle circuits to N American routes reflect absence of cable facilities. By comparison, large idle capacity on routes to Asia and Oceania reflect recent introduction of new cable facilities Satellite capacity utilization is generally not reflected by this data because U S carriers do not acquire international satellite capacity in advance

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affiliates (Sprint and AT&T both have ISR authority in the U.K.).

Critics of unrestricted ISR allege these hubbing activities are contrary to Canada's best interests: they undercut the revenues of Téléglobe, Canada's sole facilities-based overseas carrier. Just as importantly, this type of cross-border hubbing services tends to make Canada increasingly dependent on the U.S. because, as more and more of Canada's overseas traffic is rerouted via the U.S., any Canadian carrier (Téléglobe's monopoly expires in 1997) will find it increasingly difficult to negotiate competitive foreign operating agreements in its own right.

Ironically, analogous concerns have been expressed by U.S. carriers. But, thus far, they have had a somewhat more sympathetic regulator. Under FCC rules, U.S. carriers may not indiscriminately refile traffic to third countries. "Switched hubbing" is permitted, but this limits ISR carriers to routing third country traffic via a country which provides equivalent ISR opportunities and then refiling the traffic through the PSTN; traffic may not be refiled via another IPL.

The potential for ISR carriers to engage in switched hubbing and the difficulty of policing such arrangements is also a crucial concern of trade negotiators seeking to open national markets for basic telecommunication services on non-discriminatory (i.e., reciprocal) terms. U.S. and other World Trade Organization (WTO) parties assert that a country which does not agree to open its market might still benefit from an agreement if any party thereto (such as the U.K.) permits one-ended ISR. In that case, a non-party could establish a U.K. based ISR carrier which could pick-up and deliver traffic throughout the liberalized block of countries as well as its home country.

Box 6. Call-back = Cash-back: Why Call-back May Help Low Income Countries

It is often alleged that telephone call-back services, which permit local callers to obtain a lower priced international dialtone from a foreign carrier, deprive the local Public Telecommunications Operator (PTO) of much needed international revenues. But while call-back services may lead to reduced revenues for the national PTO, they do not necessarily penalize the developing country as a whole.

Consider the following case where a resident of a developing country spends US$10 on making a call direct via a national PTO (at US$2 per minute for a 5 minute call) and another spends the same amount with a call-back company (at US$1.33 per minute, a 7.5 minute call). Also assume that the accounting rate with the distant country is US$1.20 per minute, making the settlement payment US$0.60 per minute. (See Box 1 for a review of the accounting rate system.)

In the first case, the settlement payment out of the country is US$3.00 (5 minutes × $0.60). In the second case, the settlement payment into the country is US$4.50 (7.5 minutes × $0.60). The developing country PTO loses $7.00 in local currency for the call but gains $4.50 in hard currency settlement payments. Furthermore, in the call-back case, there are no costs incurred for the local PTO in billing for the service or in debt collection (done by the call-back provider). For the country as a whole, however, the main advantage is that the call-back user was able to make 50 percent more calls for the same price.

For many developing countries, settlement payments are now a major source of telecommunications revenue. In several Latin American and Caribbean countries, net settlement payments from the U.S. alone already make up more than half of all telecommunications revenue. In Africa too, where call-back is popular due to the high price of international calls, net inward settlement payments from the United States have tripled in just five years. A high percentage of this windfall has been poured back into network development.

Of all the different "alternative calling procedures," call-back is certainly the most suited to the needs of developing countries. Some alternative calling procedures stimulate traffic without bringing financial benefits to the local PTO (this is the case, for instance, with Internet telephony, International Simple Resale and other PSTN-bypass systems). Others bring financial benefits to the local PSTN (via the settlement payment mechanism) but do not necessarily stimulate traffic by offering lower prices (for instance, calling card traffic, country-direct services). Only call-back performs the trick of both stimulating traffic and raising cash for the local PTO.

Adapted from *Direction of Traffic 1996* © ITU/TGI

The Impact of ISR

Military strategists well know that a new weapon frequently need not be launched in order to be effective. ISR provides a similar deterrent. In 1992, many observers predicted that ISR would lead to wholesale accounting rate bypass and price cutting on major trans-Atlantic routes especially given the large amount of unused transmission capacity on key routes. But even though raw (IPL) capacity remains abundant, the volume of global ISR traffic remains modest (see Box 5). To date, with minor exception, no major carrier has wished to launch a "first strike."

For example, carrier traffic reports filed with the FCC show that as of July 1996, ISR traffic was only significant on the U.S.-Canada route (with approximately 400 million minutes of two-way traffic in 1995). On the U.S.-U.K. route, no major carrier had more than a small volume of traffic and many had not even begun ISR service (see Box 4). (By comparison, U.S. resellers of international switched services carried over 2.3 billion minutes in 1995, at least one third of which is estimated to be "call-back" traffic. The impact of this "call-back" traffic on less developed countries is discussed further in Box 6.)

Outside the U.S., the story is somewhat different. ISR carriers now carry over 5 percent of the U.K.'s outbound traffic. This is largely because the U.K. has long permitted one-ended ISR, thus permitting ISR carriers to hub traffic from non-ISR countries through the U.K. and onward to North America or Asia (via Australia) using their own dedicated IPL network. In 1995, ISR carriers in the U.K. collectively carried over 250 million minutes of international traffic. Similarly, in Australia, ISR carriers, including companies affiliated with foreign carriers—such as Singtel, Sprint and BT—now account for at least five percent of the outbound market in terms of minutes.

The Future of ISR

So long as the international accounting rate system leads carriers from competitive regimes, such as the U.S., Canada and Sweden, to run significant deficits with carriers operating in more restrictive markets, ISR is likely to have continuing appeal. (Even where a carrier does not have a deficit, ISR may still provide a means to reduce net foreign settlements.) The greater the deficit, the greater the incentive to use ISR to bypass high foreign settlement rates (see Table 1). As we have seen, however, the risks of pursuing such a strategy are considerable—others can play the same game.

The uncertain benefits of ISR have led several countries—notably, Chile, the Philippines and Mexico—to encourage competition solely by granting multiple facilities-based international licenses. Each of these countries have a significant traffic and revenue surplus—a surplus which might be eroded by foreign carriers if ISR is permitted. But so long as ISR is banned, the net in-flow of foreign settlements may be used to help jump-start multiple new carriers.

ISR also has mixed support in the European Union (EU). Apart from the Scandinavian countries and the U.K., other EU members have decided to liberalize the market primarily by granting additional facilities-based licenses for international service. From January 1998, ISR will be permitted in most EU states, but as competition drives down accounting rates on key routes (see Table 2 following this essay) and as traffic becomes more balanced, the incentive to use ISR on intra-European routes may be relatively limited.

It would be a mistake, however, to suggest that the ISR game is almost over. Apart from the numerous routes where large traffic and revenue imbalances remain, ISR is also likely to be a major weapon for the new generation of global alliances. Two of these alliances, Concert and Global One, have put in place sophisticated international backbone networks. Once ISR becomes lawful in more countries, these new backbone networks may well become the primary means for some of the world's largest carriers to route traffic to and from their national affiliate in a way which provides the optimal mix of collection charges and settlements for their owners. When that begins to happen, the ISR game may finally begin in earnest. ◆

International Accounting Rates

Table 1. United Kingdom Accounting Rates for OECD Countries, 1991-1996

Country	1991 (US$)	1996 (US$)	Percent Change
Australia	1.00	0.56	-44%
Austria	0.58	0.50	-15%
Belgium	0.47	0.43	-7%
Canada	n.a.	0.29	n.a.
Denmark	0.53	0.35	-34%
Finland	0.62	0.37	-40%
France	0.47	0.37	-22%
Germany	0.49	0.22	-55%
Greece	0.68	0.62	-10%
Iceland	1.03	0.61	-41%
Ireland	n.a.	0.28	n.a.
Italy	0.58	0.57	-3%
Japan	2.00	1.46	-27%
Luxembourg	0.46	0.41	-10%
Mexico	2.10	1.75	-17%
Netherlands	0.48	0.43	-11%
New Zealand	n.a.	0.88	n.a.
Norway	0.56	0.35	-38%
Portugal	0.72	0.61	-16%
Spain	0.59	0.62	4%
Sweden	0.57	0.34	-42%
Switzerland	0.51	0.30	-41%
Turkey	0.86	0.57	-34%
US - BT	0.83	0.36	-56%
US - Mercury	0.76	0.44	-42%

Note: Figures based on SDR conversions of 1 SDR=$1.43 for average 1991 and 1 SDR=$1.46 for average 1996 as (of September 1). Source· Oftel

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Table 2. Accounting Rate Trends for OECD Countries, 1991-1996

	To Europe (SDRs)				To Asia-Pacific (SDRs)			
Country	1991	1994	1995	1996	1991	1994	1995	1996
Belgium	0.41	—	—	—	1.23	—	—	—
Denmark	0.47	0.40	0.30	—	2.85	2.34	1.61	—
France	0.42	0.33	—	0.31	1.20	0.80	—	0.68
Greece	0.53	0.42	0.42	—	2.18	1.22	1.07	—
Ireland	0.53	0.48	—	—	2.15	1.71	—	—
Italy	0.37	0.34	0.34	0.30	1.53	0.97	0.92	0.56
Netherlands	0.42	0.30	—	—	1.45	0.95	—	—
Norway	0.45	—	—	—	1.25	—	—	—
Spain	0.41	—	—	—	1.59	—	—	—
Sweden	0.40	—	—	—	1.22	—	—	—
Japan	1.71	1.15	—	1.09	1.34	0.75	—	0.70
New Zealand	1.45	1.14	—	—	0.97	0.60	—	—

Note: All figures are averages in SDRs for each region Source: OECD

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Table 3. United States Accounting Rates, 1992-1996 (US$)

Country	1992	1993	1994	1995	1996
Argentina	1.65	1.65/1.54	1.52	1.43	1.43
Australia (Telstra)	0.83	0.76	0.59	0.59	0.58
Austria	1.10	0.83	0.89	0.67	0.51
Brazil	1.50	1.40	1.27	1.14	1.12
Canada (Stentor)	.28/.24	.28/.24	.26/.22	.24/.20	.22/.14
Chile (ENTEL)	1.60/1.15	1.60/1.00	1.10	1.10	1.00
China	3.37	2.93	2.91	2.67	2.14
Columbia	1.55	1.50	1.40	1.30	1.27
Croatia	1.71	1.38	1.34	1.04	0.73
Cyprus	2.28/1.65	1.66	1.49	1.41	1.39
Czech Republic	n.a.	1.24	1.19	1.04	0.88
Denmark	1.38	1.38	1.19	0.74	0.58
Finland (Telecom Finland)	0.89	0.90	0.74	0.59	0.58
France	0.96	0.97	0.62	0.54	0.35
Germany	1.10	0.83	0.51	0.39	0.23
Greece	1.65	1.55	1.41	1.26	1.09
Hong Kong	1.60	1.20	1.00	1.00	1.00
Hungary	1.40	1.24	1.34	1.34	0.73
India	2.00	1.90	1.80	1.80	1.80
Indonesia	1.80	1.80	1.80	1.58	1.40
Iran	3.00/2.50	3.00/2.50	3.00/2.50	3.00/.2.50	3.00/2.50
Ireland	1.10/.92	0.93	0.82	0.67	0.44
Israel	2.28/1.9/1.63	2.16/1.85/1.40	2.16/1.85/1.40	1.90/1.63/1.23	1.18
Italy	1.65	1.5/1.10	1.22/.82	0.71	0.53
Japan (KDD)	1.31	1.04	0.94	0.94	0.92
Korea (Korea Telecom)	1.60	1.44	1.41	1.26	1.24
Kuwait	1.58	1.59	1.71	1.71	1.68
Luxembourg	1.38	0.97	1.04	0.74	0.58
Macau	1.80	1.80	1.65	1.50	1.35
Malaysia (TM)	1.80/1.20	1.15	1.05	1.00	0.89
Mexico	1.10	1.00	0.91	0.67	0.67
Morocco	3.03	3.04	3.27	1.78	1.75
Netherlands	0.69	0.69	0.59	0.37	0.36
New Zealand (TNZI)	1.65	0.83	0.89	0.59	0.44
Norway	1.10	0.97	0.74	0.45	0.44
Philippines (PLDT)	1.68/1.25	1.68/1.25	1.34	1.23	1.20
Poland	1.30	1.25	1.20	1.15	0.95
Portugal	1.65/.69	1.49/.69	1.41/.74	1.20/.74	.95/.73
Russia (Rostelcom)	2.60	2.60	2.60	2.60	2.12
Saudi Arabia	2.20	2.20	2.20	2.20	2.20
Singapore	0.85	0.86	0.92	0.92	0.90
Slovenia	1.71	1.71	1.49	1.11	0.73
South Africa	1.80	1.50	1.20	1.20	1.00
Spain	2.06/1.38	1.80/1.10	1.78/1.04	1.44/.95	0.64
Sweden (Telia AB)	0.69	0.69	0.37	0.37	0.18
Switzerland	1.11	0.84	0.91	0.52	0.51
Taiwan	1.40	1.20	1.20	1.20	1.20
Thailand	1.75	1.60	1.60	1.55	1.50
Turkey	1.93	1.66	1.78	1.63	1.24
United Arab Emirates	2.00/1.30	2.00/1.30	2.00/1.30	2.00/1.30	2.00/1.30
United Kingdom (BT)	.74/.52	.61/.48	0.49	0.37	.37/.22
Venezuela	1.30	1.30	1.30/1.00	1.30/1.00	1.15/1.00
Yugoslavia	1.73	1.49	1.34	1.19	1.17

Note: Rates are for largest carrier serving the route, different accounting rates may apply to competing carriers. Where two rates are shown, there are peak/off-peak rates or growth-based rates (i.e., traffic above a benchmark level is eligible for a lower rate). 1996 data current to September 1. All figures expressed in US$. Source: FCC

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SETTLEMENTS FOR PHONE SEX

Major Providers of International Audiotex

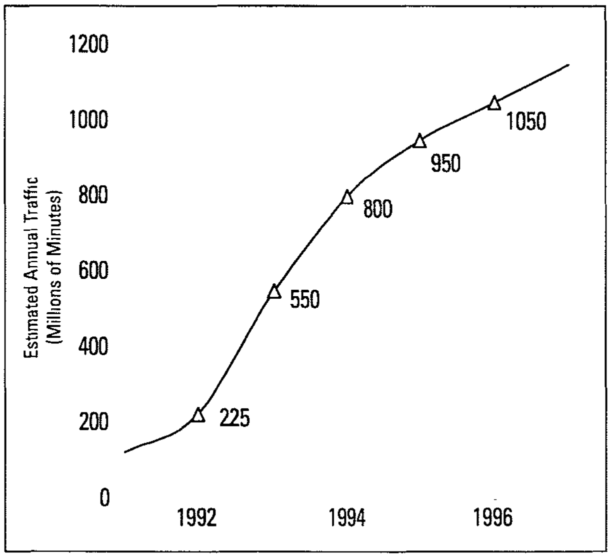
Estimated Incoming Audiotex Traffic, 1995

Country	Million MiTT per month
1. Netherlands Antilles	9.0
2. Guyana	9.0
3. Dominican Republic	8.0
4. Hong Kong	8.0
5. São Tome	4.2
6. Niue	4.2
7. Canada	4.0
8. Philippines	4.0
9. Australia	3.4
10. Israel	3.0
11. Chile	2.3
12. Northern Marianas	2.3
13. USA	2.3
14. Norfolk Islands	2.0
15. Moldova	1.7
16. St-Pierre and Miquelon	1.1
17. Portugal	1.1
18. Haiti	1.0
19. Jamaica	1.0
20. Antigua	1.0
Other	3.8
TOTAL	**76.4**

Source: Industry interviews.

Global Audiotex Traffic Growth, 1992-1996

Estimated International Traffic (MiTT)



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What do you get when you cross the international accounting rate system with the demand for phone sex? The answer: a $2 billion industry that is responsible for more than 900 million minutes of international telephone traffic.

Since 1990, stricter domestic regulation of "adult" content provided over public telephone lines has pushed a piece of the phone sex industry across international boundaries. By relocating a sex-talk business in a relatively distant country, service providers can take advantage of high international call prices and the telephone company billing system while bypassing local regulations.

The consumer in the originating country (e.g., the U.S.) places a call to an advertised number in another country (e.g., Guyana). The consumer then pays for the call on the next phone bill, like any other per-minute long distance charge. The only difference from a normal international call is that the settlement payment made by the originating (billing) carrier to the telco in the terminating country is split with the service provider. Therefore, the countries with the highest settlement rates offer the most lucrative environment for international audiotex.

Not all audiotex is pornographic. The types of services available range from sports scores to live chat lines to pre-recorded fantasies. And in many cases the terminating country may not even be the host for the service. In this scenario, the terminating country acts as a collection vehicle for inward traffic which is then rerouted (by private line) to an audiotex provider in a third country or even back to the country from which the incoming calls originate.

Settlement Rates for Audiotex Providers

(All figures in US$)

Country	Country Code	U.S. (9/96)	W. Europe (1995 est.)
Australia	61	0.29	0.45
Canada	1-604/416	0.11	0.30
Chile	56	0.50	0.85
Dominican Republic	1-809	0.55	0.70
Guyana	592	0.85	0.80
Hong Kong	852	0.50	0.75
Israel	972	0.59	0.90
Moldova	373	1.04	0.60
Netherlands Antilles	597	0.38	0.70
Niue	683	1.50	1.75
Northern Marianas	670	0.30	0.85
Philippines	63	0.60	0.75
Portugal	351	0.48	0.40
Sao Tome	239	1.17	1.00

Note: The settlement rate is the per-minute payment made by the originating carrier to the terminating carrier. The payment is typically split with the service provider. U.S. rates for peak only. W. Europe are aggregate estimates.

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The Internet

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INTERNET TRAFFIC STATISTICS: AN OVERVIEW

In a perfect world (one crafted by geographers) the Internet would map itself. And the billions of bits flowing from one computer to another would be counted too. The technology already exists—computers connected to the Internet would simply use the Internet Protocol (IP) to add a header encoding the geographic origin of each data packet as well as its destination.

This scheme is not really far-fetched. Geographic tags can already be added to World Wide Web pages. And tomorrow's computers may well include a standard radio module which, like a cellular phone, constantly updates the computer's position via the network of Global Positioning Satellites or a terrestrial system. Right now, however, mapping the Internet's ever changing traffic patterns still presents a colossal challenge.

How much traffic flows between Internet Service Providers (ISPs) in the United States and other countries? What is the mix of traffic? How much is e-mail, how much is generated by the World Wide Web, and how much is real-time traffic, such as Internet telephony or video conferencing? And how has the changing number and distribution of Internet computers (hosts) affected the volume and balance of traffic between different countries and backbone networks?

In *TeleGeography 1995*, we provided rudimentary answers to some of these questions based upon a late 1994 survey of traffic flowing over the NSFNet, then underwritten by the U.S. National Science Foundation (NSF) (see Box 1 below). While not all Internet traffic flowed over NSFNet, the bulk of it did.

But NSFNet was shut down beginning in November 1994, and there is no longer a central Internet backbone. The traffic data now available thus reflects only isolated sections of the network. Internet-wide measurements simply do not exist.

Performance Measurements

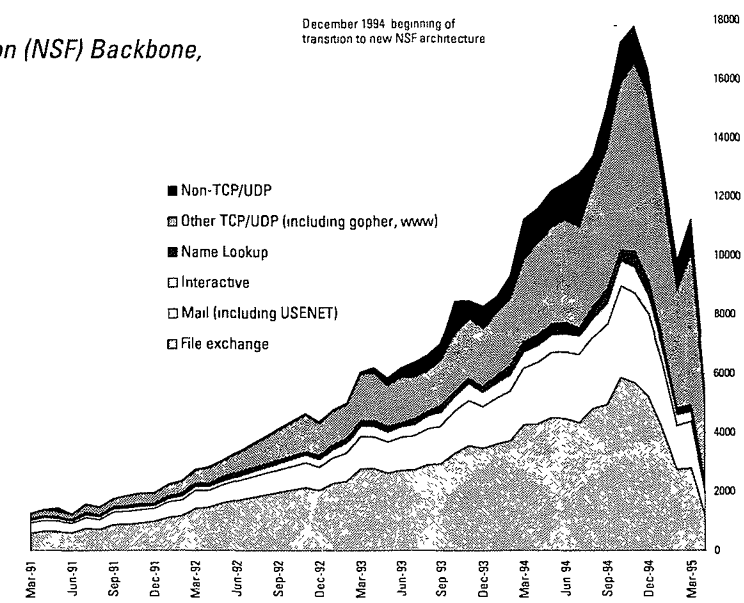
The business press has recently discovered the Internet statistics gap as stories about network congestion begin to make front-page news (see Box 2, "Mr. Quarterman's Internet Weather Report," on the next page). During peak hours, many Internet sites are hard to reach ("connection refused"); data packets are lost (20 percent or more at some network exchange points) and downloading files can be maddeningly slow. Some Internet engineers also expect the Net to suffer from periodic service "brownouts" or worse as operators scramble to meet the demand for new bandwidth-hungry services, such as real time Internet audio and video communications.

In this environment the demand for statistics has gathered force—statistics which will help ISPs and backbone operators identify the "trouble spots," test the impact of new

Box 1. The Traffic Statistics Dry Up

Traffic on the U.S. National Science Foundation (NSF) Backbone, by category of service

Until its decommissioning on April 30, 1995, the NSF Backbone Network was the most heavily used, large-scale Internet interconnection facility in the world. It was also a superb window on Internet usage, both for total volumes and breakdowns by type of traffic.
Under the new architecture, traffic flows on commercial networks, such as ANS, MCInet, and Sprintlink, and it is no longer possible to measure Internet use by protocol as before.
TCP/UDP are basic Internet standards that allow up to 128,000 different network applications and services to be provided over the Internet. Non-TCP/UDP standards include Open Systems Interconnection (OSI) and various special network services.



Source: Merit, ftp //nic.merit.edu/nsfnet/statistics/

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Box 2. Mr. Quarterman's Internet Weather Report

John Quarterman, a computer consultant in Austin, Texas, has been mapping the furthest reaches of the Internet since the 1980s (see "The Ends Of The Matrix" in TeleGeography 1993*). And while others have made headlines with predictions about the Internet's imminent demise, Quarterman's research group, the Matrix Information and Directory Service (MIDS), has been quietly compiling data on the Net's actual performance.*

Since 1994, MIDS has measured the round-trip time for sending a message from its Austin computer to approximately 4,500 Internet sites world wide. MIDS uses a program known as ping (technically ICPM ECHO) to verify the presence of hosts computers. The MIDS test sites are "pinged" five times per site every four hours, seven days a week. The record of each ping is mapped and each day's maps are then animated using the MPEG movie protocol. Soon after, the results are posted on the World Wide Web (http://www.mids.org/mids/weather.html).

These Internet Weather Reports (IWRs) show plenty of storms. But Quarterman suggests that longer average response times for any particular site are often due to local causes, such as an overloaded computer, a slow drive or a congested ISP which don't really effect overall Internet performance. Still, IWRs do show an interesting cyclical feature: Congestion increases during the work week with five days of relatively high latencies (round trip times) followed by two days of shorter latencies. Holiday seasons usually produce better performance but during the last Christmas-New Year season, latencies went up, says Quarterman, perhaps because lots of people "got Internet connections for Christmas."

The IWRs also show that from January 1994 to January 1996 there was a 30 percent improvement in mean latencies. That is, during this period, the average round trip time went down, which means that the quality of the Internet actually got better—not worse. Quarterman thinks that some of the Internet improvement could be due to better performance by MIDS's local ISP as well as increased port connection speeds by a number of distant sites. Nevertheless, Quarterman thinks that the 30 percent improvement is hard to explain solely by these factors.

But, does the data mean "all is cool with the Internet?" "No" says Quarterman. The "long latencies shown in the reports are real: servers that can't keep up with traffic are a problem in themselves. And there really are frequent outages and breaks in wide area IP carriers and in their interconnecting points. But overall these don't appear to be any worse than they used to be and the general trend is clearly towards improvement."

To learn more, read John S. Quarterman, "Imminent Death of the Internet," Matrix News, *June 1996 (http://www.mids.org).*

hardware and software, and compare the performance of one portion of the Internet to another.

Major business users have also begun to lobby for Internet performance statistics. Most big companies currently are unwilling to entrust strategic or mission critical business applications to the Internet. In some cases, they have persuaded ISPs to establish dedicated IP intranets to handle such traffic so that guaranteed performance criteria can be met on an end-to-end basis. Some of these business users also want similar performance criteria for the public Internet so that they have wider service options.

Traffic Measurements

Why measure Internet traffic? On the telephone network, the answer is obvious: traffic is money. Long distance (and some local) calls are billed by the minute. On the Internet, however, most users pay a flat monthly fee; the cost is the same whether one is connected for a minute or an hour, and whether one downloads one thousand bytes or one billion.

But, for Internet service providers, each user's connect time and the number of bytes that are picked up and delivered does have economic implications. Computer hard drives, routers and private lines to backbone networks cost money. And the investment needed to maintain a given level of performance depends, in part, upon traffic volumes, although the relationship is much looser than on the public telephone network. To recoup the cost of these resources, ISPs will soon need to charge heavy users of the Internet—and those requiring real-time traffic delivery (e.g., for telephony)—more than users which place limited demands on the network. Traffic statistics are likely to play a role in making these new pricing mechanisms work.

Measuring Internet traffic volumes is not easy though. The Internet is a "connectionless" network. There is no fixed path for sending packets between one ISP and another, let alone between the ISPs in one country and another.

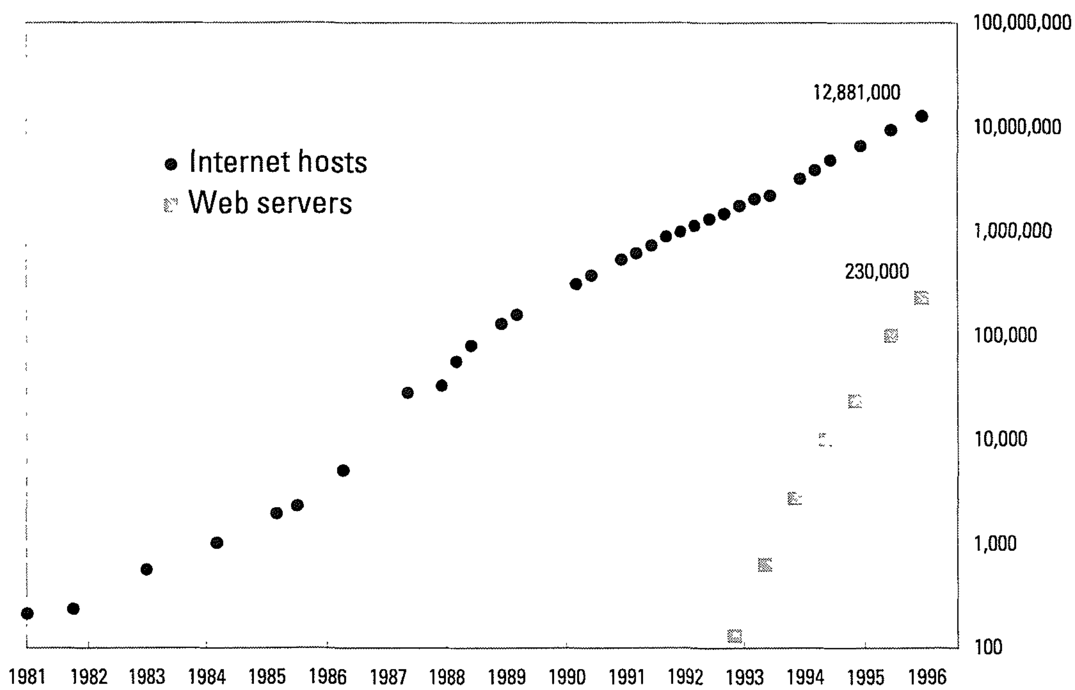
A sender's message is digitally encoded, split up into packets, and sent to the local ISP for onward transmission. The ISP then switches the packets to a backbone network by the most efficient route available using an ever changing set of routing tables. The backbone operator, in turn, forwards the packets in a like manner to another network and so on until they reach their destination.

All point-to-point measurements of Internet traffic volumes and traffic balances are therefore problematic. We may know how much traffic is switched from one network to another but the ad hoc routing of national as well as international traffic may make ISP-by-ISP as well as country-by-country traffic statistics (i.e., in/out balances) quite unreliable.

Internet engineers also have found that the statistical techniques developed in the telephone industry for predicting the volume of traffic which can be handled by a given number of dedicated circuits (e.g., Erlang-B statistics) and the distribution of calls in a given time period generally do not hold for the Internet's connectionless traffic. For the most part, Internet traffic directed to a given address arrives, but sometimes it doesn't or is delayed, and the arrival time and route cannot be predicted, on average, with any certainty.

In sum, despite their bravado, it appears that most Internet operators are probably building blind. Backbone providers and local ISPs are adding massive new routers and large increments of transmission capacity. Yet, despite these large expenditures, no single ISP can be sure that any given investment will lead to a measurable increase in the quality

Box 3. Internet Host Growth, 1981-1996



In years past, each host on the Internet represented one computer. But the definition of hosts has changed such that a single computer can act like many hosts with many names and many addresses all at once. Network Wizards, the company trying to keep track of Internet host growth, admits that "it is not possible to determine the exact size of the Internet." Source: Network Wizards, http://www.nw.com/zone/host-count-history.

Mathew Gray, a graduate student and researcher at MIT's Media Lab, has been counting Web servers since the beginning. His most recent estimate puts Web growth on a pace that doubles the number of servers every six months. The Internet as a whole (measured by hosts), however, only appears to double every twelve months. Source: Mathew Gray of the Massachusetts Institute of Technology, http://www.mit.edu/people/mkgray.

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of service offered to users. Nor can the ISP be sure that its own efforts will reduce the likelihood of a future network wide "brownout" or crash.

The three articles which follow look at different aspects of the Internet traffic dilemma described above. The first article by K. Claffy, a staff scientist at the San Diego Supercomputer Center, reviews the basic demand for Internet traffic statistics and other metrics; the technical problems involved in making the necessary measurements; and what might be done about these problems. The second article, by *TeleGeography's* technical consultant, Zachary Schrag, looks at how new software deployed by ISPs might cope with the increasing volume of traffic generated by Internet telephony and other real time applications.

A third article by Robert Shaw, an expert with the International Telecommunication Union (ITU) in Geneva, looks at the current debate over the assignment of addresses to Internet host computers. On first impression, this topic may not seem directly related to the size and measurement of Internet traffic volumes. But any regime for assigning Internet addresses affects both the number and location of networked computers. The location of computers in turn affects the volume of traffic between one part of the network and another. Hence, the ongoing debate over cyberspace property rights (i.e., registration of domain names) may well have a long term operational impact on future Internet traffic flows and the economic base of major ISPs. ◆

For further research:

Much of the press about the coming Internet "crash" has been sparked by the views of Robert Metcalfe (http://www.cio.com), inventor of Ethernet and a founder of 3Com He is also a monthly columnist for *InfoWorld*.

A good introduction to the claims and counterclaims on Internet congestion is provided by the two-part series written by Charles Bruno ("Internet Health Report: Condition Serious") for *NetworkWorld* beginning with the September 16, 1996 issue (http://www.nwfusion.com). Another overview appears in the October 1996 *Network World* issue headlined "The Big Crash—Is it Coming." See also "Bandwidth, Blockages, Brownouts," *Meme* 2.01 (http://www.virtualschool.edu/mon/Internet); Jeremy Schlosberg, "It's the Bandwidth, Stupid...or is it? *Computerworld*, April 29, 1996 (http://www.computerworld.com); Simson Garfinkle, "Web Brownout," *Wired*, September 1996, pp. 94-100.

A sampling of operational statistics for the Internet is available from the Routing Arbiter (RA) project (http://www.ra.net) managed by Merit, a non-profit research and educational organization based in Michigan and funded by the U.S. National Science Foundation (NSF). However, some technical background is necessary to make sense of RA's statistics, (e.g., "the RA is regularly performing ring tests across the NAP [Network Access Point] fabric and recording SNMP [Simple Network Mail Protocol] calls of the route servers for BGP [Border Gateway Protocol] statistics"). For a plain English guide, see *Matrix Maps Quarterly* (http://www.mids.org).

The U.S. National Laboratory for Applied Network Research (NLANR) also maintains links to operational statistics data from research sites and ISPs (http://www.nlanr.net).

Background on Internet pricing and congestion can be found at the following sites: http://www.sims.berkeley.edu/resources/infoecon/pricing.html and http://www.oecd.org/dsti/gd_docs/s96_xxe.html. Also, recent work at the University of Texas at Austin on usage-based pricing has drawn attention (visit http://cism.bus.utexas.edu/alok/pricing.html).

CLOSING THE INTERNET STATISTICS GAP

by K. Claffy

This article covers three areas:

- why current Internet statistics are limited and why data collection is more difficult on the Internet than on the public telephone network;
- who needs Internet statistics and why and;
- possible models for ISPs and users to narrow the gap in understanding the nature of Internet traffic.

How We Got Here: Limitations of Current Statistics

The existence of the NSFNet (1986-1995) as a central network for the research and education community facilitated research into aspects of aggregate network traffic patterns and the anomalies in those patterns caused by the introduction of new or unique applications. Decommissioning the NSFNet backbone left the Internet community with no dependable public source of statistics on Internet workloads. And yet the empirical investigations of current workloads and their resource requirements, as well as how they change over time, is vital to supporting Internet evolution.

Workload profiles are changing more rapidly than ever before. Keeping pace with them in an increasingly competitive, increasingly proprietary environment, is even more important now than during the life of the NSFNet backbone.

The transition to the new NSFNet program, with commercial operators providing both regional service as well as cross-service provider network access points (NAPs—see page 51), renders statistics collection a much more difficult task. There are several dimensions of the problem, each with their own cost-benefit tradeoff.

- Thus far users have demanded few statistics from their providers. Even the NSF, one of the largest and most forward-looking users, called for few statistics in the cooperative agreements with NAP providers. This is understandable, because the NSF did not know enough about the way the post-NSFNet system would operate (neither did anyone else, although presumably the providers knew slightly more than the NSF).

The situation is similar for other emerging Internet service providers (ISPs). However, as it turned out, the NAPs and ISPs found it challenging enough just getting and keeping their infrastructure operational; statistics have never been a top priority. Nor do the NAPs really have a good sense of what to collect, as all of the technology involved is quite new to them as well. The issue is not whether traffic analysis would help, even with equipment and routing problems, but that traffic analysis is perceived as a secondary issue, and there is no real mechanism (or spare time) for collaborative development of an acceptable model.

- Many emerging Internet services are offered by companies whose primary business has been telecommunications. The NAPs and the very high speed backbone network service (vBNS) providers are good examples. Phone companies are accustomed to reasonable analytic tools for modeling telephony workload and performance (e.g., Erlang B distributions).[1] Unfortunately, the literature on Internet traffic characterization, both in the analytical and performance measurement domains, indicate that wide area networking technology has advanced at a far faster rate than has the analytical and theoretical understanding of Internet traffic behavior.[2]

Moreover, there is still no consensus on how statistics can support research in IP traffic modeling. Critics within the Internet community are skeptics of empirical studies that rely on collecting real data from the Internet. These critics claim that because the environment is changing so quickly, within weeks any collected data is only of historical interest. They argue that research is better served by working on mathematical models rather than by empirical surveys that, at most, capture only one stage in network traffic evolution.

- The Internet's early financial history has also contributed to the lack of traffic statistics. A few U.S. government agencies assumed the financial burden of building and maintaining the transit network infrastructure. There was little need to trace network usage for the purposes of cost allocation.

The new commercial Internet is characterized by hundreds of ISPs, many on shoestring budgets in low margin competi-

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Portions of this article draw upon "Report Of The NSF-Sponsored Workshop On Internet Statistics Measurement And Analysis, 19-20 February 1996" by Mark Garrett and Hans-Werner Braun et al., http://www.nlanr.net/ISMA/Report, and "A Survey of Internet Statistics/Metrics Activities" by T. Monk and K. Claffy, http://www.nlanr.net/metricsurvey.html.

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tion. They generally view statistics collection as a luxury that has never proven its operational utility. The last publicly available source of Internet workload and performance data for the NSFNet backbone, was basically a gift from the NSF—an investment of U.S. tax dollars with the hope that tools, methodologies, theories of traffic, refinements and feedback would emerge from groups like the Internet Engineering Task Force (see Box 2). But there was never any fiscal pressure to justify allocating the resources required to collect statistics.

Larger telecommunications companies entering the marketplace will inevitably learn to devote more attention to this area. But the pressure will probably not occur until the system breaks, at which point billed customers will demand, and be willing to pay for, better guarantees and data integrity.[3]

- Privacy has always been a serious issue in network traffic analysis. Most ISPs have service agreements that prohibit them from revealing information about individual customer traffic. Collecting and using more than aggregate traffic counts will require customer cooperation regarding what may be collected and how it will be used. For an ISP to breach customer expectations or ethical standards, even for the most noble research goals, does not bode well for future business.

> *THE NEW INTERNET IS CHARACTERIZED BY HUNDREDS OF ISPS, MANY ON SHOE-STRING BUDGETS... THEY GENERALLY VIEW STATISTICS COLLECTION AS A LUXURY THAT HAS NEVER PROVEN ITS OPERATIONAL UTILITY.*

Where We Are: Who Needs Internet Statistics and Why

In *Routing in a Multi-Provider Internet*, Yakov Rekhter, an engineer at Cisco Systems, writes:

> *Despite all the diversity among the providers, Internet-wide IP connectivity is realized via Internet-wide distributed routing, which involves multiple providers, and thus implies a certain degree of cooperation and coordination. Therefore, we need to balance the provider goals and objectives against the public interest of Internet-wide connectivity and subscriber choices. Further work is needed to understand how to reach the balance.*[4]

Many internet service providers currently collect basic statistics on performance of their own infrastructure, typically measuring utilization, availability, and perhaps delay and throughput. In the the post-NSFnet era, the only baseline against which networks evaluate performance is their past performance metrics. There are no data available or even standard format defined against which to compare performance with other networks or with a baseline. Increasingly, both users and providers need information on end-to-end performance, which is beyond the realm of what is controllable by individual networks.[5]

The vacuum created in national-level statistics/metrics collection after the transition to the commercial architecture has also complicated planning for national service providers and others. Detailed traffic and performance measurements are essential to identifying the causes of network problems and formulating corrective actions. But it is trend analysis and accurate network/systems monitoring that permit network managers to identify hot spots (overloaded paths), predict problems before they occur, and avoid them through efficient resource deployment and optimal network configuration.[6]

Service Quality and Pricing Models

Demands for implementing multiple Internet service levels are increasing. From the providers' standpoint, such offerings will enable increased revenue through business-quality services offerings. From the user's perspective, the ability to contract for higher priority service will enable many industries to switch from intranets and private networks to Internet-based infrastructure. The ability to specify or reserve the services one needs from the network will in turn require mechanisms for accounting and pricing (or else there is no incentive not to reserve all one can, or not to use the highest priority).[7]

The Internet is still relatively devoid of pricing models or other mechanisms to allocate and prioritize scarce resources—particularly bandwidth—and acutely needs mechanisms for more rational cost recovery, that is, more accurate accountability for resources consumed. In particular, the Internet architecture is not prepared to deal with traffic flows that vary by several orders of magnitude. Of major concern in workload profiles today is the disparity in size between most current Internet flows/transactions, at less than ten packets, and newer multimedia applications with much higher volume and duration.

The disparity in workload profiles in the current cross-section of Internet applications necessitates revised metrics of network behavior. Simple mean or peak utilization figures do not address a service provider's engineering needs, because they say nothing about the transaction profile constituting and perhaps dominating those figures. Keeping track of workload profiles requires measuring flow data at relevant network locations.[8]

Box 1. The NSF Transition

Until recently, the vast majority of Internet hosts were in the United States and relied upon a common backbone network supported by the U.S. National Science Foundation (NSF). The NSFNet was the largest and most widely used Internet interconnection facility and backbone traffic measurements provided a reasonable indication of Internet traffic trends worldwide.

The NSF decommissioned this government funded backbone in April 1995, as it became clear that multiple commercial providers were in a position to offer Internet backbone services. NSF withdrawal from support of backbone services to the research and engineering community involved modifications to the NSFNet architecture to ensure Internet stability during the transition from government supported services to full privatization of the network.

These modifications involved the creation of four new projects, three infrastructural, and one research related:

- *general purpose Network Access Points (NAPs): to connect the commercial backbone networks thus avoiding network partitioning;*
- *a routing arbiter, to provide routing coordination among providers during the transition (see http://www.ra.net);*
- *regional interconnectivity to regional networks. (Specifically, NSF-sponsored regional providers, i.e., those who received funding from the NSF throughout the life of the NSFNet, will continue to receive funding for four more years so long as they connect to a backbone provider that connects to all three NSF NAPs. This constraint is the only leverage NSF had to prevent partitioning since the backbone providers themselves received no funding from NSF and thus had less incentive to "do the right thing" at the time. In any event, regional funding ends after four years, at which point the regional providers will have had ample opportunity to become fully self-sustaining within the marketplace.)*
- *very High Speed Backbone Network Services (vBNS), a wide area network initially connecting the NSF supercomputer centers for use by both application scientists as well as network researchers.*

More accurate resource consumption statistics, and concomitant pricing models, will allow progress with another severe need in the current infrastructure: a service architecture from the perspective of the end user. Maximizing value for the end user in the Internet is difficult since the economic value model is quite randomized. In most markets, prices rise along with quality of service (QoS). The Internet should be no exception: rational pricing would provide the right feedback to providers and users to encourage more appropriate use. Currently QoS signals are unclear. Users need operating signals, accompanied by measurement-distinguishable service qualities, so they can declare the QoS for which they will pay. Otherwise high value users may get degraded by high requirement, low value users.[9]

The lack of a common business model for inter-ISP relations inhibits settlements. Some suggest that the per minute traffic settlements used by international telephone carriers could be applied to ISP settlements. But because the Internet relies upon a connectionless network, where per minute point-to-point traffic flows are meaningless, others argue that new pricing models must be developed.

Where to Go Next: Models for Data Collection

Although much of the Internet community agrees that we should seek out measurement statistics in the commercially decentralized Internet, there is definite dissonance as to which measurements would help, and who should have access to them. While a public measurement infrastructure could help researchers and end users, ISPs might benefit more from the ability to collect statistics that were too sensitive to release publicly, and perhaps from comparing them to corresponding statistics from other ISPs.

The best means for collecting the various statistical needs outlined in this article may be a provider consortium. The National Laboratory for Advanced Network Research (NLANR) has suggested a possible framework for such a collaboration, which would serve as a forum for:

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- facilitating the identification, development and deployment of measurement tools across the Internet;
- providing commercial providers with a neutral, confidential vehicle for data sharing and analysis;
- providing networking researchers and the general Internet community with additional realtime data on Internet traffic flow patterns;
- enhancing communications among commercial Internet service providers, exchange/peering point providers and the broader Internet community.

Focal areas of the consortium would include tracking outages, congestion monitoring, examining the use of backbone routing, studying peering relationships, and creating a forum for the discussion of charge policies. Market pressures upon ISPs to participate in such a consortium concept include:

- customers' increasing dependence on the Internet for mission critical applications;
- settlements that require authenticated and possibly confidential provider statistics;
- the meshed nature of the Internet, which suggests that no single company can do it alone, and that systemic improvements will require collaboration.

The business constraints hindering such cooperation relate to the competitive nature of the Internet business environment, as well as the appearance of industry collusion by major providers. However, a charter with principles of openness and inclusion can readily address these concerns, as well as address constraints arising from the lack of adequate pricing models and other mechanisms for economic rationality in Internet business practices.

Technology constraints hindering the collection and analysis of data on Internet metrics center on the nascent develop-

Table 1. Internet Metrics and Tools

Needs	Why	Measurements and Tools	Where
Aggregate traffic flow analysis	Capacity/topology planning	Traffic matrices	At a sample of ISPs
Trouble-shooting	• Cache management • Optimize queuing • Congestion and scaling dynamics • Aggregate transport behavior	• Full header traces	At a few high aggregation points (e.g., near NAPs)
Specifications for ISPs to give vendors of routers	Router benchmarking	• Flow counts/parameters	• NAPs • Backbone core points • corporate campuses • Large customers
Specifications for users to give ISPs	• Service quality assessments • Comparison of ISPs • Billing • Transit-related settlements agreements	• Multi-function beacon testing platforms • Mathis' treno • Paxson's probe daemon	• Bridged at strategic interconnects • Customer sites
Routing stability (i.e., avoiding crashes; "brownouts")	• Reliability • Availability • Quality of service • Outage tracking	• Route archiving • Caching • Database implementation	Route servers
Testing new applications/protocols	• Deployment of IPv6 • Bandwidth reservation • Multicast caching • Directory services • Interoperability tracking across ISPs	• Internal and border routers	Peering points

Box 2. The Internet Engineering Task Force

The Internet Engineering Task Force (IETF) is a large, open community of network designers, operators, vendors, and researchers whose purpose is to coordinate the operation, management and evolution of the Internet, and to resolve short-range and mid-range protocol and architectural issues. It is a major source of proposals for protocol standards which are submitted to the Internet Architecture Board (IAB) for final approval. The IETF meets three times a year and extensive minutes are included in the IETF Proceedings.

The IETF IP Provider Metrics (IPPM) working group is one of many working groups in the IETF, it is comprised of researchers and service providers interested in defining basic metrics and measurement methodologies in order to develop standardized performance evaluations across different Internet components.

ment stage of measurement tools for IP and ATM (Asynchronous Transfer Mode) network flows. Complications also arise from the adoption of new and emerging technologies (e.g., gigaswitches and ATM). These and other constraints are likely to be solved, given sufficient technical attention and market pressure.Developing an effective provider consortium would require, minimally:

- participation by three or more of the major service providers (e.g., ANS, AT&T, BBN Planet, MCI, Netcom, PSI, Sprint, or UUNet);
- a neutral third party with sufficient technical skills to provide the core data collection and analysis capabilities required by the consortium;
- appropriate privacy agreements to protect the interests of members;
- agreement on which basic metrics to collect, collate/analyze, and present and;
- agreement on which tools to develop, particularly those related to emerging infrastructures using new technologies.

This organization would coordinate not only a solid consistent library of tools that could appeal to both users and providers, but, with the cooperation of ISPs, would allow the testing of real data without compromising anyone's proprietary data or technology. Data collection would strictly focus on engineering and evolution of the overall Internet environment. Accurate data on traffic patterns could allow engineers to design more efficient architectures, and design them more quickly, thus conserving both labor and resources now unnecessarily allocated to parts of the network where they are not needed. The right statistics collection and cross-ISP dissemination mechanisms would facilitate faster problem resolution, saving the time and money now devoted to chasing down bugs.

Developing the appropriate metrics and tools to measure such phenomena, as well as end-to-end performance and workflow characteristics, is still a looming task. Experience with data will foster the development of more effective usage-based economic models, which, in the final analysis, will allow ISPs to upgrade their infrastructure in accordance with customer demand. ◆

Endnotes

1. Erlang-B tables are used by telephone engineers to determine the number of circuits needed to accommodate a given volume of traffic at a determined grade of service (i.e., to determine whether a call will be blocked). The tables reflect the work of A. K. Erlang, a Danish mathematician. Erlang correctly assumed that for most telephone networks the number of calls that terminate in any given time period is proportional to the elapsed time and to the number of calls in progress but does not depend on when the calls were initiated. He assumed a Poisson distribution of calls arriving in a given interval. A Poisson distribution is bell shaped but the peak is shifted off-center (e.g., a Poisson distribution would show that the probability a given number of calls will be dialed in any 12 second period is highest between four and five seconds.) See generally I. R. Pierce, *Signals: The Telephone and Beyond* (W.H. Freeman & Co., San Francisco, 1981) pp. 133-134.

2. Traditional mathematical modeling techniques, e.g., queuing theory, have met with little success in today's Internet environments. Years ago, for example, the assumption of Poisson arrivals was acceptable for the purposes of characterizing small LANs. On the Internet, however, whether in terms of packet arrivals within a connection, connection arrivals within an aggregated stream of traffic, or packet arrivals across multiple connections, collected data do not fit a Poisson distribution. Some experts are investigating alternatives to Poisson modeling, specifically the use of self similarity (fractal) mathematics to model IP traffic. See V. Paxson, "Empirically-Derived Analytical Models of Wide Area TCP Connections," *IEEE/ACM Transactions on Networking*, Vol. 2 No. 4, August 1994; also see W. Leeland, M. Taquu, W. Willinger, and D. Wilson, " On the Self-Similar Nature of Ethernet Traffic (extended version)," in *IEEE/ACM Transactions on Networking*, Vol. 2, February 1994. For prior studies on national backbone traffic characteristics see the following sources: K. Claffy, H.-W. Braun, and G. C. Polyzos, "Long-term traffic aspects of the NSFNET," in *Proc. of INET '93*, pp. CBA—1:10, August 1993; K. Claffy, H.-W. Braun, and G. C. Polyzos, Tracking long-term growth of the NSFNET backbone," *Proceedings of the ACM*, vol. 37, pp. 39-52, August 1994; K. Claffy, *Internet workload characterization*, Ph.D. thesis, UC San Diego, June 1994. The limitation of this work has led to a review of the WAN traffic characterization which focus on a single or a few attachment points to transit networks to investigate shorter-term aspects of certain kinds of Internet traffic (e.g, TCP, UDP, and DNS).

3. With the transition to Asynchronous Transfer Mode (ATM) and high speed switches, it is in many cases no longer even be technically feasible to access IP layer data in order to do traffic flow profiling, certainly not within commercial ATM network equipment. Many switches have little if any capability for collecting statistics at NAPs, or even looking at traffic in the manner allowed on a broadcast medium (e.g., FDDI and Ethernet), where a dedicated machine can collect statistics without interfering with packet forwarding. Statistics collection functionality in newer switches takes resources directly away from forwarding, driving customers toward switches from competing vendors who sacrifice such functionality in exchange for speed.

4. Yakov Rekhter, "Routing in a multi-provider Internet," Internet Request for Comments Series RFC 1787, April 1995.

5. Another example of statistics maintained in isolation within an individual ISP is trouble ticket tracking of problems that originate and are resolved within the context of a single ISP. Throughout most of the life of the NSFNet backbone, resolving route instabilities and other trouble tickets was the the responsibility of Merit, which had a cooperative agreement with NSF for operation of the NSFNet backbone. In the current environment there is no such entity to claim to share responsibility for national much less global management of the Internet. As a result, there are no scalable mechanisms available for resolving or tracking problems originating or extending beyond the control of an individual network.

Route instability is another area that can have a direct, sometimes profound, effect upon the performance of individual networks. Some networks are seeking to improve the stability of their routing by peering directly with the Routing Arbiter (RA) at network access points (e.g., SprintNAP and FIX-West/MAE-West) (see Box 1 to the main article).

6. Examples include measurements of: round-trip-time (RTT), e.g., with probe queries, to assess congestion and other conditions at an infrastructure-wide level; routing behavior (beyond that currently available through the Routing Arbiter project), to assess status and stability, as well as unusually configured routing and the conflict between simultaneous presence of more specific routes for a given route aggregate.

7. Some fear pricing will stifle the open, vibrant nature of the Internet community. But pricing is likely to motivate the constructive exploration of more efficient and innovative networking applications.

8. NLANR currently supports http://www.nlanr.net, an interface to the operational collection of such data at several points, including data from the FIX-West multiagency network interconnection facility.

9. In his recent "Internet Draft on Metrics for Internet Settlements," Brian Carpenter (of CERN) asserts that financial settlements are a "critical mechanism for exerting pressure on providers to strengthen their infrastructures." He suggests that metrics used in Internet settlements should not rely on expensive instrumentation such as detailed flow analysis, but rather simple measurements, estimated, if necessary, by statistical sampling.

THE ACHILLES HEEL OF INTERNET TELEPHONY

New Congestion Controls Could Raise the Price of Realtime Traffic

by Zachary M. Schrag

Internet telephony—using a computer to make telephone calls over the Internet, a private network—is cheaper than public telephony for three reasons. First, it uses network resources more efficiently, by relying on a packet-switching technology rather than circuit-switching, as does the public network.[1] Second, it generally avoids the economic regulations which constrain the public network. In the U.S., for example, Internet telephony escapes payments to universal service funds and other local interconnection fees. Finally, it exploits the current architecture and billing practices of the Internet, using more resources than it pays for.

Today, with the right software, a microphone and speakers, and an Internet connection, one can talk with a similarly equipped friend or colleague an ocean away without paying long distance charges per-minute or per-packet.[2] For the most part, users of Internet telephony are not charged more than other Internet users, though they may consume very much more capacity and contribute disproportionately to network congestion.

But this may soon change. Before unmetered Internet telephony becomes attractive to millions of users, it may be sharply curtailed by Internet service providers (ISPs) anxious to conserve their expensive capacity. New software protocols now coming into use will give the ISPs the ability to limit or snuff out Internet calls on their networks with just a few keystrokes.

Once these protocols are in place, Internet telephony and other realtime applications will run only at the mercy of the ISPs. To understand why, one must look at how these applications differ from e-mail, World Wide Web traffic, and other Internet applications. Not all Internet packets are alike, and the same distinctive protocols that Internet telephony uses to push its packets ahead of the crowd may also allow ISPs to filter them out.

TCP vs. UDP

In one sense, protocols are the Internet. In 1974, Vinton Cerf and Robert Kahn created the Internet as we know it by designing TCP, or the Transport Control Protocol. TCP was designed to carry the most popular forms of data at that time: e-mail messages and files to be transferred. But it has since been adopted for Usenet, gopher, and the World Wide Web, the last of which accounts for about two-thirds of all traffic on the Internet (see Figure 1).

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Cerf and Kahn decided that the most efficient way of transmitting these types of data would be to break them into packets and treat them as store-and-forward messages. Their speed in getting across the network was less important than the assurance that they would arrive eventually.

To ensure that its packets would get through even when the Internet was clogged, TCP was later modified to include *Slow-Start.* When faced with Internet congestion, Slow-Start TCP packets wait their turn, traverse the network by different routes if necessary, and then are reassembled at their destination. If packets are lost, they are sent again until they eventually arrive. Thus, if necessary, TCP sacrifices speed for reliability.

In 1979, Jonathan Postel created an alternative to TCP, called the User Datagram Protocol.[3] Because UDP sends only single, small packets at a time, it skips the reassembly process required by TCP, making it simpler and faster than TCP, but less reliable. If some UDP packets cannot get to their destination in the specified time, they are never delivered.

Unlike TCP, UDP does not delay its packets when confronted by congestion on the network. As a result, today's routers favor UDP packets over TCP packets when congestion hits. They permit UDP packets to jump to the front of the line, not because anything in the UDP specification said they should, but simply because UDP was commonly used for sending important, brief messages like Internet Name Server queries. Though UDP was not designed as a high-priority protocol, in practice it functioned that way until very recently.

Realtime UDP

In 1992, the Internet Engineering Task Force's Audio/Video Transport Working Group was chartered to explore ways to transmit realtime data over the Internet (primarily for conferencing, rather than one-to-one conversations). The group realized that because of UDP's impatience, it might be used to carry time-sensitive data like telephone calls. But the group doubted that UDP would be the best tool for the job, saying in its charter that "UDP transmission of audio and video is only sufficient for small-scale experiments over fast portions of the Internet."[4]

As the Internet grew, the T-1 (1.5 Mbps) lines that had seemed fast became common, and using UDP for real-time transmission became more practical. Hence, when the working group released its specifications for the Realtime Transport Protocol (RTP) in January 1996, it stated that applications would "typically run RTP on top of UDP" (that is, with UDP) although "RTP may be used with other suitable underlying network or transport protocols."[5]

Meanwhile, realtime applications using proprietary protocols on top of the UDP layer began to enter the marketplace. These applications included popular Internet telephony packages, like Internet Phone, as well as CU-SeeMe, a videoconferencing package developed at Cornell University and now commercialized by White Pine Software. Each of these applications depend upon UDP's speed, compensating for UDP's tendency to drop packets by interpolating lost phonemes or video frames.

The more realtime applications were sent over the Internet using UDP, the more the software's main drawback came to the fore: UDP lacks congestion control. It provides no incentive to end-users to conserve bandwidth. Thus as RTP's designers put it, in January 1996:

> *[T]he current Internet cannot yet support the full potential demand for real-time services. High-bandwidth services using RTP, such as video, can potentially seriously degrade the quality of service of other network services. Thus, implementors should take appropriate precautions to limit accidental bandwidth usage. Application documentation should clearly outline the limitations and possible operational impact of high-bandwidth real-time services on the Internet and other network services.*[6]

So far, realtime UDP software has caused congestion only on relatively small sections of the Internet, or for short lengths of time. But the effects of such "brownouts" fall not on the UDP users who cause them, but on TCP-using bystanders on the same network. According to Jon Knight of Loughborough University of Technology,

> *some ISPs are reticent about high bandwidth applications. Firstly, these applications typically use UDP based technology (and in the case of many of the proprietary Mac and PC based ones, unicast UDP). High UDP traffic flows can be bad news for other users as, unlike TCP, UDP doesn't have any way to 'back off'*

Figure 1. World Wide Web Traffic as a Percentage of Total Internet Packets

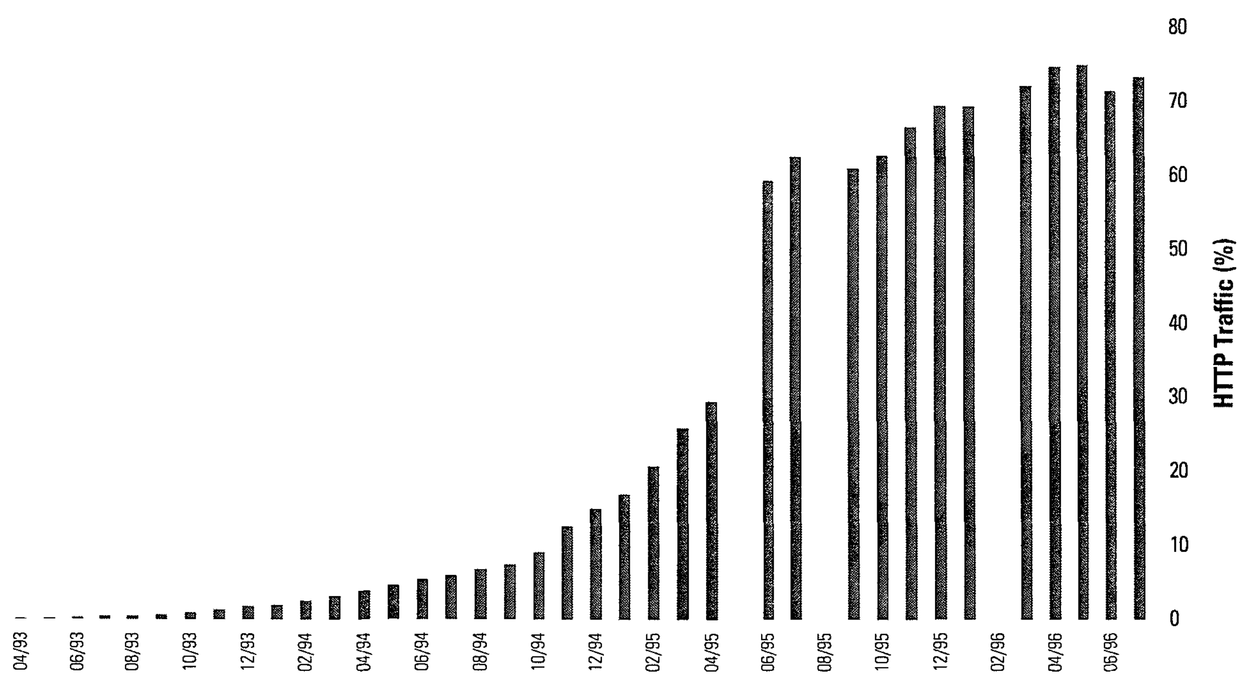

Figure 1: HTTP (World Wide Web) Packets as a Proportion of Total Internet Packets on the ANS backbone. For now, the Web is by far the most popular use of the Internet, responsible for much of the attention, money, and subscribership the Net has received. ISPs would be foolish to let a few Internet telephony users degrade the service that most of their subscribers use.
Source: Daniel McRobb, ANS Network Services

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when it hits congestion in the network. What happens in some situations is that a couple of users start high bandwidth UDP sessions which cause the better behaved TCP connections opened by lots of other users to back off. The other users then see rotten performance and complain to the ISP.[7]

As one group of researchers put it, current "congestion control designs do not work if some users choose to misbehave; in particular, greedy users can capture more than their share of bandwidth by not responding to congestion signals. Such greedy users not only capture more bandwidth for themselves, but also seriously degrade the service obtained by cooperating users."[8]

Congestion Control

UDP packets only precede TCP packets because routers, the computers that pass on Internet traffic, let them. And routers can be reprogrammed. To reduce congestion from voice or video, routers need only do two things: identify voice and video streams and act to limit these streams.

Identification is quite straightforward. Despite occasional claims that Internet telephony packets are indistinguishable from other Internet traffic, in fact each Internet telephony software package marks its packets with a distinctive port number. For example, packets generated by Internet Phone all are marked with port number 22555.

ISPs beset by congestion (and customer complaints), can easily program their routers to reject packets based on their port numbers, in effect turning off specific applications. This has already happened. To prevent a small number of video users from taking over their expensive transoceanic capacity, some providers in the Netherlands and some universities in Australia have already blocked UDP port use by CU-SeeMe, at least during certain hours. (Forty people receiving CU-SeeMe streams can tie up an entire T-1 line, which could be an ISP's entire link to the main Internet backbones.) Thus, by denying UDP packets to a few, they keep the TCP packets flowing smoothly to the majority of their users.

Because all the most crucial UDP applications (like the Name Server) have port numbers below 1024, an ISP desperate to shake off realtime traffic can block all ports above 1024, disabling all realtime voice and video while preserving the basic UDP functions.

> ***DROPPING UDP PACKETS WOULD FREE UP BANDWIDTH FOR WEB SURFERS AND OTHER TCP USERS, AND IT WOULD DEGRADE THE QUALITY OF INTERNET TELEPHONY CONVERSATIONS, THUS DISCOURAGING MORE CALLS.***

Such crude, all-or-nothing means of congestion control are necessary for the moment. The development of realtime software has simply outpaced the development of congestion control protocols. The current system for handling Internet traffic was designed for the small, cooperative, nonprofit Internet of the 1970s and 1980s. That Internet still exists, but it has been submerged beneath the large, anonymous, commercial Internet.

But ISPs will soon gain more control over UDP traffic. A new protocol, called Random Early Detection (RED), allows operators to ration bandwidth more carefully than before. RED, which ISPs can install on their routers, identifies offending packets not by reading port numbers but simply by determining which streams are contributing the most to congestion. Then it can clamp down on just those streams.

"RED gateways could easily identify which connections have received a significant fraction of the recently-marked packets.... This information could be used by higher policy layers to restrict the bandwidth of those connections during congestion."[9] In other words, RED could let by swift, slim messages like Name Server queries and http requests for files, while clamping down hard on bandwidth guzzlers like voice and video.

Though RED was first proposed some years ago, only now is it coming into widespread use. According to Stephen Casner, chairman of the IETF working group on Audio-Video Transport,

with the significant increase in UDP traffic ... the time has come when routers must implement congestion control. Algorithms such as RED ... have already been implemented in routers and are ready to deploy. It is expected that network service providers will deploy the new software and turn on these congestion control mechanisms over the next few months. This will cause the loss experienced by UDP traffic to go way up, and the loss experienced by TCP traffic to go down, so the TCP traffic will regain its fair share.[10]

Two leading manufacturers of routers have announced their support of the Integrated Services Architecture (ISA), which includes RED.[11]

With RED, ISPs will be able to fine tune the use of their networks. If a network manager decides that Internet telephony users are clogging the pipe, she can configure RED to begin dropping UDP packets. Dropping UDP packets would free up bandwidth for web surfers and other TCP users, and it would degrade the quality of Internet telephony conversations, thus discouraging more calls.

Pricing the Internet

Of course, ISPs do not want to punish their customers; they just want to make sure that each user pays his share. They will be able to use RED to force users into a new pricing regime, in which delay-tolerant and realtime users pay for the level of service they want.

The key to such a regime is yet another protocol, the Reservation Protocol (RSVP). RSVP allows providers to charge additional fees for guaranteed bandwidth. Only those realtime UDP streams paying the extra toll would be allowed through the RED gateway.[12]

This would mean that Internet telephony would no longer be unmetered. It might remain quite cheap; anywhere from a penny per minute to US$0.50, depending on a host of variables, but not free. And cheap and free can be very different when it comes to business models. Given the range of international telecom services available, it is not clear why consumers would pay much for Internet telephony when other inexpensive options, like call-back, offer superior quality and convenience.

Alternatively, the current all-or-nothing approach to blocking UDP could divide providers into two classes. Some providers could raise their fixed monthly fees, using the money to invest in more capacity for realtime applications, thus forcing realtime users to bear the full cost of their bandwidth demands. Other providers could block out the realtime UDP traffic, keeping congestion down without raising prices.

Whether they choose between providers or between two types of service from the same provider, users will be faced with two classes of Internet services: a more expensive realtime service and a less expensive delay-tolerant service.

In a February 1996 interview with *Interactive Age,* Vice President Marc Andreessen of Netscape (a company promoting Internet telephony) himself predicted that the spread of Internet telephony would destroy the very structure of unlimited-use pricing that has helped make it so alluring. Andreessen predicts extra fees for those using realtime Internet services, such as voice and video. "At the end of the day, it is an economic question. Either it will be worth the additional money (for end users) or it won't. Prices will be adjusted to reflect that reality."[13] ◆

Endnotes

1. Unlike circuit-switched telephony, which consumes an entire circuit even when people on both ends are silent, Internet telephony only uses bandwidth when someone says a word. Numerous technical articles on Internet telephony may be found at http://www.von.org, the Web site for Voice on the Net (VON).
2. Where local access to the Internet is metered, however, per minute charges generally apply as they do for any on-line session.
3. Internet Engineering Note (IEN) 88, http://www.uwaterloo.ca:80/uw_infoserv/ien.html
4. AVT Charter, http://www.ietf.cnri.reston.va.us/html.charters/avt-charter.html
5. RFC 1889, ftp://ds.internic.net/rfc/rfc1889.txt
6. *Id.*
7. Personal communication, February 14, 1996
8. Christopher Lefelhocz et al., "Congestion Control for Best-Effort Service: Why We Need a New Paradigm." *IEEE Network,* January/February 1996, vol. 10, No. 1, http://www.ieee.org/comsoc/lefelhocz.html
9. Sally Floyd and Van Jacobson, "Random Early Detection Gateways for Congestion Avoidance," *IEEE/ACM Transactions on Networking,* August 1993.
10. Personal communication, July 2, 1996.
11. Fred Baker, "Real-Time Services for Router Nets," *Data Communications on the Web,* May 21, 1996, http://www.data.com/Tutorials/Real_Time_Services.html
12. *See* Thomas Nolle, "Reservations about RSVP," *NetworkWorld,* October 28, 1996.
13. Richard Karpinski, "Andreessen Discusses Netscape's Real-Time Audio, Video" *Interactive Age,* February 7, 1996.

INTERNET DOMAIN NAMES

Whose Domain Is It Anyway?

by Robert Shaw

The past year has seen an intense debate in the press and on the Internet regarding policies for allocating domain names, the Internet's online equivalent of telephone numbers. The outcome is likely significantly to affect how the Internet is governed as well as its workload—that is, the routing of traffic from one section of the Internet to another.

The millions of computers which are connected to the Internet all have a unique geographical location. But on the Internet, what matters is their domain name or virtual address. And today the most coveted place on the Internet is the *.com* domain, a geographical domain intended for commercial organizations. It is now used for everything from locating the World Wide Web site of a company (www.ibm.com) to the online marketing of Hollywood movies (www.missionimpossible.com).

Until recently, registration of such domain names was first come, first served. Many names corresponding with well-known trademarks have been registered by nimble amateurs, sometimes with innocent intent, and sometimes in the hope of a quick payoff from a sleepy company which suddenly wants to get online. But the corporate world (especially in the litigious U.S.) is waking up (see Box 2 below).

Even so, registration under the *.com* domain won't work for much longer. This domain now has over 550,000 entries and registrations are running at over 20,000 per week; the desirable permutations of easy to remember names is quickly running out. With the current system, there's not enough space for the millions of new registrants who will want their own mnemonic cybersite.

Worse still, what is essentially a U.S. mess is turning into a global one. Domain name registrations in other countries are, unlike in the U.S., typically tagged with a "country code." For example, France uses *.fr* and Japan uses *.jp*. But *.com* is a non-country specific international top level domain that can be used by anyone in the world. As of June 1996, non-U.S. entities accounted for about 75,000 of the existing international top level domain registrations—and their relative percentage is rising.[1] What will happen when more non-U.S. companies want in and start waving their national trademarks too?

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So the rules for the Internet Domain Name System (DNS) are clearly overdue for reform. However, there is little agreement on what to do next. The only consensus seems to be that something needs to be done—and fast. But what and how?

Given the many policy issues relating to any modification of the DNS, this problem particularly begs the question: who should be setting Internet policy? Should it be the brilliant engineers who keep the Net running? Should it be governments who have partially subsidized domain name registration services? Should it be the commercial sector, which depends increasingly on the Net and is concerned about the relationship between trademarks and domain names? What about Internet service providers (ISPs) who also have a clear interest in a stable infrastructure? Should international multilateral organizations try to provide a forum for a neutral and international solution? (See Box 1 at page 43, "The Internet's Unelected Governors," for profiles of some of the major players.)

And what about the money involved? Internet domain names are a new form of intellectual property and insofar as they represent a scarce resource, they are quite valuable, both to those who hand them out and those who own them. Who, if anyone, should be profiting from the sale of this new cyber property?

What is the Domain Name System?

The Internet Domain Name System basically provides a method to map a user friendly name such as "www.microsoft.com" to a numeric address such as "198.105.232.6."

The suggestion for a hierarchical name space for the Internet was probably publicly described first in the RFC[2] document *Internet Name Domains* by D.L. Mills of Comsat Laboratories in 1981.[3] A few years later, J. Postel and J. Reynolds described a set of generic top level domains (TLDs) that are still in use today (see Table 1).[4]

Postel and Reynolds also defined top level domains based on two-letter "country codes" from the International Organization for Standardization's (ISO) 3166 standards.[5] Delegation and management of ISO 3166-based TLDs have been typically assigned to national, or (when not practical) regional reg-

Table 1. Generic Top Level Domains

Generic Top Level Domains Defined in RFC 920	Intended Usage
.gov	government
.edu	education
.com	commercial
.mil	military
.org	organization
Top Level Domains Later Defined	**Intended Usage**
.net	networking providers
.int	international treaty organizations and Internet databases
ISO Country Code Top Level Domains (a few examples)	**Intended Usage (According to Regional or National Registry Policy)**
.af	Afghanistan
.ch	Switzerland
.fr	France
.us	United States of America
.zw	Zimbabwe

Note: There is one more top level domain— arpa—which is solely used for Internet technical infrastructure needs.

istries.[6] At the national level, these assignments have typically been made on a first come, first served basis.

The usage of ISO-3166-based TLDs introduces a geographic and territorial (and therefore political) component to domain name space. However, since the Internet grew in a bottom-up fashion from research and academic environments, governments have traditionally taken little interest in the national registries. This is slowly changing. In some cases, government authorities have begun to give specific guidance to national name registries.[7] Other governments (often those with a restrictive political or highly regulated communications environment) have insisted on total responsibility for TLD management. Recognizing the politics involved, it has been one of those many unwritten Internet policies that if a government requests TLD management for a country, it gets it.[8]

With the commercialization of the Internet, national TLD registries have been rapidly moving away from the previously informal arrangements for domain name registrations. For example, both the U.K. and the Netherlands[9] have recently set up new legally distinct entities to handle domain name registrations. Naturally, the quickly developing relationship between domain names and trademarks has also led registries to be more concerned about potential legal liability. For example, the French Network Information Center (NIC) advisory group on naming policy recently declared:

> *The majority of representatives judge that it is necessary to apply legal criteria, exterior to the France NIC, for the definition of the naming plan ... in a manner to avoid direct litigation.*[10]

Another trend of the national registries is the widespread introduction of annual fees for domain name holders. For example, Switzerland's registration authority SWITCH introduced an annual fee of approximately US$80 after consultation with the Swiss telecommunications regulatory authority.[11] In Australia, France, Japan, the United Kingdom and other countries, the national TLD authorities have created subdomains under the country code TLD to further classify and divide the name space.[12]

Although there is also a country-code-based *.us* domain,[13] it is not used very much and many don't even know it exists. Many complain there is a problem of access. The *.us* domain has an elaborate subdomain naming scheme based on "political geography," but noticeable by their absence are the *.com, .net* and *.org* subdomains that many other countries use.

In any case, the poorly-developed use of the *.us* domain and what Internet cognoscenti refer to as "domain name envy," ".com envy" or "international envy" has led individuals and corporations alike to register in the generic TLDs without a national tag. Some perceive this as a great "equalizer" which reflects part of the spirit of the Net. However, outside the United States, American's lack of use of the *.us* country tag is widely perceived as an abuse of the domain name system.

There is a wide spread misperception that the generic TLDs *.com, .net,* and *.org* are U.S.-only domains. In fact, the rest of the world is learning that anyone can register in these domains and an increasing number of non-U.S. companies are doing so—from Swissair (swissair.com) to Mercedes-Benz (mercedes-benz.com).

Domain Name Registrations

In a cooperative agreement[14] with the U.S. National Science Foundation, Network Solutions Incorporated (NSI) of Herndon, Virginia has since 1993 administered the registration of the generic TLDs *.com, .net, .org, .gov* and *.edu.* The *.mil* domain is managed by the U.S. Department of Defense. The remaining *.int,* a specialized TLD intended for international treaty organizations, will, pending final agreement, be administered by the International Telecommunication Union (ITU) in Geneva, Switzerland. As mentioned, the *.gov, .edu* and *.mil* domains are restricted to U.S. applicants by allocation policy. This leaves *.com, .net,* and *.org,* which should be considered as international TLDs (iTLDs).

The NSF and NSI have been struggling to deal with the astronomical growth and commercialization of the Internet. When NSI began domain name registrations in the spring of 1993, approximately 400 domain names were being registered per month. However, in September 1996, this had risen to about 75,000—approximately a 15 percent growth rate per month. Since the overwhelming percentage were in the *.com* category, the NSF found itself essentially subsidizing commercial registrations which did not fall into its mandate. Reacting to this, NSF amended its cooperative agreement with NSI, allowing it to institute a US$50 a year charge for domain name registrations from 14 September 1995.[15]

Box 1. The Internet's Unelected Governors

Who?	Where You Can Find Out More	What You Really Need to Know
IETF	Internet Engineering Task Force http://www.ietf.cnri.reston.va.us/	These are the engineers who make Internet standards. You're essentially a member of the IETF if you participate in their work or pay to attend one of their tri-annual meetings.
IESG	Internet Engineering Steering Group http://www.ietf.cnri.reston.va.us/iesg.html	Handles the internal management of the IETF. Formed by Area Directors who handle Working Groups, an IETF Chair, and an IETF Executive Director who is principally funded by the US Government.
IAB	Internet Architecture Board http://www.iab.org/iab/	The Internet Architecture Board (IAB) is a technical advisory group of the Internet Society (ISOC).
ISOC	Internet Society http://www.isoc.org/	A "non-profit, scientific, educational and charitable" entity, incorporated in 1992 in the District of Columbia, USA, separate from the Corporation for National Research Initiatives (CNRI), to which it formerly belonged.
IANA	Internet Assigned Numbers Authority http://www.isi.edu/iana/ *See also ISI at http://www.isi.edu/*	An "Internet Service""of the High-Performance Computing and Communications (HPCC) Division of the *Information Sciences Institute (ISI)*, part of the University of Southern California's (USC) School of Engineering.
CRNI	Corporation for National Research Initiatives http://www.cnri.reston.va.us/	The IETF secretariat is located at the Corporation for National Research Initiatives (CNRI)
NSF	National Science Foundation http://www.nsf.gov/ See also NCRI at http://www.cise.nsf.gov/ncri/index.html	Provides support and grants for research in networking and communications including the now commercial NSFNet. The relevant group is the Networking and Communications Research and Infrastructure (NCRI) Division in the Directorate for Computer and Information Science and Engineering (CISE).
InterNIC	InterNIC http://www.internic.net/ The directory service can be found at http://ds.internic.net/. The registration service is at http://rs.internic.net/.	A project comprised of two distinct services partially funded by the NSF: Directory and Databases Services managed by AT&T and Registration Services managed by NSI.
NSI	Network Solutions Incorporated http://www.netsol.com/ See also SAIC at http://www.saic.com/	The company that performs most generic domain name registrations in a cooperative agreement with NSF. NSI is a subsidiary of a major privately owned U.S. Department of Defense contractor, Science Applications International Corporation (SAIC). SAIC has proposed to acquire Bellcore, the R&D company cooperatively owned by the U.S. Regional Bell Operating Companies.

Internet Monikers and Money

Among Internet users, the fee led to widespread negative reaction. Though the initial anger has now died down somewhat, criticism continues regarding the amount of money being made by NSI, a private corporation with a U.S. government blessed monopoly over essentially international name resources. During the period from September 1995 to September 1996, the new annual fee generated on the order of US$55 million in revenue (two years must be paid up front).[16] If the current monthly growth rate (15 percent) continues unabated, the fee will generate more than US$158 million in annual revenue for NSI. It is not clear what the actual costs are of performing a domain name registration. However, a significant revenue stream will accrue from the yearly renewal fee which involves little more than sending out a bill. Of the fees collected, NSI keeps 70 percent and the rest goes into an Internet "Intellectual Infrastructure" fund administered by the NSF. As of September 1996, this fund contained around US$7 million. Clearly, Internet domain name registries are now a big business.

Domain names are also being brokered for increasing amounts of money. For example, when Microsoft wanted "slate.com" for their new WWW-based interactive magazine of politics and culture, they reportedly purchased it for $10,000 (through a third party for obvious reasons). Undoubtedly greater amounts have been paid to obtain strategic domain names. Sometime the price is too high. An offer of US$50,000 is reported to have been rejected for "television.com." When AT&T wanted to launch their new Internet service, they attempted to purchase the domain name "worldnet.net," owned by a Paris-based Internet service provider. But even they balked at the reported US$500,000 asking price.

Box 2. Domain Names and Trademarks

The principle for registration of domain names has been till now first come, first served. Some domain names relating to famous trademarks like "7up.com" and "mcdonalds.com" were snagged early on by Internet aficionados and were handed over to their respective companies for token gifts or donations to charity. However, the realization that big companies were often willing to pay thousands of dollars for a mnemonic cyberpresence has lead to many cases of what has come to be known as domain name "hijacking." Many a company has realized after requesting an appropriate domain name that it belongs to somebody else. For instance, "coke com" currently belongs to Rajeev Arora of California and "rolex.com" is registered to Janice Ard of Colorado. At least in the case of well known trademarks (and especially when faced with legal action), most amateur speculators can be bribed to amicably relinquish an important name.

Caught in the middle between domain name holders and trademark owners, NSI instituted a policy in July 1995, later modified in November 1995, that gave trademark owners the ability to reclaim a domain name if they could produce a corresponding federal (national) trademark.

But this policy has neither mollified trademark owners or domain name holders Many rightly point out that trademark law allows multiple entities to share the same name if they are not in competing businesses and/or the same geographical area—for example, there can be a McDonald's computer company and a McDonald's hamburger company. However, on the Internet, there can only be one "mcdonalds.com" (now owned by the latter). Trademark lawyers also discovered that a trademark from any country could possibly be used to defend the usage of a domain name. This led to trademark registrations by domain name holders in places like Tunisia, where in 48 hours, a "federal" trademark can be produced. The NSI policy also does not deal with domain names that, although not identical to a trademark, can constitute infringement of U.S. "common law" trademarks not registered under the Lanham Act

One of the basic problems that NSI faces is that it is handing out international domain names but that existing trademark law is fundamentally national—there is no such thing as a widely recognized "international trademark." In the non-Internet world, there is an established tradition of dealing with trademarks on a national basis. Trademark rules may be different in the U.S., France or Japan but in each country there is a procedure and clear jurisprudence for dispute resolution. This is strongest at the national level with occasional provisions at the regional and international level Trademarks are only the first of many issues that will fundamentally put territorial based legal systems into conflict with the Internet.

The relationship between trademarks and domain names has been described in detail elsewhere. One of the best summaries is probably David Maher's "Trademarks on the Internet. Who's in Charge?"(http://www.aldea.com/cix/make.html). Another survey is "What's In a Name?" from students at the Georgetown University Law School (see http://www law.georgetown.edu/lc/internic/domain1.html).

Box 3. International or National Top Level Domains?

Arguments for New International TLDs	Arguments for Country-Code-based TLDs
• Already over 400,000 registrations in .com, .net and .org exist that would be impossible to "repatriate" to country-code-based TLDs	• Respects national sovereignty in definition of National Information Infrastructure (NII) policies
• Marketplace seems to have indicated that domain names without country codes are preferred	• Respects national naming conventions (e.g., co.uk, plc.uk, ltd.uk) and national language conventions (e.g., .gov.uk, gouv.fr)
• Globalization trend in telecommunications services (e.g., international freephone services)	• Provides an up-front national registry-level basis for rejecting name registrations with potential trademark conflicts
• Introduces competition in domain name registries (breaks NSI monopoly)	• Provides a basis for dealing with domain names that are considered offensive
• Facilitates alternative access to what has become a "scarce" resource (.com)	• International TLDs further complicate the legal quagmire of trademark issues dispute resolution
	• New international TLDs would lead to more users who acquire "rights" in international name space without a legal framework

Evolving Domain Name Space

Proposals for the evolution of DNS have gained momentum since late 1995 with a series of workshops sponsored by the Harvard Information Infrastructure Project, the NSF, the Commercial Internet eXchange (CIX) and the Internet Society (ISOC).[17]

In November 1995, an Internet draft was published by B. Carpenter et al., "Proposal for an ISOC Role in DNS Name Space Management." It suggested that the "Internet Society take a formal role in the oversight and licensing of competitive registries for international Internet name space." This was followed by another Internet draft in January 1996 by R. Bush et al., "Delegation of International Top Level Domains (iTLDs)." Most recently, Jon Postel, Head of the Internet Assigned Numbers Authority (IANA) has authored a proposal "New Registries and the Delegation of International Top Level Domains"[18] that plans the creation of up to 150 new international top level domains (like *.com*, *.net* and *.org*). Up to 50 new registries performing functions similar to NSI would be awarded. In this scheme, ISOC would be the "international, legal and financial umbrella" of IANA.

There are both pros and cons to creating new international top level domains (see Box 3). While doing so may or may not be a good idea, the problems here seem really of a process nature. Which parties should be consulted in reforming of international Internet name space? Certainly many more than are currently involved. Many of the potentially concerned parties such as the WWW Consortium, the European Commission DGXIII, Réseaux IP Européens (RIPE), and Asia-Pacific Network Information Center (APNIC), have been listed by Anthony M. Rutkowski, ex-Executive Director of ISOC, in a recent paper posted on the Internet.[19] It is also obvious that many governments also want to have a say in issues related to a nascent Global Information Infrastructure. As Rutkowski as pointed out, even though any DNS policy decision would have an impact on international name space, no non-U.S. public policy officials have ever been involved in the public meetings held to date.

Would a neutral solution for international name space really be encouraged by bringing the ISOC into the process? Reading between the lines, it's hard to see. According to Postel's draft, these potentially multi-million dollar generating registries will be awarded by an "ad-hoc working group" comprised of three people from IANA, two from the Internet Engineering Task Force (IETF) and two from ISOC. Yet these groups of engineers (albeit well intentioned) have a very limited legal or policy authorization. For ISOC (or any group) to claim responsibility for delegating international name space when there are such high stakes appears unsustainable. The Internet has become far too commercial and strategically important as a global communications tool to simply perpetuate the same informal arrangements that have kept it glued together until now. Interestingly, ISOC has now seemed to recognize this and has proposed that iTLD policy be set by an "International Ad Hoc Committee" (IAHC), including a more international representation.

At the recent Montreal IETF/INET meeting in June 1996, however, the ISOC Board of Trustees voted, in principle, to back the new proposal. Note that the last version of the pro-

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posal calls for ISOC to receive 2 percent of the annual income from the registries.

How DNS Rules Affect The Internet's Workload

Historically, the servers responsible for the root (sometimes referred to as the "." zone) have also been responsible for domain name lookup services for all international top level domains (iTLDs) like *.com, .net,* and *.org.* With one exception, these servers are all located in the United States. They are operated by Network Solutions in Virginia, the Information Sciences Institute (ISI) at the University of Southern California, large Internet service providers, NASA, the University of Maryland, Paul Vixie (primary author of DNS code) in California, two by the U.S. Department of Defense, and one by NORDUnet in Sweden. The IANA has traditionally had responsibility for coordination of these sites.

There has been some discussion of diversifying the geographical location of the root servers and placing them more towards the "core" of the global Internet; starting with experimental root servers in Asia and Europe (DNS technology allows up to 13 root servers). These still inconclusive deliberations are taking place in the the Internet Engineering and Planning Group (IEPG); a group mainly comprised of Internet Service Operators.[20]

There are also grumblings in the Internet technical community that, considering the amounts of money that NSI takes in from *.com* registration services, it should more directly contribute to the costs of running the root name servers. And in fact, NSI has offered machinery and funding to these groups. However, the uneasy tension between NSI and the Net technical community (which feels NSI has been unfairly handed a cash cow by NSF) has resulted in some of these offers being rejected to maintain independence.

At the root level, the limited number of new international top level domains being proposed would have a minimal impact on the root servers since it is hard to imagine that there would ever be more than 500 entries (there are currently about 200 ISO 3166 TLD entries plus the existing iTLDs). Therefore, the service requirements for the root level are several orders of magnitude less than lookup services required for the current 550,000 entries in ".com." However, the fact that the root server are run for free, combined with the increasing load of existing iTLDs (e.g., .com) means it may make sense to remove iTLD name services from the root servers.

Technically there is no reason that this couldn't happen. In fact, considering the somewhat different operational and administrative requirements of the root and iTLD name services, it is probably a good idea. One catalyst might be new international top level domains. There is the sentiment that the considerable income garnered from domain name registration services should be used to directly pay for distributed iTLD name servers. And since the plan for new iTLDs is that they be awarded to new registries around the globe (where related name servers would be co-located), the eventual popularity (which is unclear) of iTLD name servers than the U.S.-centric model that exists today.

Conclusion

The Internet is in a painful transition period and appears to be caught in a cross-fire between tremendous commercial, political, legal and operational interests and anarchistic Net individuals who still want to do their own thing. While chaos may still be one of the Internet's strengths, others are concerned with a certain stability of infrastructure, international comity, respect for legal issues such as trademarks and accountability which is part of the real world.

The current conflicts concerning DNS are likely only the tip of an iceberg. What seems important to the Internet technical community will need to be increasingly balanced with the views of other communities—an inescapable consequence of the new strategic and commercial importance of the Net. In fact, the skirmishes within the trademark community may well prove to be minor when compared to likely future battlegrounds where the stakes are higher (e.g., Internet telephony and interexchange settlements for backbone providers). In this new Internet of many stakeholders, it's going to get increasingly difficult to reach that IETF credo of "rough consensus." ◆

Endnotes

1. See MIDS Press Release: Global Domain Names Grow Rapidly Worldwide at http://www.mids.org/prdomreg.html.

2. The 'Request for Comments' (RFC) document series is the official publication channel for Internet standards documents and other publications of the IESG (Internet Engineering Steering Group), IAB (Internet Architecture Board), and Internet community. See C. Huitema et al., "Not All RFCs are Standards," RFC 1796, ftp://ds.internic.net/rfc/rfc1796.txt, April 1995. Any RFC can be retrieved with the address ftp://ds.internic.net/rfc/rfcxxx.txt where xxx is the RFC number.

3. D.L. Mills, *Internet Name Domains,* RFC 799, ftp://ds.internic.net/rfc/rfc799.txt, September 1981.

4. J. Postel, J. Reynolds, *Domain Requirements,* RFC 920, ftp://ds.internic.net/rfc/rfc920.txt, October 1984.

5. ISO 3166, see http://www.iso.ch/cate/d22748.html. The standard defines two character (alpha-2) and three character (alpha-3) versions. The Internet domain name system uses the alpha-2 version.

6. Notably the Asian-Pacific Network Information Center (APNIC) at http://www.apnic.net and Réseaux IP Européens (RIPE) at http://www.ripe.net.

7. See 5e REUNION DU COMITE DE CONCERTATION NIC FRANCE du 14/02/96, http://www.nic.fr/Presentation/CC/cc-960214.html.

8. See notes from workshop Internet Names, Numbers, and Beyond: Issues in the Coordination, Privatization and Internationalization of the Internet, http://ksgwww.harvard.edu/iip/nsfmin1.html, November 20, 1995.

9. See http://www.nic.uk/press.html and http://www.domain-registry.nl/.

10. See http://www.nic.fr/Presentation/GT/gt-960320.html.

11. See http://www.nic.ch.

12. See Domain Names within the U.K. at http://www.nic.uk/new/domains.html and http://www.nic.uk/proposals/rup1.html. See also Pages Jaunes des Domaines de la Zone Francaise (FR) at http://www.nic.fr/Annuaire/index.html.

13. A. Cooper and Jon Postel, *The U.S Domain,* RFC 1480, ftp://ds.internic net/rfc/rfc1480.txt, June 1993.

14. See NSF Cooperative Agreement at http://rs.internic.net/nsf/agreement.

15. See http://www.isoc.org/adopsec/nsf-name-fees.html and http://rs.internic.net/announcements/index.html.

16. See NSF Cooperative Agreement No. NCR-9218742, Amendment 4 at http://rs.internic.net/nsf/agreement/amendment4.html.

17. Internet Names, Numbers, and Beyond: Issues in the Coordination, Privatization and Internationalization of the Internet, convened in November 1995 in Washington, D.C. The workshop was sponsored by NSF's Networking and Communications Research and Infrastructure (NCRI) Division and the Harvard Information Infrastructure Project (IIP). A second workshop on Internet Administrative Infrastructure was held in February 1996 sponsored by the Commercial Internet Exchange (CIX) and ISOC. A third related workshop Coordination and Administration of the Internet was held in 1996 in Cambridge, Massachusetts, sponsored by the Harvard IIP, CIX, ITU and ISOC.

18. Jon Postel, "New Registries and the Delegation of International Top Level Domains," Internet Draft, ftp://ds.internic.net/Internet-drafts/draft-postel-iana-itld-admin 01.txt, June 1996.

19. See http://www.wia.org/pub/policy-orgs.html. See also Richard Hovey and Scott Bradner, "The Organizations Involved with IETF Standards Process," Internet Draft, ftp://ietf.cnri.reston.va.us/internet-drafts/draft-ietf-poised95-ietf-orgs-03.txt, June 1996.

20. For further discussion on how DNS can geographically spread the Internet's workload, see T. Brisco, "DNS Support for Load Balancing," RFC 1794, ftp://ds.internic.net/rfc/rfc1794.txt, April 1995.

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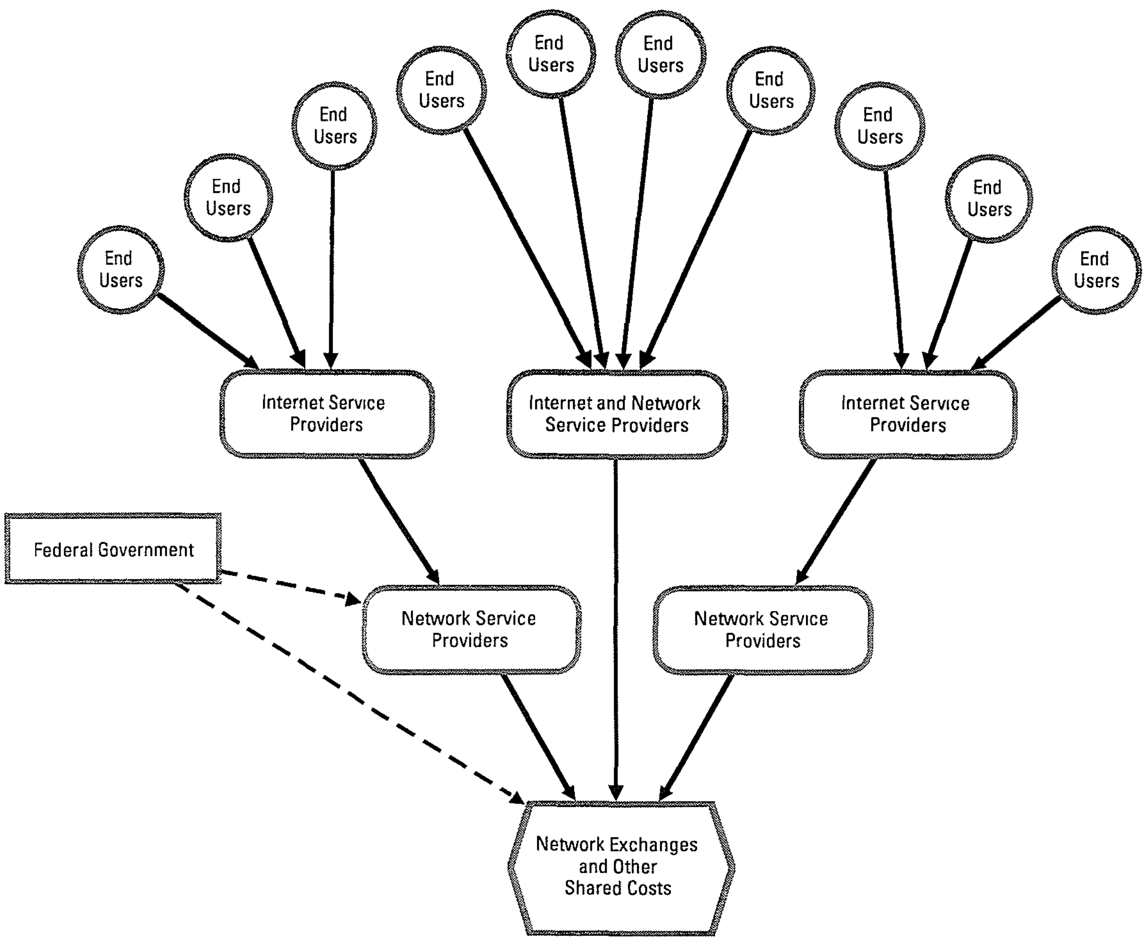
Mapping the Internet

How does the Internet work? A map of the infrastructure—the main backbone networks and Network Exchanges—does not tell you very much about how packets of data actually get from one computer to another. Likewise, if you simply map the flow of packets from one site to another you can easily miss how the money flows. Hence, the following pages try to provide an overview of how the Internet works by presenting three different views: commercial, operational and geographical. Each provides part of the answer.

Figure 1. Internet Cash Flows



Cash flows on the Internet begin with the end user (e.g., an individual, company, or university) that pays an Internet service provider (ISP) for access. Many small ISPs, in turn, pay larger ISPs for access to their networks. Each ISP must directly or indirectly connect with, and pay for access to, a Network Service Provider (NSP). The NSPs consist of regional, national and international backbone providers that connect to each other at Network Exchange points. In North America these Exchanges are commonly known as Network Access Points (NAPs) or Metropolitan Area Exchanges (MAEs). The major North American Exchanges are profiled at p. 52 below. In some cases the functions of ISPs and NSPs are consolidated into a single entity (e.g., Internet MCI).

Note: The chart is intended to be illustrative of economic relationships in the U S only. The U S Federal Government, which originally subsidized the network for scientific and defense purposes, has withdrawn most funding but continues to contribute towards research and essential services.

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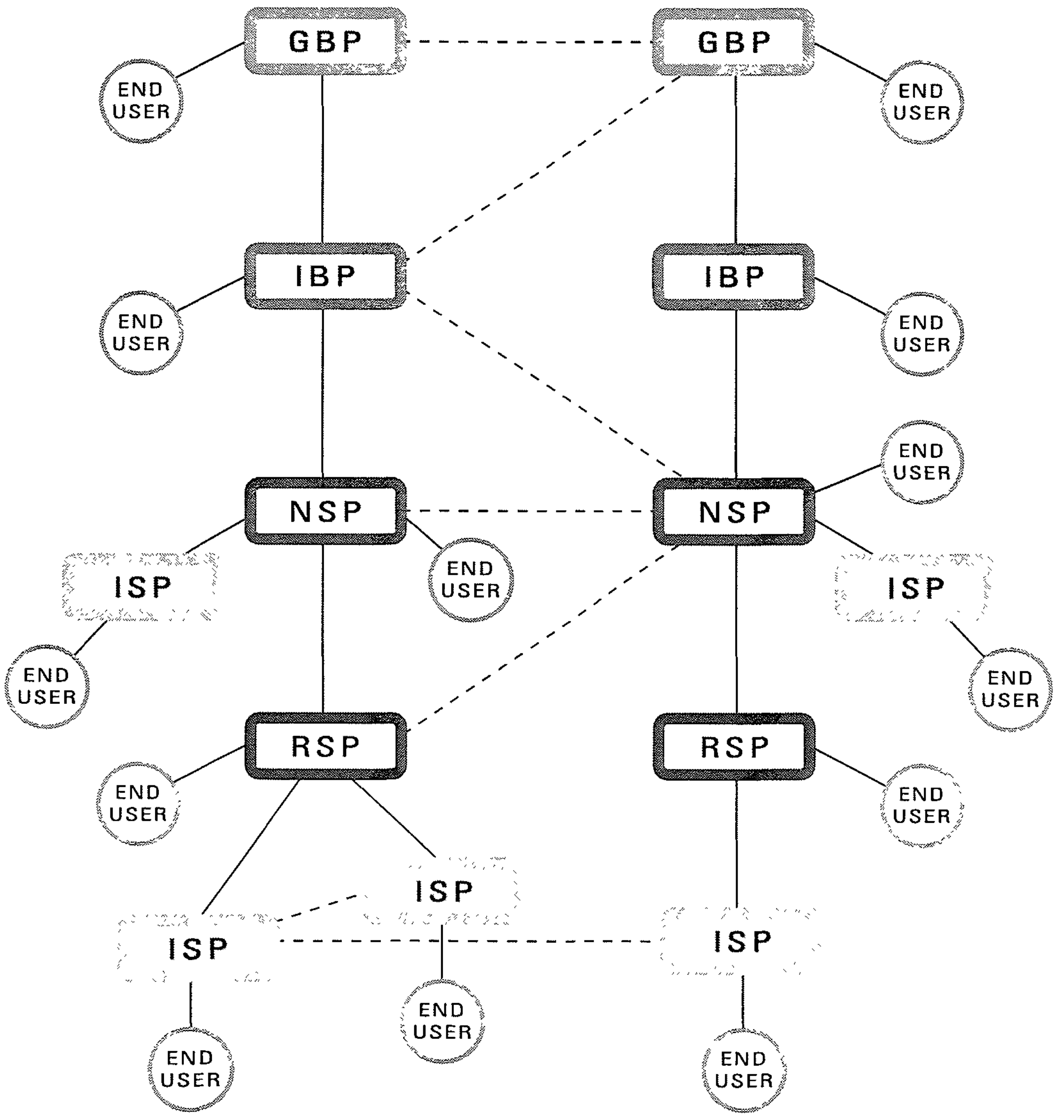
Figure 2. Internet Packet Flows: End Users to Global Backbones



Competition and rapid growth are bringing both diversification and stratification in Internet infrastructure. Global connectivity can be assured only through a complex set of peering and transit relationships between providers. Peer networks exchange their own customer routes with each other; a network providing transit to another allows its backbone to be used to reach a destination not on its own network. Individuals or enterprise networks choose providers based on service offerings, cost, support, and quality of service.

KEY

———— = customer or transit relationship
- - - - - - = peering relationship
GBP = global backbone providers
IBP = international backbone providers
NSP = national service provider
RSP = regional service provider
ISP = internet service provider / reseller
End User = individual or enterprise network

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Box 1. Internet Exchanges: Where the Backbones Meet

Until 1994, the backbone transmission facilities used for the Internet were underwritten by the U.S. National Science Foundation (NSF) As multiple commercial backbones took over the government's role, the NSF established a series of priority network access points (NAPs) for national and regional networks to interconnect.

The high priority NAPs designated by the NSF included: Sprint's New York NAP, Ameritech's Chicago NAP, and PacBell's San Francisco NAP. In addition, the MFS metropolitan area exchange (MAE) for Washington, D.C., MAE-East, was given special priority status. A similar facility in northern California, MAE-West, also attracted a number of networks

The NSF's system of NAPs could not keep up with the growth of new backbones and traffic, however. Packets destined for an e-mail box located across the street in Los Angeles, for example, might take a trans-continental journey to MAE-East and back for delivery. By early 1996 many network service providers began to establish regional exchanges that could avoid the congestion at the major U.S. national exchanges (see Table 1 at p. 52).

These new sub-national switching points for Internet traffic provide a low-cost alternative for local interconnection to the NSF priority NAPs, other national exchanges, and continental transit backbones. In the simplest designs, Internet service providers (ISPs) link to an exchange using frame relay protocol or a shared Ethernet hub. As the exchange traffic increases, other technologies are easily introduced. Most of these facilities are located in large metropolitan areas in which a significant portion of the traffic (estimated between 10 to 50 percent), is expected to remain local.

The regional exchanges may prove effective in reducing traffic routed over the more expensive large exchanges Further, as major national transit providers begin moving towards private interconnects, the balance of traffic routed through private, national and regional interconnects can be expected to change dramatically in 1997.

—Barbara Dooley

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Table 1. The Internet's Big Switches: Major U.S. Network Access Points (NAPs)

Region	City	NAP Name	NAP Type	Type of Connection	Facilities Owner or Operator	Networks Connected
Eastern						
Massachusetts	Boston	Boston MXP	Regional	Frame Shared Ethernet Switched Ethernet	Management Analysis Inc. (MAI)	n.a
New Jersey	Pennsauken	NY NAP (NSF) FIX-East	National International Federal	FDDI Switched Ethernet	Sprint	21+6 pending
New York	New York (Manhattan)	NYIIX	National International	FDDI Switched Ethernet	Telehouse America	2+4 pending
	New York (Manhattan)	NYRIX	Regional	Switched Ethernet	Telehouse America	planned
	New York (Manhattan)	MAE-NY	Regional	FDDI Switched Ethernet	MFS Datanet	planned
Washington, DC Metro	Tysons Corner, VA	MAE-East	National International	FDDI Switched Ethernet Switched FDDI	MFS Datanet	55+
	Tysons Corner, VA *(moving to Pennsauken)*	FIX-East	Federal	FDDI Switched FDDI Switched Ethernet	US Government	3
Central						
Illinois	Chicago	Chicago NAP (NSF)	National	ATM FDDI	Ameritech (AADS)	18+2 pending
	Chicago	MAE-Chicago	Regional	FDDI Switched Ethernet	MFS Datanet	3
Michigan	Detroit	Detroit MXP	Regional	FDDI Switched Ethernet Shared Ethernet TCNS	MAI	2
Missouri	St Louis	STLOUIX	Regional	Shared Ethernet	Data Research Associates	2
Southern						
Texas	Dallas	MAE-Dallas	Regional	Switched Ethernet	MFS Datanet	n.a.
	Houston	MAE-Houston	Regional	Switched Ethernet	MFS Datanet	4+ pending
Western						
Arizona	Phoenix	Phoenix REP	Regional	Switched Ethernet	RTD	5
	Tucson	Tucson NAP	Regional	Frame Relay Switched Ethernet	RTD	4+ pending
	Tucson	Tucson Interconnect	Regional	Frame Relay	ACES Research	8
California	San Francisco	SF NAP (NSF)	National International	FDDI ATM	Pacific Bell	22+ pending
	Palo Alto	Digital Internet Exchange Palo Alto (PAIX)	Regional National International	FDDI	Digital Equipment Corp	6+ pending
	Palo Alto/Santa Clara (moving to Palo Alto)	CIX NAP	National International	FDDI Frame Relay SMDS	Digital Equipment Corp./Wiltel (transition to Digital)	13 SMDS 17 direct connect + pending
	San Jose	MAE-West	National International	FDDI Switched FDDI Switched Ethernet	MFS Datanet	37+ pending
	Mountain View	MAE-West FIX-West	National Federal	FDDI Switched FDDI Switched Ethernet	NASA-Ames	10
	Los Angeles	LA NAP	Regional	ATM	Pacific Bell	1
	Los Angeles	MAE-LA	Regional	Switched FDDI Switched Ethernet	University of Southern California	3
	Los Angeles	MAE-LA	Regional	Switched Ethernet	MFS Datanet	planned
Utah	Salt Lake City	Utah REP	Regional	Frame Relay Shared Ethernet Switched Ethernet	Inquo	4
Northwest	Oregon/Washington	NW Internet eXchange (NIX)	Regional	Frame Relay	ELI	4

Acronyms:
ATM = Asynchronous Transfer Mode
FDDI = Fiber Distributed Data Interexchange
SMDS = Switched Multimegabit Data Service
TCNS = Thomas Conrad Network Service

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Box 2. High-Speed Internet Backbones, 1995-96

Like a river system or tree canopy, the Internet comprises millions of tiny connections feeding into progressively larger links that ultimately connect to a few large trunks. In the case of the Internet, these "backbones" are leased circuits on fiber-optic cables connecting switching computers called routers.

The size of the backbones is constantly growing. In 1991, the American NSFNet backbone consisted of T-1 (1.5 Mbps) lines, which were the highest-capacity lines used for the Internet at that time. In the early 1990s, this backbone was upgraded to T-3 speeds (45 Mbps), and now several commercial T-3 networks cover the United States. Even 45 Mbps may soon seem slow, as MCI has installed OC-3 (155 Mbps) lines on both its own U.S. network and the vBNS network it operates for the National Science Foundation. And in June it announced plans to upgrade its commercial network to OC-12 (622 Mbps).

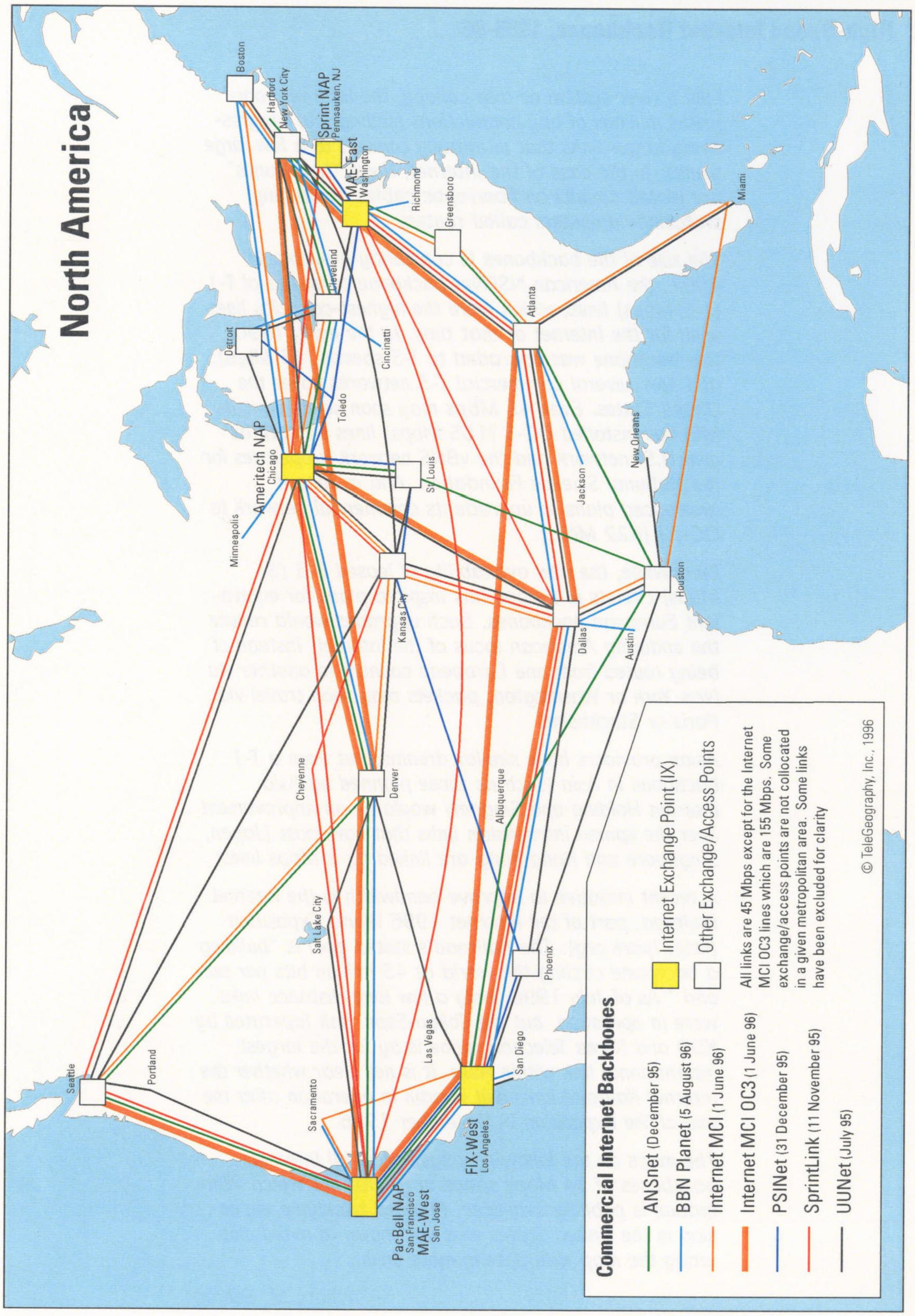
Meanwhile, the new availability of leased E-3 (34 Mbps) circuits in Europe has inspired plans for equivalent European backbones. Such upgrades would reduce the enduring American focus of the Internet. Instead of being routed from one European country to another via New York or Washington, packets may soon travel via Paris or Stockholm.

Asian providers have similar dreams, but even a T-1 backbone in Asia (such as those planned by Asia Internet Holding and Singnet) would be an improvement over the sparse intra-Asian links that now exist (Japan, Singapore and Hong Kong are linked by 2 Mbps lines).

A recent initiative to improve bandwidth is the Internet Railroad, part of the Internet 1996 World Exposition (http://park.org). The Railroad's stated goal is "building a backbone circling the world at 45 million bits per second." As of July 1996, only a few long-distance links were in operation, but the Tokyo-Seoul link (operated by KDD and Korea Telecom) alone is by far the largest international link within Asia. It is not clear whether the Internet Railroad links will remain in operation after the end of the Exposition in December 1996.

The maps on the following pages show all Internet backbones of 34 Mbps speed or greater for which information is publicly available. Planned backbone expansion in the United States was not shown to avoid cluttering the map with dozens more links.

—Zachary M. Schrag


North America
Boston
Hartford
New York City
Sprint NAP
Pennsauken, NJ
MAE-East
Washington
Richmond
Greensboro
Miami
Cleveland
Detroit
Cincinatti
Toledo
Atlanta
Ameritech NAP
Chicago
St Louis
Minneapolis
New Orleans
Jackson
Kansas City
Houston
Dallas
Austin
Cheyenne
Denver
Albuquerque
Salt Lake City
Phoenix
Las Vegas
San Diego
Seattle
Portland
Sacramento
FIX-West
Los Angeles
PacBell NAP
San Francisco
MAE-West
San Jose
Commercial Internet Backbones
ANSnet (December 95)
BBN Planet (5 August 96)
Internet MCI (1 June 96)
Internet MCI OC3 (1 June 96)
PSINet (31 December 95)
SprintLink (11 November 95)
UUNet (July 95)
Internet Exchange Point (IX)
Other Exchange/Access Points
All links are 45 Mbps except for the Internet MCI OC3 lines which are 155 Mbps. Some exchange/access points are not collocated in a given metropolitan area. Some links have been excluded for clarity
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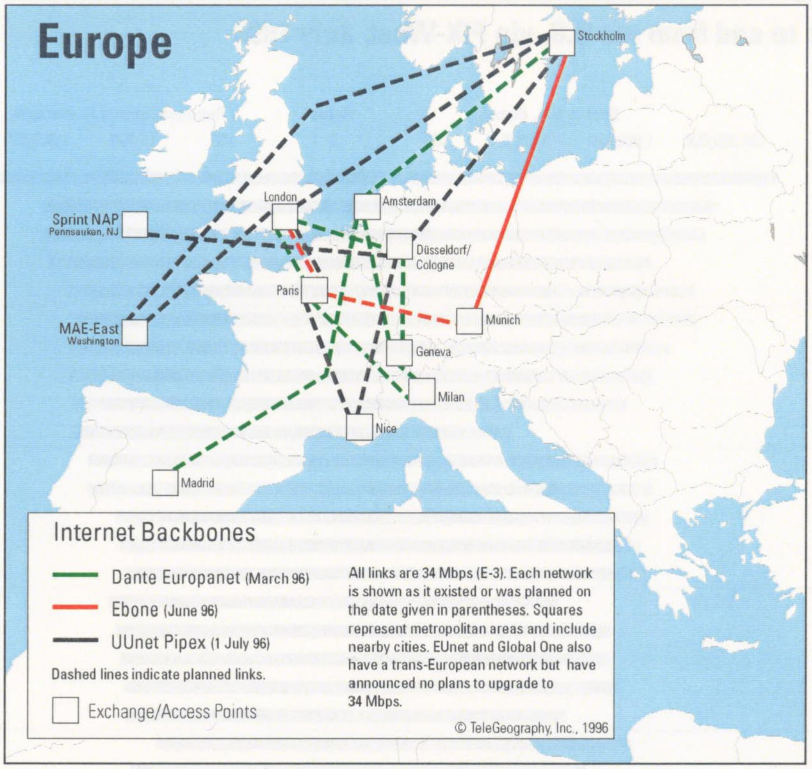
Europe
Stockholm
London
Amsterdam
Sprint NAP
Pennsauken, NJ
Düsseldorf/
Cologne
Paris
Munich
MAE-East
Washington
Geneva
Milan
Nice
Madrid
Internet Backbones
Dante Europanet (March 96)
Ebone (June 96)
UUnet Pipex (1 July 96)
Dashed lines indicate planned links.
Exchange/Access Points
All links are 34 Mbps (E-3). Each network is shown as it existed or was planned on the date given in parentheses. Squares represent metropolitan areas and include nearby cities. EUnet and Global One also have a trans-European network but have announced no plans to upgrade to 34 Mbps.
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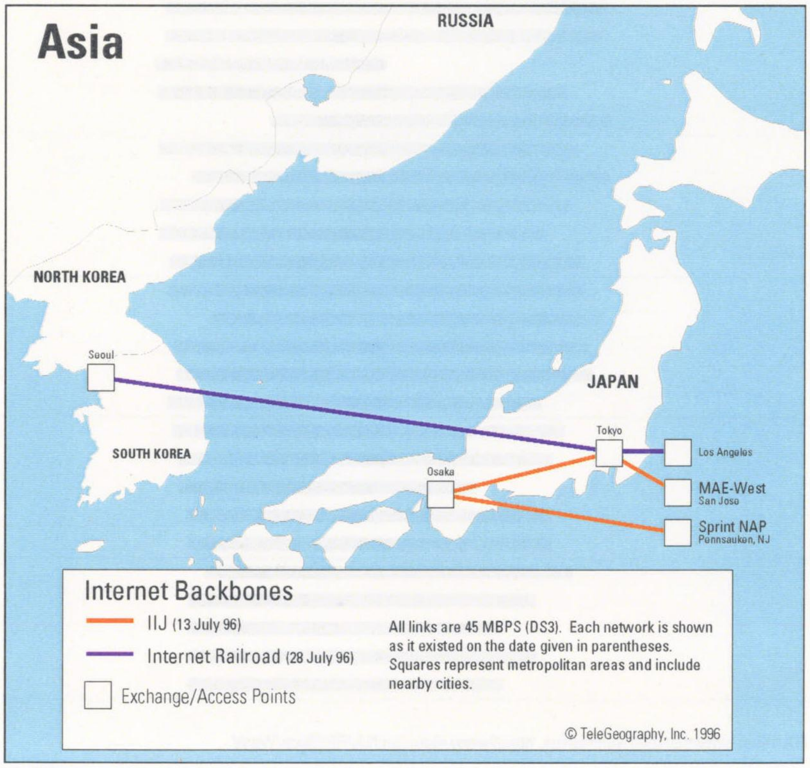
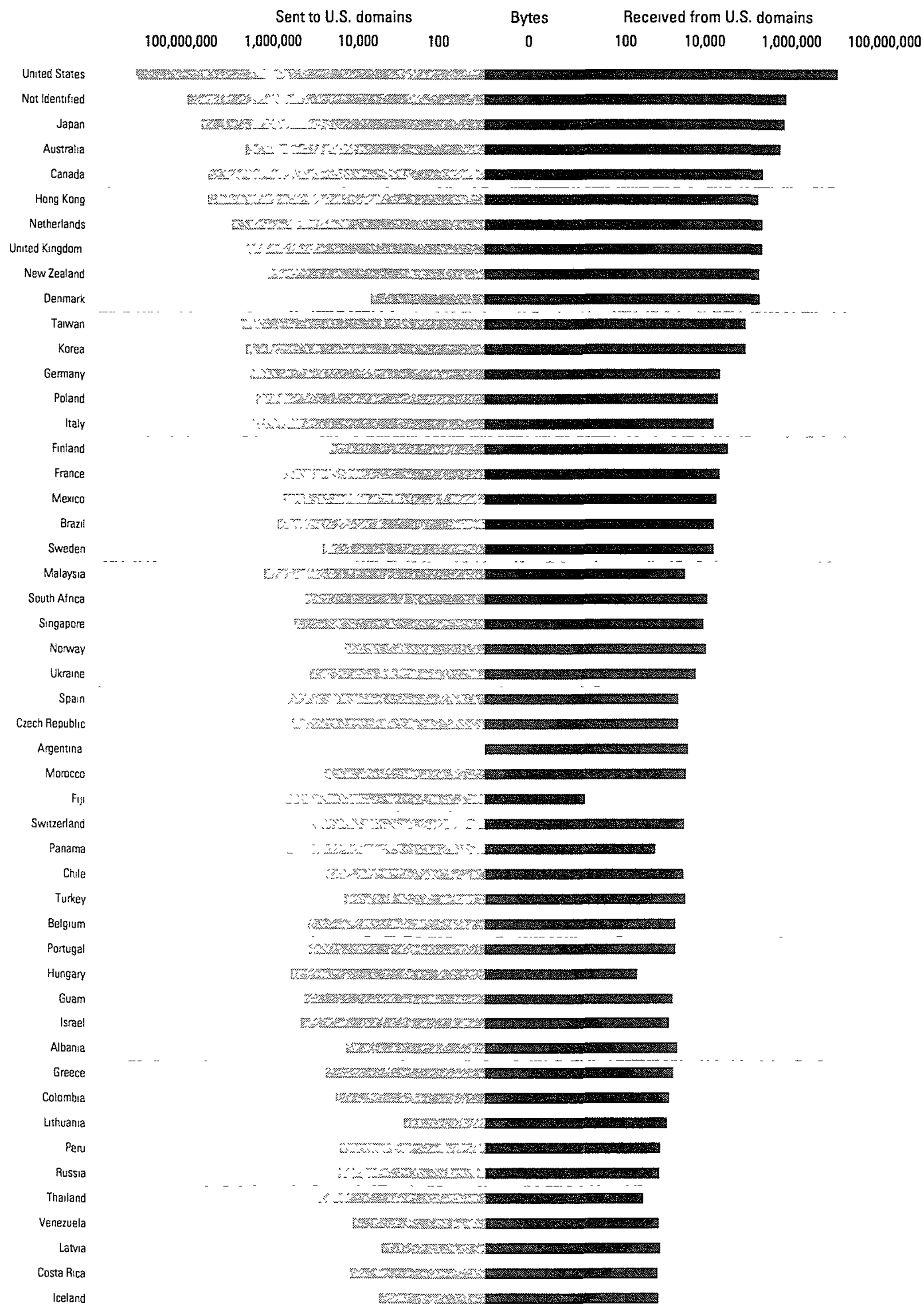

Asia
RUSSIA
NORTH KOREA
Seoul
JAPAN
Tokyo
Los Angeles
SOUTH KOREA
Osaka
MAE-West
San Jose
Sprint NAP
Pennsauken, NJ
Internet Backbones
IIJ (13 July 96)
Internet Railroad (28 July 96)
Exchange/Access Points
All links are 45 MBPS (DS3). Each network is shown as it existed on the date given in parentheses. Squares represent metropolitan areas and include nearby cities.
© TeleGeography, Inc. 1996

Figure 3. Traffic to and from the U.S. via FIX-West, July 1996



Source. FIX-West statistics data summaries, http://www.nlanr.net/NA/FIX/Stats/West/

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Table 2. Host Computer Growth by Domain, 1995-1996

Domain	*Hosts, July 1995*	*Hosts, July 1996*	*Growth, 95-96*
Commercial (com)	1,743,390	3,323,647	191%
Education (edu)	1,411,013	2,114,851	150%
Network (net)	300,481	1,232,902	410%
United Kingdom (uk)	291,258	579,492	199%
Germany (de)	350,707	548,168	156%
Japan (jp)	159,776	496,427	311%
United States (us)	113,226	432,727	382%
Military (mil)	224,778	431,939	192%
Canada (ca)	262,644	424,356	162%
Australia (au)	207,426	397,460	192%
Government (gov)	273,855	361,065	132%
Organization (org)	201,905	327,148	162%
Finland (fi)	111,861	277,207	248%
Netherlands (nl)	135,462	214,704	158%
France (fr)	113,974	189,786	167%
Sweden (se)	106,725	186,312	175%
Norway (no)	66,608	120,780	181%
Italy (it)	46,143	113,776	247%
Switzerland (ch)	63,795	102,691	161%
South Africa (za)	41,329	83,349	202%
New Zealand (nz)	43,863	77,886	178%
Denmark (dk)	36,964	76,955	208%
Austria (at)	40,696	71,090	175%
Spain (es)	39,919	62,447	156%
Korea, Republic of (kr)	23,791	47,973	202%

Note: The vast majority of computers using three-letter domains (com, edu, org, gov, mil, and net) are located in the United States Host computers are not necessarily located in the same country as the domain name.

Source Network Wizards, Internet Domain Survey (http://www nw.com)

Want to Keep up on Mapping Cyberspace?

Visit Martin Dodge, a researcher at the University College of London and keeper of the "Geography of Cyberspace" homepage. His Web page has extensive links to sites and resources which address everything from network topology to Web demographics (http://www.geog.ucl.ac.uk/casa/martin/geography_of_cyberspace.html).

A country-by-country listing of international network connectivity (i.e., who has full Internet access and who has e-mail only) is maintained by Larry Landweber, Computer Sciences Department, University of Wisconsin and can be obtained via anonymous ftp from ftp.cs.wisc.edu in the connectivity_table directory. Maps are also available.

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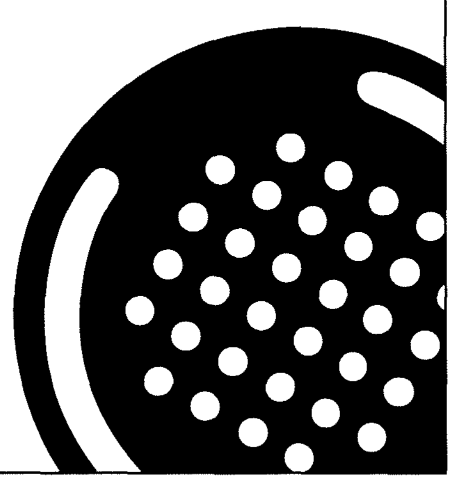
International Facilities and Carriers



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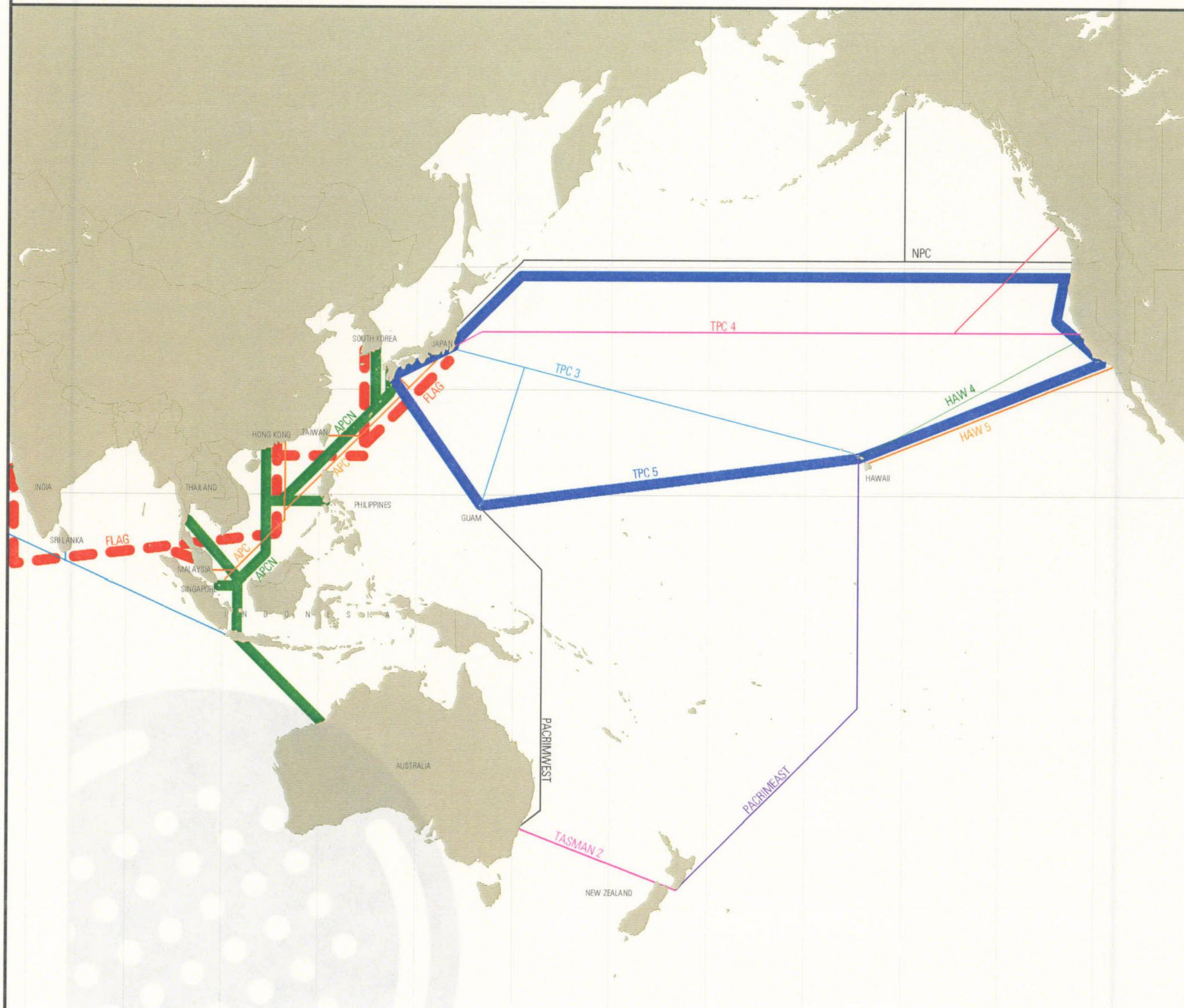
Trans-Pacific Cable Systems

Year in Service	Cable System	Cost (US$) per voice path	Capacity (voice paths)
1957	Hawaii 1*	378,000	91
1964	TPC-1*	406,000	167
1974	Hawaii 2*	41,000	1,690
1975	TPC-2*	73,000	1,690
1988	TPC-3	16,000	37,800
1991	North Pacific Cable	5,000	85,000
1992	TPC-4	5,500	75,600
1996	TPC-5	2,000	605,000
1997	FLAG	1,500	605,000



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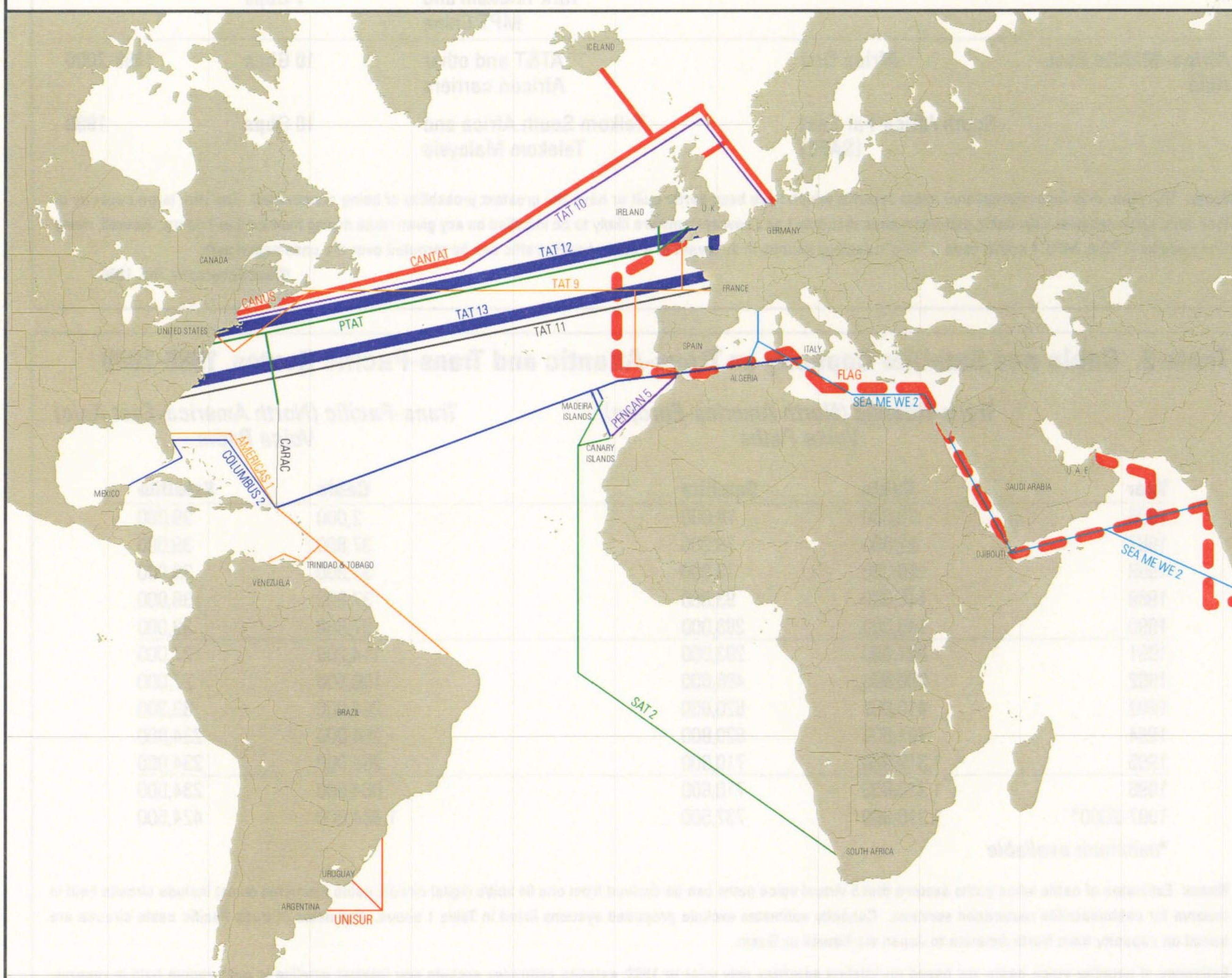
Major Submarine Cables

Trans-Atlantic Cable Systems

Year in Service	Cable System	Cost (US$) per voice path	Capacity (voice paths)
1956	TAT-1*	557,000	89
1965	TAT-4*	365,000	138
1970	TAT-5*	49,000	1,440
1983	TAT-7*	23,000	8,400
1988	TAT-8	9,000	37,800
1989	PTAT	6,000	85,000
1993	TAT-10	2,700	113,400
1994	CANTAT-3	1,000	302,000
1996-97	TAT-12/13	1,000	600,000



Note: Costs are capital and construction costs only, stated in US$ to the nearest $500, unadjusted for inflation. Current technology permits approximately 5 virtual voice paths to be derived from a digital channel operating at 64,000 bits per second (64 Kbps). Fiber optic cables are expected to have a useful life of at least 25 years. Table reports average cost per voice path for cables with multiple landing points. For example, the TAT-9 system connects the U.S. and Canada with the U.K., France and Spain. The average U.S.-U.K. cost per voice path is approximately $4000. Reserve capacity of cables is generally excluded. Source: FCC and carriers.

* No longer in service.

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Table 1. Proposed Fiber-Optic Cable Systems

Route	System	Lead Investors/Owners	Capacity	Service Date
Trans-Atlantic	Atlantic Express 1 and 2	Atlantic Express Co. (private U.S. company)	10 Gbps	1998-99
	MFS 1 and 2 (Gemini)	MFS Communications, Cable & Wireless	10 Gbps	1998-99
Trans-Pacific	TPC-6	KDD and AT&T Corp.	≈100 Gbps	2000-2001
Europe–Middle East–Asia	FLAG	NYNEX, Marubeni, Gulf Assoc., Dallah-Al-Baraka Group	10 Gbps	1997-98
	SEA-ME-WE3	France Télécom, Singapore Telecom, KDD and 75 others	10 Gbps	1998-1999
	Trans-Siberian Link	Rostelecom and other European carriers	1.2 Gbps	1996-97
	Trans-Asia-Europe (TAE)	Deutsche Telekom, Turk Telekom and MPT China	560 Kbps–1 Gbps	1997
Africa–Middle East–Asia	Africa One	AT&T and other African carriers	10 Gbps	1999-2000
	South Africa-Far East (SAFE)	Telkom South Africa and Telekom Malaysia	10 Gbps	1999

Notes: This table only lists international cable systems which have been partly built or have the greatest probability of being constructed. The very large capacity of fiber optic cable systems now being planned means that only 1 or 2 new systems are likely to be installed on any given route during the next 5 to 7 years. As well, many new systems (TPC-5; MFS-1 and 2) have a "ring" topology so that, in the event of a cable break, traffic can be rerouted over the undamaged path.

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Table 2. Cable and Satellite Capacity on Trans-Atlantic and Trans-Pacific Routes, 1986-2000

	Trans-Atlantic (North America-Europe) Voice Paths		*Trans-Pacific (North America-East Asia) Voice Paths*	
Year	**Cable**	**Satellite**	**Cable**	**Satellite**
1986	22,000	78,000	2,000	39,000
1987	22,000	78,000	37,800	39,000
1988	60,000	78,000	37,800	39,000
1989	145,000	93,000	37,800	39,000
1990	145,000	283,000	37,800	39,000
1991	221,000	283,000	114,200	27,000
1992	296,600	496,000	190,500	27,000
1993	410,000	620,800	264,000	83,300
1994	701,800	620,800	264,000	234,000
1995	1,310,800	710,800	264,000	234,000
1996	1,310,800	710,800	864,600	234,000
1997-2000*	1,310,800	737,500	1,464,600	424,500

**minimum available*

Notes: Estimates of cable voice paths assume that 5 virtual voice paths can be derived from one 64 kbit/s digital circuit; cable estimates do not include circuits held in reserve for cable/satellite restoration services. Capacity estimates exclude proposed systems listed in Table 1 above. Estimates of trans-Pacific cable circuits are based on capacity from North America to Japan via Hawaii or Guam.

Estimates of satellite voice paths are based on Intelsat satellites only prior to 1993; satellite estimates exclude one Intelsat satellite in each region held in reserve. Estimates also assume one voice path per channel until 1989 deployment of Intelsat VI series with 24,000 channels or 120,000 voice paths using Digital Code Multiplication Equipment (DCME). The Intelsat VII series, deployed in 1992, has a nominal capacity of 18,000 channels or 90,000 voice paths using DCME. For 1993-2000 time period, estimates assume full capacity of the following non-Intelsat systems is available: PAS-1, PAS-3, Orion-1 and TDRS-4 (trans-Atlantic); and PAS-2 Rimsat/Express (2 satellites) and TDRS-174 (trans-Pacific).

Source: FCC and carriers

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Box 1. The Next Generation of Cables: 100 Gbps and Beyond

The third generation of undersea fiber optic cables now entering service (TAT 12/13; TPC 5) can carry approximately 5 Gigabits per second (Gbps) per fiber pair or approximately 320,000 virtual voice channels. This represents an order of magnitude increase from the second generation of cables (operating at 560 Mbps) which, in turn, provided a tenfold increase in capacity over first generation cables such as TAT-8.

Recent trials and experiments by AT&T, Alcatel and KDD suggest that the next generation of cables, to be deployed in the 2000-2005 timeframe, will increase capacity by at least another order of magnitude to 50 Gbps and probably to 100 Gbps or more. That will be enough to transmit at least 3.5 million simultaneous telephone calls or several hundred thousand channels of compressed video services.

The enormous capacity of the next generation of fiber optic cables will result from two new technologies—optical soliton transmission and wave division multiplexing (WDM)—which leverage the benefits of earlier breakthroughs, such as optical amplifiers.

Digital communications generally are sent over a fiber optic cable by very rapidly transforming the original electrical signal into tiny pulses of laser light; the presence or absence of a pulse in a given period represents a binary 1 or 0. However, optical fibers can only carry a signal for a few hundred kilometers before it becomes too blurred or weak to be useable. Thus, long distance fiber optic cables contain repeaters, spaced at regular intervals, to amplify the signal.

For many years the only way to regenerate a signal in a long haul cable was to use an opto-electronic amplifier which converted the weak light pulses into an electronic signal, boosted the signal through an amplifier, and then transformed the boosted signal back into light pulses. In the late 1980s, however, amplifiers were developed to regenerate the optical signal without any electronic intermediary. These optical amplifiers typically consist of a few meters of erbium-doped fiber (EDF) inserted into the transmission path and hence are known as EDF Amplifiers or EDFAs. An EDFA permits a signal to be "pumped" up using a laser light source thousands of kilometers away at one of the cable head ends.

Notwithstanding optical amplifiers, the bit rate of long haul cable systems has generally been limited to 5 Gbps due to the way in which the light pulses propagate. But scientists have now developed a way to create unique pulses of light, known as solitons, which maintain their shape and intensity at very high bit rates over great distances. For example, in 1995 KDD demonstrated the feasibility of transmitting a 20 Gbps optical soliton data stream by time division multiplexing 10 Gbps pulses on a 8100 kilometer fiber optic cable test bed.

By coupling soliton technology with wave division multiplexing (WDM) the aggregate transmission capacity of any given fiber optic cable may be increased severalfold. In one experiment by Alcatel, sixteen 2.5 Gbps channels, each with a different wavelength, were multiplexed together to create a 40 Gbps data stream over a distance of over 1,400 kilometers. And in February 1996, KDD and AT&T announced they had transmitted over 110 Gbps on a 730 km test bed cable and would deploy WDM technology on a new trans-Pacific cable to be completed by 2001. Later KDD announced that it would use the same technology for a 100 Gbps cable around the islands of Japan.

Field trials of WDM technologies elsewhere are also promising: Alcatel has reported WDM transmission of four 2.5 Gbps data streams over 3,500 kilometers on the RIOJA cable system between the U.K. and Spain; AT&T has conducted a similar trial transmitting 10 Gbps over a segment of the Columbus-2 cable between Florida and St. Thomas in the Caribbean.

The commercial impact of these developments will be felt well before the next generation of cables is in the water. As shown by the RIOJA and Columbus-2 trials, WDB technologies will permit some cable owners to upgrade capacity merely by changing the equipment at the cable head ends. Four or even eightfold capacity increases may be possible. Second, development of WDM techniques is likely to make fiber optic systems increasingly flexible and hence attractive to new investors. For example, because WDM can be used to create different virtual (frequency specific) channels, a cable can be partitioned to satisfy the routing requirements (landing points) of particular carriers or countries without reducing the cable's overall capacity.

Finally, as soliton WDM technology moves into commercial production, the historical relationship between inter-continental and local prices is likely to flip flop. By 2002, for example, a call from Los Angeles to Tokyo via TPC-6 may cost less than a call from one of Los Angeles' many area codes to another. This is the new telecom economics which light wave technology will soon usher in.

Sources:

Franklin W. Kerfoot and Peter K. Runge, "Future Directions For Undersea Communications," *AT&T Technical Journal* (January/February 1995) Vol. 74 #1, pp. 93-100.

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Table 3. The Top 40 International Carriers, 1990-1995

Rank	Company	Country	Outgoing Traffic (millions of MiTTs) 1995	1994	Change 94-95	1993	1990
1	AT&T (a,b)	United States	8482	7947	6.7%	7129	6080
2	Deutsche Telekom (c)	Germany	5244	5147	1.9%	4680	3146
3	MCI (a,b)	United States	4452	3517	26.6%	2839	1184
4	BT (d)	United Kingdom	2909	2489	16.9%	2310	2170
5	France Télécom (a)	France	2805	2603	7.8%	2576	2126
6	Telecom Italia (e)	Italy	1908	1708	11.7%	1610	1045
7	Swiss PTT	Switzerland	1778	1649	7.8%	1572	1356
8	Sprint (a,b)	United States	1765	1471	20.0%	1175	577
9	Hongkong Telecom (a,d,f)	Hong Kong	1692	1578	7.2%	1377	1120
10	Stentor (b,g)	Canada	1467	1525	-3.8%	1552	1344
11	KPN (a)	Netherlands	1459	1346	8.4%	1238	905
12	China MPT (f)	China	1390	1170	18.8%	900	350
13	Mercury (d)	United Kingdom	1107	1018	8.7%	820	354
14	Belgacom (a)	Belgium	1106	1049	5.4%	979	731
15	KDD (d)	Japan	1079	1011	6.7%	952	764
16	Telefónica	Spain	1025	948	8.1%	847	611
17	Telmex (a)	Mexico	950	844	12.6%	625	421
18	Austrian PTT (a)	Austria	901	819	10.0%	767	559
19	Téléglobe (a)	Canada	898	861	4.3%	808	565
20	Telstra (h)	Australia	807	690	17.0%	640	565
21	Singapore Telecom (d,j)	Singapore	773	643	20.2%	480	223
22	Telia AB (i)	Sweden	702	697	0.7%	683	631
23	DGT Taiwan (a)	Taiwan	593	498	19.1%	441	242
24	Worldcom (b,m)	United States	547	278	95.7%	n.a.	n.a.
25	TeleDanmark	Denmark	533	488	9.2%	452	362
26	Etisalat	U.A.E.	504	428	17.8%	342	242
27	Saudi Com. Ministry	Saudi Arabia	499	477	4.6%	455	320
28	OTE (a)	Greece	468	423	10.6%	336	213
29	Norwegian Telecom	Norway	432	396	9.1%	376	281
30	Telekom Malaysia	Malaysia	408	342	19.3%	258	140
31	Telecom Eireann (a,d,l)	Ireland	407	324	25.6%	316	262
32	Korea Telecom	Rep. of Korea	404	327	23.5%	265	188
33	Telekomunikacja Polska	Poland	381	357	6.7%	273	81
34	Turkish PTT	Turkey	374	284	31.7%	265	159
35	Videsh Sanchar (d,k)	India	341	314	8.6%	284	147
36	Telebras	Brazil	319	199	60.5%	182.4	165
37	Rostelcom	Russia	287	229	25.4%	201	n.a.
38	IDC (d)	Japan	282	263	7.2%	239	56
39	Telkom South Africa	South Africa	280	263	6.5%	255	156
40	ITJ (d)	Japan	270	251	7.6%	228	61

MiTT is Minutes of Telecommunications Traffic. Data are for public voice circuits only rounded to the nearest million MiTT.

a. Data from 1993 forward based on billing point of call, not originating point.
b. Data for North American carriers include cross-border traffic.
c. For Deutsche Telekom, all data include outgoing traffic from the former East Germany.
d. Data are for the Fiscal Year (April 1995 to March 1996). HKT and Mercury are majority owned by Cable & Wireless (U.K.).
e. Combined totals for Iritel and Italcable. Prior to 1994, Iritel (formerly ASST) handled intra-continental traffic only, and Italcable carried overseas traffic .
f. Includes Hong Kong-China traffic.
g. Stentor was formerly Telecom Canada; Stentor traffic is for U.S. only of which approximately 70% is originated by Bell Canada.
h. Telstra was formerly AOTC.
i. Telia AB was formerly Televerket.
j. Singapore Telecom data, except for 1990, include traffic to Malaysia (except local border traffic).
k. Videsh Sanchar data exclude traffic to Bangladesh, Nepal, Pakistan and Sri Lanka.
l. Telecom Eireann data exclude traffic to Northern Ireland.
m. 1995 WorldCom data reflects full year data from IDB, LDDS and WilTel acquisitions.

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Table 4. The Top 50 International Routes, 1995

	Countries	MiTT each way	Total MiTT
1.	United States/Canada	2998.0/2063.7	5061.7
2.	United States/Mexico	1915.3/833.9	2749.2
3.	United States/United Kingdom	1017.4/678.1	1695.5
4.	Hong Kong/China	913.6/750.0	1663.6
5.	United States/Germany	657.7/290.3	948.0
6.	United States/Japan	574.3/319.1	893.4
7.	Switzerland/Germany	408.2/383.0	791.2
8.	Germany/Austria	416.3/368.6	784.9
9.	Germany/United Kingdom	365.1/364.4	729.5
10.	Germany/France	389.8/325.9	715.7
11.	United Kingdom/France	360.8/317.7	678.5
12.	Netherlands/Germany	339.5/335.9	675.4
13.	Germany/Italy	375.5/299.0	674.5
14.	United Kingdom/Ireland	371.4/264.0	635.4
15.	United States/France	355.4/180.9	536.3
16.	Germany/Turkey	375.6/124.5	500.1
17.	Belgium/France	263.0/228.2	491.2
18.	France/Italy	242.1/239.0	481.1
19.	Netherlands/Belgium	238.6/229.8	468.5
20.	United States/Korea	312.3/141.0	453.0
21.	Switzerland/France	280.0/154.6	434.6
22.	Switzerland/Italy	252.8/181.8	434.6
23.	United States/Dominican Republic	342.9/86.3	429.2
24.	Germany/Poland	278.9/146.4	425.3
25.	United States/Hong Kong	314.1/102.7	416.8
26.	Singapore/Malaysia	218.0/184.0	402.0
27.	United States/Taiwan	273.2/111.0	384.2
28.	United States/Brazil	277.6/101.3	378.9
29.	United States/Italy	273.4/103.6	377.0
30.	United States/Philippines	294.8/62.0	356.8
31.	Netherlands/United Kingdom	179.9/173.5	353.4
32.	United States/Australia	200.1/144.0	344.1
33.	France/Spain	179.7/158.2	337.9
34.	United Kingdom/Italy	188.0/149.3	337.3
35.	United States/India	284.1/49.9	334.0
36.	Germany/Spain	170.4/160.7	331.1
37.	United Kingdom/Spain	171.1/147.0	318.1
38.	United States/Colombia	253.2/58.8	312.0
39.	Australia/United Kingdom	182.0/127.3	309.3
40.	Australia/New Zealand	142.0/142.0	284.0
41.	United States/Israel	213.4/70.3	283.7
42.	United States/China	230.2/52.3	282.5
43.	Germany/Belgium	144.4/137.4	281.8
44.	Japan/Korea	150.3/126.0	276.3
45.	Canada/United Kingdom	142.0/120.5	262.5
46.	Japan/China	171.0/88.8	259.8
47.	Taiwan/China	140.9/115.0	255.9
48.	United States/Netherlands	161.3/89.7	251.0
49.	Norway/Sweden	111.0/124.0	235.0
50.	Sweden/Finland	128.0/99.0	227.0

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 31.7 billion minutes, 53 percent of all international traffic. For routes to and from the United States, calls are measured by point of billing in both directions (see Methodology).

Table 5. Market Share of Competing International Carriers, 1988-1995

Percentage of Outgoing MiTT

Country/Carrier	1988	1989	1990	1991	1992	1993	1994	1995
United States								
AT&T	89.1	83.3	78.4	74.8	70.3	62.2	60.1	54.3
MCI	7.0	10.2	14.6	17.8	21.2	24.8	26.5	28.5
Sprint	3.5	5.8	6.4	6.3	7.3	10.3	11.1	11.3
Worldcom					n.a.	0.6	2.1	3.5
Others							0.2	2.4
United Kingdom*								
BT	95.5	91.0	86.0	81.0	76.8	74.2	68.6	67.7
Mercury	4.5	9.0	14.0	19.0	23.2	24.0	28.1	25.8
IPL Resellers						2.2	3.3	6.5
Japan*								
KDD		93.3	88.0	73.3	69.7	66.9	66.3	66.2
IDC		3.7	6.5	13.3	15.3	16.9	17.3	17.3
ITJ		3.0	5.5	13.4	15.0	16.2	16.4	16.5
New Zealand*								
TNZ			92.0	82.0	80.0	78.4	74.8	78.0
ClearCom			8.0	18.0	20.0	21.6	25.2	22.0
Korea, Republic of								
Korea Telecom					79.9	74.5	68 7	72.6
Dacom					20.1	25.5	31.3	27.4
Chile								
Entel Chile					80.0	55.0	36.3	36.5
Chilesat					20.0	20.0	24.8	23.1
VTR Telecom					<1.0	<5.0	24.2	7.4
CTC-Mundo							12.8	20.2
BellSouth Chile							1.5	9.9
Iusatel							0.1	1.7
CNT							0.3	0.5
Philippines								
PLDT					91.6	84.2	69	68
Philippine Global Com					8.4	15.8	23	23
Eastern Telecom					n.a.	n.a.	7	6
Capitol Wireless					n.a.	n.a.	<1	<1
Smart								<1
ICC								<1

Notes: MiTT is Minutes of Telecommunications Traffic. Data based on outgoing international traffic for the public switched network only. Unless stated, data exclude traffic and market share of carriers reselling international private line services (IPL resellers). Market shares are for the full year, beginning in the first year of competition. In 1995, some U.S. facilities-based international carriers also resold the international switched services of other U.S. facilities-based carriers as follows: MCI, 50.5 million minutes; Sprint, 39.6 million minutes; WorldCom, 423.3 million minutes. Market shares for U.S. carriers prior to 1994 exclude resellers and, prior to 1993, traffic to Canada and Mexico; for the traffic base of second tier U S. carriers, see page 87. U.K. carriers' traffic to Ireland is excluded prior to 1994. In 1993, Chilean shares do not add up to 100% because Chilesat reportedly acted as an international gateway in 1993. The 1994 and 1995 market shares for Chile are based on traffic for the month of December only.

* Market shares based on fiscal year reporting.

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Table 5. Market Share of Competing International Carriers, 1988-1995 (continued)

Percentage of Outgoing MiTT

Country/Carrier	1988	1989	1990	1991	1992	1993	1994	1995
Australia								
Telstra					98.0	87.0	76.3	73.4
Optus					2.0	13.0	21.9	23.4
IPL Resellers							1.8	3.2
Canada (Canada-U.S. route only)								
Stentor						93	80	65
Unitel						2	8	8
Westel						<1	<1	<1
IPL Resellers						4	11	26
Dominican Republic								
Codetel						>90	85.8	83.0
Tricom						n.a	6.7	7.5
All America Cables and Radio, Inc. (AACR)						n.a.	7.5	9.5
Sweden								
Telia AB						92.3	86.9	78.0
Tele-2						7.7	13.1	22.0
Finland								
Telecom Finland							90	72.8
Finnet International							5	19.1
Telivo							3	7.7
Others							2	0.4
Indonesia								
PT Indosat							99	>95
PT Satelindo							<1	<5

Notes: MiTT is Minutes of Telecommunications Traffic. Data based on outgoing international traffic for the public switched network only Unless stated, data exclude traffic and market share of carriers reselling international private line services (IPL resellers) Market shares are for the full year, beginning in the first year of competition. For 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. For Canada, market shares reflect an estimated 200 million minutes of traffic handled by IPL resellers which is not reflected in official carrier reports. For Indonesia, PT Satelindo only began international service in September 1994; the 1995 figures reflect June 1995 market estimates

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International Traffic Statistics

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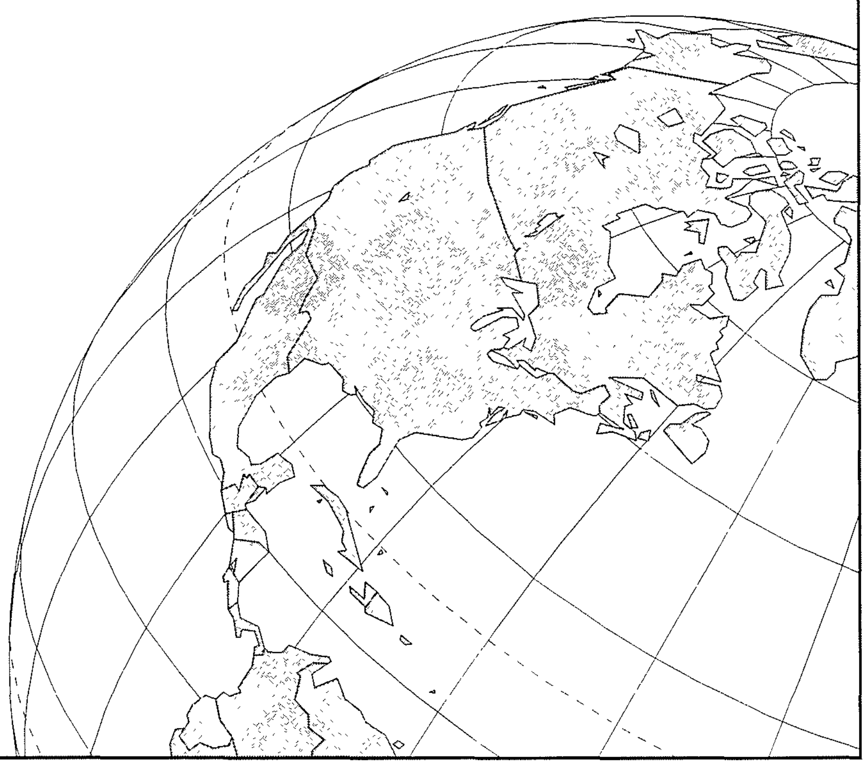
Americas

International Traffic



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Argentina

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	35.4	19.7%
2. Uruguay	32.7	18.2%
3. Brazil	21.9	12.2%
4. Chile	12.6	7.0%
5. Spain	11.4	6.3%
6. Italy	9.3	5.2%
7. Paraguay	7.8	4.3%
8. Peru	5.3	2.9%
9. Bolivia	4.8	2.7%
10. France	4.0	2.2%
11. Germany	3.5	2.0%
12. Mexico	3.5	1.9%
13. United Kingdom	3.4	1.9%
14. Israel	2.9	1.6%
15. Colombia	2.2	1.2%
16. Canada	2.1	1.2%
17. Venezuela	1.9	1.1%
18. Ecuador	0.9	0.5%
19. Netherlands	0.8	0.5%
20. Japan	0.7	0.4%
Other	12.4	6.9%

MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes for public voice circuits.

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	192.3	252.6	299.4
Outgoing	137.1	175.0	179.4
Surplus (Deficit)	55.4	77.7	119.9
Total Volume	39.4	427.6	478.8

Note: Data based on billing point of traffic.

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Bolivia

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	4.8	23.1%
2. Argentina	3.3	15.9%
3. Brazil	3.2	15.4%
4. Chile	2.3	11.1%
5. Peru	1.6	7.7%
6. Germany	0.5	2.4%
7. Spain	0.4	1.9%
8. Colombia	0.4	1.9%
9. Mexico	0.4	1.9%
10. Paraguay	0.3	1.4%
11. Italy	0.3	1.4%
12. Venezuela	0.2	1.0%
13. United Kingdom	0.2	1.0%
14. France	0.2	1.0%
15. Japan	0.2	1.0%
16. Canada	0.2	1.0%
17. Ecuador	0.2	1.0%
18. Switzerland	0.2	1.0%
19. Uruguay	0.2	1.0%
20. Panama	0.2	1.0%
Other	1.5	7.2%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	n.a.	49.2
Outgoing	16.6	18.0	20.8
Surplus (Deficit)	n.a.	n.a.	28.4
Total Volume	n.a.	n.a.	70.0

Note: Data based on billing point of traffic.

Brazil

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	100.2	31.4%
2. Argentina	24.4	7.6%
3. Italy	14.2	4.4%
4. Germany	13.8	4.3%
5. Portugal	13.4	4.2%
6. United Kingdom	11.5	3.6%
7. France	10.3	3.2%
8. Uruguay	7.8	2.5%
9. Japan	7.7	2.4%
10. Spain	7.1	2.2%
11. Lebanon	6.8	2.1%
12. Paraguay	6.4	2.0%
13. Chile	6.1	1.9%
14. Moldova	5.4	1.7%
15. Switzerland	4.7	1.5%
16. Canada	4.6	1 4%
17. Sao Tome and Principe	4.6	1.4%
18. Bolivia	4.6	1.4%
19. Israel	4.6	1.4%
20. Mexico	4.0	1.2%
Other	57.1	17.9%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	373.8	408.0	495.5
Outgoing	182.4	199.0	319.4
Surplus (Deficit)	191.4	209.0	176.1
Total Volume	556.2	607.0	814.8

Note: Data based on billing point of traffic.

Canada

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	2061	69.7%
2. United Kingdom	142	4.8%
3. France	47	1.6%
4. Germany	41	1.4%
5. Hong Kong	40	1.4%
6. India	36	1.2%
7. Italy	35	1.2%
8. Philippines	30	1.0%
9. Australia	29	1.0%
10. Jamaica	26	0.9%
11. Japan	21	0.7%
12. Netherlands	18	0.6%
13. Mexico	18	0.6%
14. Poland	16	0.5%
15. Switzerland	15	0.5%
Other	384	13.0%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	503.4	543.8	603.4
Outgoing	761.5	861.2	897.9
Surplus (Deficit)	(258.1)	(317.4)	(294.5)
Total Volume	1264.9	1405.0	1501.3

Notes: Incoming and outgoing totals are for Téléglobe only and exclude all Canada-U.S. traffic. Téléglobe data based on billing point of traffic. U.S. route traffic is for Stentor, Unitel and IPL resellers combined, but IPL resellers' traffic is not included on other routes (i.e., to the U.K. and Australia). For further details, see Methodology Section. Route data are rounded to the nearest million minutes.

Chile

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	45	33.1%
2. Argentina	23	16.9%
3. Brazil	11	8.1%
4. Spain	10	7.4%
5. Peru	6	4.4%
6. Canada	4	2.9%
7. Germany	4	2.9%
8. Mexico	4	2.9%
9. Bolivia	3	2.2%
10. France	3	2.2%
11. United Kingdom	3	2.2%
12. Ecuador	3	2.2%
13. Italy	3	2.2%
Other	14	10.3%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	105.0	n.a.	n.a.
Outgoing	61.7	73.5	136.9
Surplus (Deficit)	43.3	n.a.	n.a.
Total Volume	166.7	n.a.	n.a.

Note: Data rounded to the nearest million minutes. Incoming traffic for Entel, VTR and CTC totaled 134.1 million minutes in 1995. Other carriers terminated approximately 30-40 million minutes.

Colombia

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	58.8	46.2%
2. Venezuela	14.2	11.2%
3. Spain	5.4	4.2%
4. Ecuador	5.3	4.2%
5. Panama	4.6	3.7%
6. Mexico	4.6	3.6%
7. Italy	3.7	2.9%
8. United Kingdom	3.0	2.4%
9. Costa Rica	2.6	2.0%
10. France	2.5	2.0%
11. Germany	2.5	2.0%
12. Brazil	2.3	1.8%
13. Peru	2.3	1.8%
14. Argentina	2.2	1.7%
15. Canada	1.9	1.5%
Other	11.2	8.8%

MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes for public voice circuits.

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	278.7	302.8	351.5
Outgoing	102.4	120.3	127.3
Surplus (Deficit)	176.3	182.5	224.2
Total Volume	381.1	423.1	478.8

Note: Totals may appear inconsistent with other figures due to rounding. Data based on billing point of traffic.

Dominican Republic

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	60.2	70.5%
2. Puerto Rico	9.9	11.6%
3. Spain	1.8	2.1%
4. Germany	1.5	1.8%
5. Italy	1.4	1.6%
6. Canada	1.2	1.4%
7. Venezuela	0.8	0.9%
8. Mexico	0.6	0.7%
9. Colombia	0.5	0.6%
10. Cuba	0.5	0.6%
11. Switzerland	0.5	0.6%
12. Panama	0.4	0.5%
13. Haiti	0.4	0.5%
14. Argentina	0.3	0.4%
15. France	0.3	0.4%
16. Curacao	0.3	0.3%
17. United Kingdom	0.3	0.3%
18. Costa Rica	0.3	0.3%
19. Netherlands	0.2	0.3%
20. Austria	0.2	0.2%
Other	3.7	4.3%

MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes for public voice circuits.

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	404.0	424.1
Outgoing	58.3	63.5	85.4
Surplus (Deficit)	n.a.	340.5	338.7
Total Volume	n.a.	467.5	509.4

Note: Data are for Codetel only and are based on billing point of traffic. In 1995, AACR had 9.4 million minutes of outbound traffic and 59.1 million minutes inbound.

Ecuador

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	19.1	51.3%
2. Colombia	5.0	13.4%
3. Chile	1.3	3.4%
4. Venezuela	1.0	2.8%
5. Peru	0.9	2.4%
6. Brazil	0.9	2.4%
7. Spain	0.9	2.4%
8. Mexico	0.7	1.9%
9. Argentina	0.7	1.9%
10. Panama	0.7	1.8%
11. Italy	0.6	1.7%
12. Canada	0.6	1.6%
13. Germany	0.6	1.5%
14. France	0.4	1.0%
15. United Kingdom	0.4	1.0%
16. Costa Rica	0.3	0.8%
17. Switzerland	0.3	0.7%
18. Bolivia	0.2	0.5%
19. Japan	0.2	0.4%
20. Hong Kong	0.2	0 4%
Other	2.4	6.4%

MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes for public voice circuits.

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	102.3	128.6	154.8
Outgoing	33.6	36.4	37.2
Surplus (Deficit)	68.7	92.2	117.6
Total Volume	136.0	165.0	192.0

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding.

Mexico

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	831.8	87.6%
2. Canada	14.2	1.5%
3. Spain	11.4	1.2%
4. France	9.4	1.0%
5. Cuba	6.1	0.6%
6. Germany	5.9	0.6%
7. Colombia	5.8	0.6%
8. United Kingdom	5.4	0.6%
9. Argentina	4.8	0.5%
10. Guatemala	4.6	0.5%
11. Italy	4.4	0.5%
12. Brazil	3.8	0.4%
13. Costa Rica	3.1	0.3%
14. Chile	3.0	0.3%
15. Venezuela	3.0	0.3%
16. Japan	2.4	0.3%
17. Peru	2.4	0.3%
18. El Salvador	2.2	0.2%
19. Israel	2.1	0.2%
20. Switzerland	1.9	0.2%
Other	22.3	2.3%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	1,370.6	1,829.4	2,114.0
Outgoing	625.4	844.1	950.0
Surplus (Deficit)	745.2	985.4	1,164.0
Total Volume	1,996.0	2,673.5	3,064.0

Note: Data based on billing point of traffic. 1993 figures do not include traffic generated by Teléfonos del Noroeste (Telnor), a Telmex subsidiary. Totals may appear inconsistent with other figures due to rounding.

Paraguay

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Argentina	6.4	33.0%
2. Brazil	4.4	22.6%
3. United States	2.8	14.4%
4. Chile	1.1	5.7%
5. Uruguay	1.0	5.2%
6. Italy	0.7	3.4%
7. Germany	0.4	2.1%
8. Spain	0.4	1.8%
9. Taiwan	0.3	1.5%
10. Bolivia	0.3	1.3%
11. Korea, Rep. of	0.3	1.3%
12. Peru	0.2	1.2%
13. France	0.2	1.0%
14. Japan	0.2	0.8%
15. Hong Kong	0.2	0.8%
16. United Kingdom	0.1	0.6%
17. Switzerland	0.1	0.6%
18. Canada	0.1	0.6%
19. Mexico	0.1	0.5%
20. Panama	0.1	0.5%
Other	0.2	1.0%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	24.5	30.6	n.a.
Outgoing	15.5	18.1	19.4
Surplus (Deficit)	9.0	12.5	n.a.
Total Volume	40.0	48.7	n.a.

Note: Totals may appear inconsistent with other figures due to rounding.

Peru

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	25.5	38.2%
2. Chile	5.5	8.2%
3. Argentina	3.5	5.2%
4. Spain	3.5	5.2%
5. Italy	2.0	3.0%
6. Brazil	2.0	3.0%
7. Colombia	2.0	3.0%
8. Venezuela	1.5	2.2%
9. Bolivia	1.5	2.2%
10. Mexico	1.5	2.2%
11. Ecuador	1.5	2.2%
12. Japan	1.5	2.2%
13. Germany	1.0	1.5%
14. Canada	1.0	1.5%
15. United Kingdom	1.0	1.5%
Other	12.0	18.0%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	152.4	178.6	195.4
Outgoing	39.0	51.0	66.7
Surplus (Deficit)	113.4	127.6	128.7
Total Volume	191.4	229.6	262.1

Note: Data based on billing point of traffic and rounded to the nearest 0.5 million . Totals may appear inconsistent with other figures due to rounding.

United States (Outgoing)

Largest Telecommunications Routes, 1995

Destination	MiTT 1994	MiTT 1995	Percentage of Outgoing Traffic 1995
1. Canada	2,635.2	2,998.0	19.2%
2. Mexico	1,654.3	1,915.3	12.3%
3. United Kingdom	905.5	1,017.4	6.5%
4. Germany	603.3	657.7	4.2%
5. Japan	465.6	574.3	3.7%
6. France	304.5	355.4	2.3%
7. Dominican Republic	309.7	342.9	2.2%
8. Hong Kong	213.3	314.1	2.0%
9. Korea, Rep. of	282.7	312.3	2.0%
10. Philippines	258.6	294.8	1.9%
11. India	188.6	284.1	1.8%
12. Brazil	221.5	277.6	1.8%
13. Italy	250.4	273.4	1.7%
14. Taiwan	225.6	273.2	1.7%
15. Colombia	229.2	253.2	1.6%
16. China	169.2	230.2	1.5%
17. Israel	195.4	213.4	1.4%
18. Australia	154.4	200.1	1.3%
19. Jamaica	167.3	186.3	1.2%
20. Netherlands	110.5	161.1	1.0%
Other	3,636.0	4,488.2	28.7%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	5,342.8	6,133.1	7,010.6
Outgoing	11,392.2	13,200.3	15,623.0
Surplus (Deficit)	(6,049.4)	(7,067.2)	(8,612.4)
Total Volume	16,735.0	19,333.4	22,633.6

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding. Totals for 1995 include IPL reseller traffic. Data excludes non-Continental U.S. territories (Puerto Rico, Virgin Islands and Guam).

United States (Incoming)

Largest Telecommunications Routes, 1995

Destination	MiTT 1994	MiTT 1995	Percentage of Incoming Traffic 1995
1. Canada	1,688.1	2,063.7	29.4%
2. Mexico	747.0	833.9	11.9%
3. United Kingdom	588.7	678.1	9.7%
4. Japan	304.7	319.1	4.6%
5. Germany	275.8	290.3	4.1%
6. France	170.0	180.9	2.6%
7. Australia	138.4	144.0	2.1%
8. Korea, Rep. of	123.5	140.7	2.0%
9. Taiwan	93.4	108.4	1.5%
10. Italy	101.0	103.6	1.5%
11. Hong Kong	100.5	102.7	1.5%
12. Brazil	61.8	101.3	1.4%
13. Netherlands	82.3	89.7	1.3%
14. Dominican Republic	60.5	86.3	1.2%
15. Switzerland	72.8	77.0	1.1%
16. Israel	59.8	70.3	1.0%
17. Sweden	58.2	62.0	0.9%
18. Colombia	58.1	58.8	0.8%
19. Venezuela	54.9	56.0	0.8%
20. China	48.4	52.3	0.7%
Other		1,391.5	19.8%

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Note: Data based on billing point of traffic. Incoming traffic reported by the United States may not match outgoing traffic to the United States reported by other countries due to different accounting procedures (some countries may report U.S.-billed calls to the U.S. as outgoing calls to the U.S.), different fiscal years, and inclusion or exclusion of operator-assisted calls. See *Methodology,* at the end of this section, for more information.

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USA: Other Correspondents

Country	Outgoing MiTT 1994	Outgoing MiTT 1995	Incoming MiTT 1994	Incoming MiTT 1995	Country	Outgoing MiTT 1994	Outgoing MiTT 1995	Incoming MiTT 1994	Incoming MiTT 1995
Argentina	110.5	157.8	31.3	28.9	Macedonia	n.a.	4.7	1.7	2.1
Austria	41.1	46.4	21.7	23.7	Malaysia	41.1	52.5	14.6	17.7
Bahrain	7.9	9.4	4.0	4.2	Morocco	11.7	13.1	4.5	4.8
Bangladesh	23.2	29.1	2.1	2.9	New Zealand	29.3	38.5	23.1	25.7
Belgium	81.3	91.5	38.6	44.4	Norway	38.5	41.5	28.9	32.4
Bolivia	23.8	26.6	4.9	18.3	Pakistan	84	101.6	8.4	9.2
Chile	55	64.4	27.2	44.9	Paraguay	9.7	12.1	2.1	2.5
China	169.3	230.2	48.4	52.3	Peru	105.5	118.9	20.1	23.9
Croatia	14.1	15.1	4.4	4.5	Philippines	258.6	294.8	41.8	41.7
Cyprus	7.5	8.7	4.1	4.4	Poland	110.3	125.3	34	31.5
Czech Republic	18.2	21.4	6.5	7.3	Portugal	41.7	41.2	11.2	12.6
Denmark	41.5	46.4	25.2	28.2	Qatar	3.9	4.6	1.7	2.2
Ecuador	108.4	131.3	12.8	12.8	Russia	61.9	73.3	29.8	25
El Salvador	120.7	135.3	8	8.9	Saudi Arabia	77.5	87.4	28.2	24.1
Estonia	1.4	1.7	1.7	1.3	Singapore	72.8	100	43.2	51
Finland	22	23.5	16	16.7	Slovak Republic	2.8	10.2	2.9	2.9
Greece	82.1	85.2	34.2	30.7	Slovenia	2.9	3	1.4	1.9
Guatemala	105.1	113.8	12.7	14.1	South Africa	53.7	73.3	24.3	26.7
Hungary	24.5	27	9.8	11.1	Spain	117	124.6	50.6	52.1
Iceland	7.9	8	6.6	6.9	Sri Lanka	7.8	8.9	1.8	2.1
India	188.6	284.1	52.0	51.9	Sweden	74	81.7	58.2	62
Indonesia	56.4	68.4	12.8	23.6	Switzerland	115	132.7	72.8	77
Iran	43.7	48.6	18.3	17.8	Syria	10.2	13.1	2.7	3.1
Ireland	91.5	104	40.2	46.9	Thailand	78.3	92.1	22.5	26.2
Jamaica	167.4	186.3	36.1	44	Turkey	45.6	51	17.7	21
Jordan	31.7	35.8	4	4.2	UAE	32.6	45.4	19.8	24.2
Kuwait	27.5	36.5	7.6	7.8	Uruguay	16.6	18.9	4.5	5.4
Luxembourg	7.9	8.4	5.2	5.5	Venezuela	97.3	116.5	54.9	56
Macau	2.4	2.8	1.1	1.2	Yugoslavia	19.9	17.1	9	7

Note: *All data are millions of minutes for public voice circuits only and are based on the billing point of the traffic (see Methodology).*

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USA: Traffic by Carrier

Market Share of International Traffic by Route, 1995

	U.S. Billed Traffic				Foreign Billed			
	AT&T	MCI	Sprint	WorldCom	AT&T	MCI	Sprint	WorldCom
Canada	54.51	25.82	12.39	2.26	54.97	23.99	7.40	1.91
Mexico	62.58	23.91	9.83	3.65	63.22	25.42	8.62	2.72
U.K.	54.65	26.34	11.73	5.31	53.90	26.28	12.09	6.61
Germany	58.15	26.37	12.18	2.82	55.58	27.79	12.87	3.25
Japan	48.45	33.62	11.88	4.75	53.34	27.79	12.12	5.32
Philippines	62.91	28.26	7.27	1.31	56.68	31.35	8.28	0.77
France	48.57	31.05	12.91	7.17	49.89	26.57	14.23	9.13
Italy	61.08	22.61	12.70	3.55	60.25	23.44	12.88	3.18
Korea, Rep. of	52.99	31.50	11.79	3.61	54.06	31.05	10.07	3.20
Brazil	56.20	24.47	8.80	10.50	62.31	22.46	9.33	5.88
India	48.97	41.72	7.59	0.31	45.48	46.46	6.55	0.00
Dominican Republic	39.10	42.40	4.66	7.74	67.75	20.56	5.27	6.41
Colombia	52.32	34.49	6.85	6.31	57.36	30.45	6.06	6.09
Jamaica	61.34	31.17	7.47	0.00	76.41	16.99	6.59	0.00
Taiwan	41.60	39.97	13.09	4.45	40.68	40.63	13.71	3.59
China	48.33	35.40	12.01	4.18	48.35	36.08	12.04	2.90
Israel	50.65	30.29	14.96	4.09	52.74	25.59	15.21	6.44
Hong Kong	30.28	31.95	33.44	4.32	38.30	36.25	15.61	8.08
Australia	47.25	22.00	17.65	6.97	54.22	23.73	14.57	6.85
Argentina	52.54	29.18	10.61	7.66	52.73	30.57	11.74	4.93
Netherlands	47.83	23.36	14.59	6.98	56.09	22.97	13.34	7.45
Spain	56.45	22.59	11.80	7.34	56.46	28.47	10.83	4.05
Switzerland	51.28	26.61	14.79	7.24	48.97	27.47	13.58	9.43
Venezuela	56.14	26.89	10.70	6.25	57.52	26.04	10.02	6.37
Sweden	51.90	28.97	13.50	4.80	58.52	25 94	12.15	3.39

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Traffic Carried by Second Tier U.S. Facilities-Based International Carriers, 1995

Carrier	Outbound Minutes (m)	Inbound Minutes (m)	Top Outbound Routes (Minutes)	Resold Outbound (Minutes)
fONOROLA	180.0	229.9	Canada (180)	0
International Telecom Corp. (ITC)	72.4	—	Dom. Rep. (18.5)	0
Pacific Gateway Exchange (PGE)	38.6	1.4	Australia (12.1) Netherlands (11.5) Japan (7.0)	89.7
WorldXchange (formerly CTS)	24.2	4.8	Canada (7.9) U.K. (6.2)	114.6
GTE Hawaiian Telephone Co.	19.2	28.3	Philippines (4.8) Japan (4.9)	0
Cable & Wireless, Inc. (CWI)	10.9	—	Italy (2.4) U.K. (5.1)	291.2
ACC Global	6.9	—	U.K. (6.9)	0
MFS International	6.8	—	U.K. (5.1)	0
Startec, Inc.	4.1	0.7	India (4.1)	6.7
Esprit U.K.	2.9	—	U.K. (1.4)	0
Total	**366.0**	**265.1**		

Note: All data in millions of minutes based on billing point of call. Carriers and traffic from off-shore U.S points (i.e., Puerto Rico, Virgin Islands, Guam) are excluded. Data includes traffic carried on International Simple Resale (ISR) facilities. The last column of the table refers to outbound minutes billed on a resale basis (i.e , the traffic was actually transported over international facilities by a third party such as AT&T) These minutes are thus included in the traffic base of other U S. carriers in Table 3 on p. 64 and in Table 5 on pp. 66-67

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Uruguay

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Argentina	27.7	55.5%
2. Brazil	6.8	13.5%
3. United States	5.4	10.8%
4. Spain	1.9	3.7%
5. Chile	1.3	2.5%
6. Paraguay	1.0	2.0%
7. Italy	0.8	1.6%
8. France	0.5	1.1%
9. Germany	0.5	0.9%
10. United Kingdom	0.4	0.7%
11. Canada	0.4	0.7%
12. Mexico	0.4	0.7%
13. Israel	0.3	0.7%
14. Venezuela	0.3	0.6%
15. Switzerland	0.3	0.6%
16. Australia	0.2	0.5%
17. Colombia	0.2	0.4%
18. Peru	0.2	0.4%
19. Panama	0.2	0.3%
20. Sweden	0.1	0.3%
Other	1.2	2.4%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	58.0	67.7	73.9
Outgoing	37.4	46.3	49.9
Surplus (Deficit)	20.6	21.4	24.0
Total Volume	95.4	114.0	123.8

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding.

Venezuela

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	55.3	42.9%
2. Colombia	17.9	13.8%
3. Spain	7.9	6.1%
4. Italy	5.9	4.6%
5. Peru	3.1	2.4%
6. Canada	2.7	2.1%
7. Portugal	2.5	2.0%
8. Brazil	2.5	2.0%
9. Mexico	2.3	1.8%
10. Argentina	2.2	1.7%
11. Dominican Republic	2.1	1.6%
12. France	2.1	1.6%
13. Ecuador	2.0	1.5%
14. Germany	1.7	1.3%
15. United Kingdom	1.7	1.3%
16. Chile	1.6	1.3%
17. Puerto Rico	1.4	1.1%
18. Netherlands Antilles	1.2	0.9%
19. Panama	1.0	0.8%
20. Switzerland	0.8	0.7%
Other	11.1	8.6%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	148.3	164.3	186.6
Outgoing	133.3	141.3	129.1
Surplus (Deficit)	15.0	23.0	57.4
Total Volume	281.6	305.6	315.7

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding.

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Europe

International Traffic

Austria

Largest Telecommunications Routes, 1994

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	344.5	42.0%
2. Switzerland	49.3	6.0%
3. Italy	42.5	5.2%
4. Yugoslavia	31.0	3.8%
5. Hungary	28.6	3.5%
6. United States	24.9	3.0%
7. Turkey	24.5	3.0%
8. Croatia	23.1	2.8%
9. France	21.0	2.6%
10. Poland	20.3	2.5%
11. Netherlands	19.4	2.4%
12. Czech Republic	18.3	2.2%
13. United Kingdom	16.6	2.0%
14. Slovenia	14.4	1.8%
15. Slovak Republic	11.0	1.3%
16. Romania	9.1	1.1%
17. Russia	9.1	1.1%
18. Belgium	8.7	1.1%
19. Sweden	7.4	0.9%
Other	95.5	11.7%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	751.0	774.5	n.a.
Outgoing	767.4	819.2	901
Surplus (Deficit)	(16.4)	(44.7)	n.a.
Total Volume	1,518.4	1,593.7	n.a.

Belgium

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. France	263.0	23.8%
2. Netherlands	229.8	20.8%
3. Germany	137.4	12.4%
4. United Kingdom	97.0	8.8%
5. Italy	58.0	5.2%
6. United States	39.9	3.6%
7. Luxembourg	39.6	3.6%
8. Spain	35.6	3.2%
9. Switzerland	25.4	2.3%
10. Sweden	12.7	1.1%
11. Portugal	11.8	1.1%
12. Greece	11.0	1.0%
13. Denmark	10.3	0.9%
14. Turkey	10.2	0.9%
15. Austria	9.7	0.9%
16. Morocco	9.3	0.8%
17. Poland	8.7	0.8%
18. Ireland	6.2	0.6%
19. Canada	5.5	0.5%
20. Norway	5.0	0.4%
Other	79.6	7.2%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	1,025.3	1,093.9	1,172.0
Outgoing	979.4	1,049.0	1,105.7
Surplus (Deficit)	45.9	44.9	66.3
Total Volume	2,004.7	2,142.9	2,277.7

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding.

Croatia

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	47.6	22.6%
2. Bosnia	46.7	22.2%
3. Slovenia	27.0	12.8%
4. Italy	17.2	8.2%
5. Austria	14.4	6.8%
6. Switzerland	6.3	3.0%
7. United Kingdom	5.7	2.7%
8. United States	5.2	2.5%
9. France	4.3	2.0%
10. Netherlands	3.3	1.6%
11. Canada	2.6	1.2%
12. Sweden	2.4	1.1%
13. Macedonia, TFYR	2.3	1.1%
14. Hungary	2.2	1.0%
15. Belgium	2.1	1.0%
16. Spain	2.1	1.0%
17. Australia	1.8	0.9%
18. Russia	1.6	0.8%
19. Czech Republic	1.6	0.8%
20. Denmark	1.1	0.5%
Other	13.1	6.2%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	170.3	240.2	309.0
Outgoing	117.2	185.5	210.7
Surplus (Deficit)	53.0	54.8	98.3
Total Volume	287.5	425.7	519.7

Notes: Data based on billing point of traffic. 1993 totals do not include traffic to and from Bosnia. Totals may appear inconsistent with other figures due to rounding.

Cyprus

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United Kingdom	30.9	26.4%
2. Greece	26.0	22.2%
3. United States	5.7	4.8%
4. Russia	5.4	4.6%
5. Germany	5.0	4.2%
6. Romania	2.9	2.5%
7. Lebanon	2.8	2.4%
8. Italy	2.5	2.1%
9. Yugoslavia	2.4	2.0%
10. France	2.3	2.0%
11. Syria	2.1	1.7%
12. Bulgaria	2.0	1.7%
13. Egypt	1.7	1.4%
14. Switzerland	1.6	1.4%
15. Canada	1.6	1.3%
16. Ukraine	1.5	1.3%
17. Netherlands	1.4	1.2%
18. Israel	1.3	1.1%
19. Sweden	1.3	1.1%
20. Austria	1.0	0.8%
Other	16.1	13.7%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	72.2	79.0	87.3
Outgoing	93.8	106.6	117.4
Surplus (Deficit)	(21.6)	(27.5)	(30.2)
Total Volume	166.0	185.6	204.7

Note: Totals may appear inconsistent with other figures due to rounding.

Czech Republic

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	58.2	31.1%
2. Austria	16.6	8.9%
3. United Kingdom	11.4	6.1%
4. Italy	9.3	5.0%
5. France	7.6	4.1%
6. Poland	7.3	3.9%
7. United States	7.3	3.9%
8. Netherlands	5.9	3.2%
9. Russia	5.7	3.1%
10. Switzerland	5.6	3.0%
11. Ukraine	4.6	2.5%
12. Vietnam	3.6	1.9%
13. Belgium	3.5	1.9%
14. Canada	3.1	1.6%
15. Israel	2.9	1.5%
16. Hungary	2.7	1.4%
17. Spain	2.5	1.3%
18. Sweden	2.2	1.2%
19. Yugoslavia	2.1	1.1%
20. Croatia	1.8	1.0%
Other	23.1	12.3%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	210.0	223.7
Outgoing	141.4	157.6	186.8
Surplus (Deficit)	n.a.	52.4	36.9
Total Volume	n.a.	367.6	410.5

Note: Data based on billing point of traffic and exclude traffic to and from the Slovak Republic.

Denmark

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	102.6	19.3%
2. Sweden	88.3	16.6%
3. United Kingdom	56.8	10.7%
4. Norway	52.0	9.8%
5. United States	26.5	5.0%
6. France	22.9	4.3%
7. Netherlands	21.9	4.1%
8. Italy	12.9	2.4%
9. Finland	10.9	2.1%
10. Switzerland	10.7	2.0%
11. Belgium	10.7	2.0%
12. Spain	10.1	1.9%
13. Faroe Islands	9.2	1.7%
14. Poland	8.8	1.7%
15. Turkey	5.8	1.1%
16. Greenland	4.8	0.9%
17. Austria	4.6	0.9%
18. Iceland	4.0	0.8%
19. Canada	3.8	0.7%
20. Greece	3.4	0.6%
Other	61.9	11.6%

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National Traffic Balance

MiTT	**1993**	**1994**	**1995**
Incoming	460.0	500.9	551.0
Outgoing	452.3	488.4	532.6
Surplus (Deficit)	7.7	12.4	18.4
Total Volume	912.3	989.3	1,083.6

Note: Totals may appear inconsistent with other figures due to rounding.

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Estonia

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Finland	15.6	29.4%
2. Russia	13.9	26.2%
3. Sweden	4.3	8.1%
4. Germany	2.9	5.5%
5. Ukraine	2.5	4.8%
6. Latvia	2.5	4.7%
7. Lithuania	1.6	3.0%
8. United States	1.4	2.6%
9. Belarus	1.1	2.1%
10. Denmark	1.0	1.9%
11. United Kingdom	1.0	1.9%
12. Netherlands	0.6	1.2%
13. Norway	0.5	0.9%
14. France	0.4	0.8%
15. Italy	0.3	0.6%
16. Poland	0.3	0.6%
17. Belgium	0.3	0.6%
18. Switzerland	0.3	0.5%
19. Canada	0.2	0.4%
20. Kazakhstan	0.2	0.4%
Other	2.1	3.9%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	50.8	56.0
Outgoing	41.2	48.1	53.0
Surplus (Deficit)	n.a.	2.7	3.0
Total Volume	n.a.	98.9	109.0

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding.

Finland

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Sweden	99.0	31.4%
2. Germany	31.5	10.0%
3. Russia	24.0	7.6%
4. United Kingdom	21.1	6.7%
5. Estonia	18.3	5.8%
6. United States	15.8	5.0%
7. Norway	11.4	3.6%
8. Denmark	10.4	3.3%
9. France	9.1	2.9%
10. Netherlands	7.9	2.5%
11. Switzerland	7.2	2.3%
12. Italy	5.3	1.7%
13. Belgium	5.2	1.6%
14. Spain	4.5	1.4%
15. Canada	3.1	1.0%
16. Turkey	1.7	0.5%
17. Austria	1.7	0.5%
18. Poland	1.6	0.5%
19. Hungary	1.4	0.4%
20. Greece	1.3	0.4%
Other	33.9	10.8%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	285	345.0
Outgoing	n.a.	259	315.4
Surplus (Deficit)	n.a.	26	29.6
Total Volume	n.a.	544	660.4

Note: Data are rounded to the nearest million minutes. Data include Telecom Finland, Finnet International, Telivo, Ålands Mobiltelefon, HTC and Botnia Link Ltd.

France

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	325.9	11.6%
2. United Kingdom	317.7	11.3%
3. Italy	242.1	8.6%
4. Belgium	228.2	8.1%
5. Spain	179.7	6.4%
6. United States	165.8	5.9%
7. Switzerland	154.6	5.5%
8. Portugal	131.9	4.7%
9. Netherlands	97.2	3.5%
10. Morocco	88.5	3.2%
11. Algeria	67.6	2.4%
12. Tunisia	48.0	1.7%
13. Canada	37.7	1.3%
14. Turkey	33.7	1.2%
15. Sweden	26.6	0.9%
16. Poland	24.5	0.9%
17. Denmark	22.4	0.8%
18. Austria	20.8	0.7%
19. Greece	20.5	0.7%
20. Luxembourg	19.8	0.7%
Other	551.4	19.7%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	2,710.0	2,739.5	2,958.9
Outgoing	2,576.0	2,602.5	2,804.6
Surplus (Deficit)	134.0	137.0	154.3
Total Volume	5,286.0	5,342.0	5,763.5

Note: Totals may appear inconsistent with other figures due to rounding.

Germany

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Austria	416.3	7.9%
2. France	389.8	7.4%
3. Switzerland	383.0	7.3%
4. Turkey	375.6	7.2%
5. Italy	375.5	7.2%
6. United Kingdom	365.1	7.0%
7. Netherlands	335.9	6.4%
8. United States	283.6	5.4%
9. Poland	278.9	5.3%
10. Spain	170.4	3.2%
11. Belgium	144.4	2.8%
12. Greece	123.5	2.4%
13. Croatia	113.3	2.2%
14. Denmark	103.5	2.0%
15. Czech Republic	86.5	1.6%
16. Sweden	77.3	1.5%
17. Yugoslavia	77.1	1.5%
18. Russia	71.7	1.4%
19. Portugal	67.7	1.3%
20. Hungary	65.7	1.3%
Other	939.2	17.9%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	3,707.8	3,881.2	n.a.
Outgoing	4,679.6	5,147.1	5,244.0
Surplus (Deficit)	(971.8)	(1,265.9)	n.a.
Total Volume	8,387.4	9,028.3	n.a.

Note: Data are for Deutsche Telekom only. From January to June 1996, Deutsche Telekom reported total outgoing traffic of 2,256 million minutes and total incoming of 2,146 million minutes.

Greece

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	82.5	17.6%
2. United Kingdom	68.6	14.7%
3. Italy	40.2	8.6%
4. United States	30.5	6.5%
5. France	23.0	4.9%
6. Cyprus	18.0	3.8%
7. Canada	16.9	3.6%
8. Bulgaria	11.8	2.5%
9. Belgium	11.0	2.4%
10. Romania	11.0	2.4%
11. Netherlands	10.9	2.3%
12. Switzerland	10.2	2.2%
13. Albania	9.5	2.0%
14. Yugoslavia	8.0	1.7%
15. Sweden	7.3	1.6%
16. Turkey	7.0	1.5%
17. Australia	6.8	1.5%
18. Russia	6.7	1.4%
19. Austria	6.5	1.4%
20. Poland	5.8	1.2%
Other	75.7	16.2%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	406.1	441.2	505.4
Outgoing	336.2	422.7	467.9
Surplus (Deficit)	70.0	18.6	37.4
Total Volume	742.3	863.9	973.3

Note: Totals may appear inconsistent with other figures due to rounding.

Hungary

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	59.4	24.0%
2. Austria	30.4	12.3%
3. Romania	14.4	5.8%
4. Italy	13.5	5.5%
5. United Kingdom	13.3	5.4%
6. United States	11.2	4.5%
7. Yugoslavia	8.4	3.4%
8. France	8.4	3.4%
9. Russia	7.5	3.0%
10. Switzerland	7.1	2.9%
11. Netherlands	6.6	2.7%
12. Slovak Republic	6.3	2.5%
13. Ukraine	5.5	2.2%
14. Belgium	3.8	1.5%
15. Sweden	3.5	1.4%
16. Israel	3.4	1.4%
17. Poland	3.3	1.3%
18. Croatia	3.2	1.3%
19. Czech Republic	2.9	1.2%
20. Greece	2.7	1.1%
Other	32.5	13.1%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	192.8	211.9	243.7
Outgoing	213.2	236.6	247.5
Surplus (Deficit)	(20.4)	(24.7)	(3.8)
Total Volume	406.0	448.5	491.2

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding.

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Iceland

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	6.8	23.7%
2. Denmark	4.4	15.1%
3. Sweden	3.0	10.4%
4. Norway	2.5	8.7%
5. Germany	2.3	7.9%
6. United Kingdom	2.2	7.6%
7. France	0.8	2.7%
8. Netherlands	0.7	2.6%
9. Faroe Islands	0.6	2.0%
10. Spain	0.4	1.5%
11. Canada	0.4	1.4%
12. Italy	0.4	1.4%
13. Belgium	0.4	1.4%
14. Finland	0.3	1.2%
15. Switzerland	0.3	1.1%
16. Portugal	0.2	0.6%
17. Austria	0.2	0.6%
18. Russia	0.1	0.5%
19. Australia	0.1	0.4%
20. Ireland	0.1	0.3%
Other	2.6	9.0%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	23.4	25.5	28.4
Outgoing	24.1	26.0	28.9
Surplus (Deficit)	(0.7)	(0.4)	(0.6)
Total Volume	47.5	51.5	57.3

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding.

Ireland

Largest Telecommunications Routes, FY 1995/96

Destination	MiTT	Percentage of Outgoing Traffic
1. United Kingdom	264	64.9%
2. United States	49	12.0%
3. Germany	18	4.4%
4. France	14	3.4%
5. Netherlands	9	2.2%
6. Italy	7	1.7%
7. Spain	6	1.5%
8. Belgium	5	1.2%
9. Canada	5	1.2%
10. Australia	4	1.0%
11. Switzerland	3	0.7%
12. Denmark	2	0.5%
13. Sweden	2	0.5%
Other	18	4.4%

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National Traffic Balance

MiTT	FY 1993/94	1994/95	1995/96
Incoming	423.0	442.9	n.a.
Outgoing	315.8	323.7	407
Surplus (Deficit)	107.2	119.2	n.a.
Total Volume	738.8	766.5	n.a.

Notes: Data rounded to the nearest million minutes. Traffic to Northern Ireland is excluded in both totals and route data. Totals may appear inconsistent with other figures due to rounding. Fiscal year ends 31 March.

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Italy

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	299.0	15.7%
2. France	239.0	12.5%
3. Switzerland	181.8	9.5%
4. United States	154.1	8.1%
5. United Kingdom	149.3	7.8%
6. Spain	66.9	3.5%
7. Belgium	54.7	2.9%
8. Austria	49.0	2.6%
9. Netherlands	43.8	2.3%
10. Yugoslavia	36.7	1.9%
11. Chile	35.9	1.9%
12. Greece	32.6	1.7%
13. Morocco	31.2	1.6%
14. Romania	29.6	1.6%
15. Poland	29.0	1.5%
16. Croatia	26.2	1.4%
17. Tunisia	24.1	1.3%
18. Canada	22.0	1.2%
19. Brazil	18.2	1.0%
20. Sweden	16.4	0.9%
Other	368.8	19.3%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	1,672.7	1,864.0	1,999.8
Outgoing	1,609.7	1,708.0	1,908.2
Surplus (Deficit)	63.0	156.0	91.6
Total Volume	3,282.4	3,572.0	3,908.1

Note: Totals may appear inconsistent with other figures due to rounding.

Luxembourg

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Belgium	52.6	22.7%
2. Germany	48.0	20.7%
3. France	46.4	20.0%
4. Portugal	14.9	6.4%
5. United Kingdom	13.3	5.7%
6. Italy	11.1	4.8%
7. Netherlands	8.2	3.5%
8. Switzerland	6.4	2.7%
9. United States	5.5	2.4%
10. Spain	3.4	1.5%
11. Denmark	3.2	1.4%
12. Austria	2.1	0.9%
13. Sweden	2.0	0.9%
14. Greece	1.5	0.6%
15. Ireland	1.0	0.4%
16. Finland	0.8	0.3%
17. Poland	0.7	0.3%
18. Japan	0.7	0.3%
19. Russia	0.7	0.3%
20. Canada	0.6	0.3%
Other	9.1	3.9%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	131.7	145.2	174.5
Outgoing	199.3	213.5	232.2
Surplus (Deficit)	(67.6)	(68.3)	(57.7)
Total Volume	331.0	358.7	406.7

Note: Totals may appear inconsistent with other figures due to rounding.

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Macedonia, TFYR

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	5.5	15.5%
2. Bulgaria	3.4	9.6%
3. Croatia	2.8	7.9%
4. Switzerland	2.4	6.8%
5. Slovenia	2.4	6.8%
6. Turkey	2.1	5.9%
7. United States	2.1	5.9%
8. Austria	1.5	4.2%
9. Italy	1.5	4.2%
10. Greece	1.2	3.4%
11. Australia	0.9	2.5%
12. United Kingdom	0.9	2.5%
13. France	0.7	2.0%
14. Sweden	0.6	1.7%
15. Netherlands	0.6	1.7%
16. Russia	0.5	1.4%
17. Albania	0.4	1.1%
18. Canada	0.4	1.1%
19. Belgium	0.3	0.8%
20. Czech Republic	0.3	0.8%
Other	5.0	14.2%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	48.0	78.3	74.0
Outgoing	27.6	35.1	35.5
Surplus (Deficit)	20.4	43.2	38.5
Total Volume	75.6	113.4	109.5

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding.

Netherlands

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	339.5	23.3%
2. Belgium	238.6	16.4%
3. United Kingdom	179.9	12.3%
4. France	112.1	7.7%
5. United States	90.0	6.2%
6. Italy	46.6	3.2%
7. Spain	42.6	2.9%
8. Switzerland	41.0	2.8%
9. Turkey	30.0	2.1%
10. Sweden	25.3	1.7%
11. Denmark	22.3	1.5%
12. Austria	19.0	1.3%
13. Canada	16.5	1.1%
14. Poland	14.0	1.0%
15. Norway	12.8	0.9%
16. Greece	12.0	0.8%
17. Portugal	10.9	0.7%
18. Morocco	10.4	0.7%
19. Ireland	10.2	0.7%
20. Russia	9.0	0.6%
Other	175.9	12.1%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	1,159.0	1,290.9	1,453.0
Outgoing	1,238.2	1,345.8	1,458.7
Surplus (Deficit)	(79.2)	(54.9)	(5.7)
Total Volume	2,397.2	2,636.7	2,911.7

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding.

Norway

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Sweden	111	25.7%
2. Denmark	60	13.9%
3. United Kingdom	59	13.7%
4. United States	32	7.4%
5. Germany	24	5.6%
6. France	13	3.0%
7. Netherlands	12	2.8%
8. Finland	10	2.3%
9. Spain	8	1.9%
10. Italy	7	1.6%
11. Switzerland	6	1.4%
12. Belgium	6	1.4%
13. Russia	5	1.2%
14. Poland	5	1.2%
15. Canada	4	0.9%
16. Turkey	3	0.7%
17. Austria	2	0.5%
18. Iceland	2	0.5%
19. Greece	2	0.5%
20. Portugal	2	0.5%
Other	58	13.4%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	322.5	352.0	373.2
Outgoing	376.2	395.5	431.5
Surplus (Deficit)	(53.7)	(43.5)	(58.3)
Total Volume	698.7	747.5	804.7

Note: Data are rounded to the nearest million minutes and are based on billing point of traffic.

Poland

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	146.4	38.4%
2. United States	30.3	7.9%
3. United Kingdom	20.6	5.4%
4. France	20.1	5.3%
5. Italy	19.2	5.0%
6. Austria	13.2	3.5%
7. Netherlands	12.1	3.2%
8. Sweden	12.0	3.1%
9. Russia	11.7	3.1%
10. Ukraine	10.1	2.7%
11. Canada	8.0	2.1%
12. Belgium	7.8	2.0%
13. Czech Republic	6.6	1.7%
14. Denmark	6.4	1.7%
15. Switzerland	5.5	1.4%
16. Belarus	5.4	1.4%
17. Netherlands Antilles	3.6	0.9%
18. Spain	3.6	0.9%
19. Australia	3.2	0.8%
20. Hungary	2.8	0.7%
Other	32.9	8.6%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	431.5	643.8	649.3
Outgoing	272.7	356.6	381.4
Surplus (Deficit)	158.8	287.2	267.9
Total Volume	704.2	1,000.4	1,030.7

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding.

Portugal

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. France	61.6	21.7%
2. Spain	45.2	15.9%
3. Germany	33.9	12.0%
4. United Kingdom	31.3	11.0%
5. Switzerland	15.3	5.4%
6. United States	12.5	4.4%
7. Brazil	12.4	4.4%
8. Italy	11.7	4.1%
9. Netherlands	9.5	3.4%
10. Belgium	9.4	3.3%
11. Angola	6.4	2.2%
12. Canada	4.3	1.5%
13. Sweden	3.3	1.2%
14. Luxembourg	3.2	1.1%
15. Cape Verde	3.2	1.1%
16. Guinea-Bissau	3.1	1.1%
17. Mozambique	2.8	1.0%
18. Denmark	2.3	0.8%
19. South Africa	2.1	0.7%
20. Austria	1.7	0.6%
Other	8.6	3.0%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	438.2	467.8	525.0
Outgoing	232.6	262.4	283.9
Surplus (Deficit)	205.6	205.4	241.1
Total Volume	670.8	730.2	808.9

Notes: Totals are combined for Portugal Telecom, which handles traffic to Europe, and CPRM, which handles overseas traffic. In 1995 Portugal Telecom handled 238.1 million MiTT outgoing and 427.8 million MiTT incoming. Data for Portugal Telecom based on billing point of traffic.

Russia

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	35.6	12.4%
2. United States	22.7	7.9%
3. Latvia	22.4	7.8%
4. Lithuania	16.9	5.9%
5. United Kingdom	14.0	4.9%
6. Estonia	13.9	4.8%
7. Finland	11.6	4.0%
8. Italy	11.5	4.0%
9. France	9.8	3.4%
10. Turkey	9.4	3.3%
11. Yugoslavia	8.6	3.0%
12. Israel	8.3	2.9%
13. Poland	7.5	2.6%
14. Austria	5.2	1.8%
15. Switzerland	5.2	1.8%
16. Netherlands	5.1	1.8%
17. China	4.6	1.6%
18. Hungary	4.4	1.5%
19. Bulgaria	4.3	1.5%
20. Czech Republic	4.1	1.4%
Other	62.3	21.7%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	268.0	365.0	448.1
Outgoing	201.0	229.2	287.4
Surplus (Deficit)	67.0	135.8	160.7
Total Volume	469.0	594.2	735.5

Note: Data are for Rostelecom only and do not include traffic to and from other former Soviet republics (see page 122 for CIS statistics).

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Slovak Republic

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	12.3	21.0%
2. Austria	9.2	15.7%
3. Hungary	5.3	9.1%
4. Italy	3.2	5.5%
5. United States	2.9	5.0%
6. United Kingdom	2.9	4.9%
7. Poland	2.2	3.7%
8. Ukraine	2.1	3.6%
9. Russia	2.1	3.6%
10. Switzerland	2.0	3.3%
11. France	1.8	3.0%
12. Netherlands	1.3	2.2%
13. Israel	1.1	1.8%
14. Belgium	0.9	1.5%
15. Croatia	0.8	1.4%
16. Canada	0.8	1.4%
17. Yugoslavia	0.7	1.2%
18. Sweden	0.5	0.8%
19. Spain	0.5	0.8%
20. Slovenia	0.4	0.7%
Other	5.7	9.8%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	33.6	68.5	81.6
Outgoing	30.5	52.5	58.8
Surplus (Deficit)	3.1	16.0	22.8
Total Volume	64.1	121.0	140.4

Note: Totals may appear inconsistent with other figures due to rounding. Data do not include traffic to and from the Czech Republic.

Slovenia

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Croatia	27.4	27.3%
2. Germany	15.4	15.3%
3. Austria	11.0	10.9%
4. Yugoslavia	10.1	10.0%
5. Italy	9.8	9.7%
6. Bosnia	3.6	3.6%
7. Switzerland	2.5	2.5%
8. Macedonia, TFYR	2.4	2.4%
9. United Kingdom	2.1	2.1%
10. France	1.9	1.9%
11. United States	1.8	1.8%
12. Russia	1.7	1.7%
13. Hungary	1.3	1.3%
14. Czech Republic	1.1	1.1%
15. Netherlands	0.8	0.8%
16. Sweden	0.7	0.7%
17. Belgium	0.6	0.6%
18. Canada	0.5	0.5%
19. Spain	0.4	0.4%
20. Poland	0.4	0.4%
Other	4.8	4.8%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	55.8	83.2	121.2
Outgoing	62.8	90.6	100.6
Surplus (Deficit)	(7.0)	(7.4)	20.6
Total Volume	118.6	173.8	221.8

Note: Totals may appear inconsistent with other figures due to rounding.

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Spain

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	160.7	15.7%
2. France	158.2	15.4%
3. United Kingdom	147.0	14.3%
4. Italy	68.2	6.7%
5. United States	48.3	4.7%
6. Portugal	40.6	4.0%
7. Switzerland	36.1	3.5%
8. Belgium	35.4	3.5%
9. Netherlands	35.3	3.4%
10. Morocco	22.8	2.2%
11. Andorra	17.2	1.7%
12. Argentina	17.1	1.7%
13. Sweden	14.5	1.4%
14. Chile	12.9	1.3%
15. Colombia	10.5	1.0%
16. Denmark	9.5	0.9%
17. Mexico	8.9	0.9%
18. Brazil	8.8	0.9%
19. Cuba	8.7	0.8%
20. Austria	8.4	0.8%
Other	155.8	15.2%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	908.4	969.9	1,076.4
Outgoing	846.9	948.3	1,024.6
Surplus (Deficit)	61.5	21.6	51.8
Total Volume	1,755.3	1,918.2	2,101.0

Note: Totals may appear inconsistent with other figures due to rounding.

Sweden

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Finland	128	14.2%
2. Norway	124	13.8%
3. Denmark	96	10.7%
4. Germany	95	10.6%
5. United Kingdom	76	8.4%
6. United States	62	6.9%
7. France	36	4.0%
8. Netherlands	26	2.9%
9. Italy	19	2.1%
10. Poland	19	2.1%
11. Switzerland	16	1.8%
12. Belgium	16	1.8%
13. Spain	14	1.6%
14. Austria	10	1.1%
15. Yugoslavia	9	1.0%
Other	154	17.1%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	630	n.a.	n.a.
Outgoing	740	802	900
Surplus (Deficit)	(110)	n.a.	n.a.
Total Volume	1370	n.a.	n.a.

Note: Data are for Telia and Tele 2 only based on billing point of traffic rounded to the nearest million minutes.

Switzerland

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	408.2	23.0%
2. France	280.0	15.7%
3. Italy	252.8	14.2%
4. United Kingdom	98.5	5.5%
5. United States	79.7	4.5%
6. Austria	76.1	4.3%
7. Portugal	60.2	3.4%
8. Spain	55.1	3.1%
9. Netherlands	42.9	2.4%
10. Yugoslavia	41.3	2.3%
11. Belgium	29.8	1.7%
12. Turkey	28.5	1.6%
13. Croatia	19.1	1.1%
14. Sweden	18.9	1.1%
15. Canada	15.4	0.9%
16. Greece	13.6	0.8%
17. Macedonia	12.1	0.7%
18. Denmark	11.8	0.7%
19. Brazil	10.7	0.6%
20. Russia	10.6	0.6%
Other	213.0	12.0%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	1,258.7	1,353.0	1,439.3
Outgoing	1,572.0	1,649.3	1,778.4
Surplus (Deficit)	(313.3)	(296.3)	(339.1)
Total Volume	2,830.7	3,002.3	3,217.7

Note: All route data are rounded to the nearest million minutes and based on billing point of traffic.

Turkey

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	124.5	33.3%
2. United Kingdom	30.8	8.2%
3. United States	20.6	5.5%
4. France	20.1	5.4%
5. Netherlands	15.8	4.2%
6. Russia	15.4	4.1%
7. Italy	11.2	3.0%
8. Switzerland	11.1	3.0%
9. Austria	9.2	2.5%
10. Romania	8.0	2.1%
11. Belgium	7.2	1.9%
12. Bulgaria	6.7	1.8%
13. Greece	6.0	1.6%
14. Israel	5.7	1.5%
15. Saudi Arabia	5.6	1.5%
16. Ukraine	5.2	1.4%
17. Iran	5.1	1.4%
18. Azerbaijan	5.0	1.3%
19. Sweden	4.0	1.1%
20. Denmark	3.0	0.8%
Other	53.5	14.3%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	605.0	601.4	705.0
Outgoing	264.6	284.3	373.6
Surplus (Deficit)	340.4	317.1	331.5
Total Volume	869.6	885.8	1,078.6

Note: Totals may appear inconsistent with other figures due to rounding.

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United Kingdom

Largest Telecommunications Routes, FY 1995/96

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	617.6	15.3%
2. Ireland	371.4	9.2%
3. Germany	364.4	9.0%
4. France	360.8	8.9%
5. Italy	188.0	4.7%
6. Netherlands	173.5	4.3%
7. Spain	171.1	4.2%
8. Australia	127.3	3.2%
9. Canada	120.5	3.0%
10. Belgium	105.4	2.6%
11. Switzerland	102.9	2.5%
12. Sweden	66.8	1.7%
13. Greece	62.9	1.6%
14. Denmark	57.6	1.4%
15. South Africa	57.5	1.4%
16. Norway	57.1	1.4%
17. India	55.5	1.4%
18. Pakistan	51.0	1.3%
19. Hong Kong	51.0	1.3%
20. Portugal	49.2	1.2%
Other	804.0	19.9%

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National Traffic Balance

MiTT	FY 1993/94	FY 1994/95	FY 1995/96
Incoming	3086	3577	4,021
Outgoing	3130	3507	4,016
Surplus (Deficit)	(44)	70	5
Total Volume	6216	7084	8037

Note: Data are for BT and Mercury only and exclude IPL reseller traffic as well as traffic between the Irish Republic and Northern Ireland. IPL resellers had approximately 280 million MiTT of outgoing traffic in FY 1995/96, of which WorldCom, ACC and Sprint accounted for 240 million MiTT. Data for carrier call minutes published in the *Market Information Upate* by the U.K. Office of Telecommunications (Oftel) may not match *TeleGeography* data because Oftel reports "retail" minutes only, which exclude (a) "wholesale" minutes sold to switched resellers and (b) operator assisted and collect calls.

Yugoslavia

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Germany	53.6	25.2%
2. Austria	23.9	11.2%
3. Switzerland	23.9	11.2%
4. Italy	10.8	5.1%
5. Macedonia, TFYR	9.7	4.6%
6. France	9.6	4.5%
7. Slovenia	8.5	4.0%
8. Russia	7.2	3.4%
9. Hungary	7.1	3.3%
10. Sweden	6.4	3.0%
11. Greece	6.2	2.9%
12. United States	5.9	2.8%
13. Canada	4.3	2.0%
14. United Kingdom	3.7	1.7%
15. Netherlands	3.2	1.5%
16. Australia	2.5	1.2%
17. Bulgaria	2.0	0.9%
18. Cyprus	2.0	0.9%
19. Turkey	1.9	0.9%
20. Czech Republic	1.6	0.8%
Other	18.8	8.8%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	223.5	229.0	296.0
Outgoing	181.5	181.9	212.8
Surplus (Deficit)	42.0	47.1	83.2
Total Volume	405.0	410.9	508.8

Note: Totals may appear inconsistent with other figures due to rounding.

Former Soviet Union

International Telecommunications Routes, 1994 (thousands of minutes)

From: \ To:	Azerbaijan	Armenia	Belarus	Georgia	Kazakhstan	Kyrgyzstan	Moldova	Russia	Tajikistan	Turkmenistan	Uzbekistan	Ukraine
Armenia	5.1		1283.3	1261.4	465.8		281.2	40775.8	30.4	682.7	638.7	5942.5
Azerbaijan			570.1	430.6	626.6	95.9	140.6	18852.5	39.9	323.5	390.9	2659.2
Estonia	145.7	115.5	1126.6	51.7	196.8	3.8	148.2	14426.2	13.9	27.1	83.7	2667.6
Kazakhstan*	323.8	266.0	555.9	87.3		1565.0	119.3	22007.0	286.6	177.7	2361.9	1537.6
Kyrgyzstan	74.9	18.3	337.6	11.6	1011.2		67.7	18209.3	718.4	393.2	359.5	928.6
Latvia			2339.9					16314.4			3687.5	
Lithuania	287.2	227.4	7536.5	117.3	547.6	45.0	454.1	24081.2	58.9	56.1	382.5	8428.4
Moldova	220.1	352.5	2854.8	38.3	608.2	55.4		3028.7	39.8	75.7	194.1	2251.4
Turkmenistan	367.1	493.9	279.1	45.7	487.3	162.9	50.2	6063.3	338.9		815.4	923.6
Ukraine	5445.3	9985.0	34367.3	3832.2	7444.3	1056.8	25483.5	378124.6	984.3	357.2	7834.0	
Uzbekistan	363.1	352.9	554.5	198.0	2838.8	1144.4	147.5	14663.0	1002.1			1442.3

From: \ To:	USA	UK	France	Germany	Turkey
Armenia	726.9	49.7	154.3	100.0	51.5
Azerbaijan	381.2	22.9	4.0	25.5	1954.5
Estonia	1230.7	767.3	303.3	2341.2	62.7
Kazakhstan*	1216.0	550.8	336.8	3324.3	1084.0
Kyrgyzstan	155.7	40	16.6	333.3	71.9
Latvia	863.9	544.5	166.8	1781.9	443.2
Lithuania	685.6	325.6	298.5	2628.8	42.6
Moldova	571.1	103.2	98.0	84.5	191.5
Turkmenistan					
Ukraine					
Uzbekistan	24.0	33.3	4.7	95.8	39.3

* September-December 1994 only.
Source: Regional Commonwealth in the Field of Communications (RCC)
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Asia, Middle East & Africa

International Traffic

Australia

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United Kingdom	182	17.8%
2. United States	158	15.4%
3. New Zealand	142	13.9%
4. Hong Kong	40	3.9%
5. Japan	34	3.3%
6. Singapore	28	2.7%
7. Canada	25	2.4%
8. Germany	24	2.3%
9. Italy	20	2.0%
10. Malaysia	20	2.0%
Other	351	34.2%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	n.a.	n.a.
Outgoing	735	852	1024
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: Data are for Telstra, Optus and IPL resellers (for 1995 only) rounded to the nearest million minutes.

Bahrain

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. India	16.2	18.3%
2. Saudi Arabia	13.8	15.5%
3. United Arab Emirates	10.6	11.9%
4. United Kingdom	8.1	9.2%
5. Kuwait	4.7	5.3%
6. Egypt	4.3	4.9%
7. United States	4.1	4.7%
8. Pakistan	4.1	4.6%
9. Qatar	3.6	4.1%
10. Oman	1.9	2.1%
11. Philippines	1.6	1.8%
12. Jordan	1.2	1.4%
13. Sri Lanka	1.2	1.3%
14. Bangladesh	1.0	1.1%
15. Iran	0.9	1.0%
16. France	0.8	0.9%
17. Morocco	0.7	0.8%
18. Germany	0.7	0.8%
19. Syria	0.6	0.7%
20. Japan	0.5	0.6%
Other	8.0	9.0%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	n.a.	299.4
Outgoing	77.0	86.8	88.7
Surplus (Deficit)	n.a.	n.a.	210.6
Total Volume	n.a.	n.a.	388.1

Note: Data based on billing point of traffic.

Bangladesh

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United Kingdom	3.7	11.2%
2. India	3.4	10.3%
3. United States	2.9	8.8%
4. Singapore	1.7	5.2%
5. Hong Kong	1.6	4.8%
6. Saudi Arabia	1.3	3.9%
7. Korea, Rep. of	1.3	3.9%
8. Japan	1.0	3.1%
9. Pakistan	1.0	3.0%
10. Malaysia	1.0	3.0%
11. United Arab Emirates	0.8	2.4%
12. Germany	0.6	1.8%
13. China	0.6	1.8%
14. Italy	0.5	1.5%
15. France	0.5	1.5%
16. Canada	0.4	1.2%
17. Sri Lanka	0.2	0.6%
Other	10.5	31.8%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	83.9	n.a.	122.1
Outgoing	17.2	22.1	33.0
Surplus (Deficit)	66.7	n.a.	89.1
Total Volume	101.1	n.a.	155.1

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China

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Hong Kong	750.0	56.0%
3. Taiwan	115.0	8.6%
2. Japan	86.8	6.5%
4. United States	75.0	5.6%
5. Korea, Rep.	45.7	3.4%
6. Macau	41.4	3.1%
7. Singapore	24.6	1.8%
8. Australia	13.5	1.0%
9. Germany	12.0	0.9%
10. Canada	10.7	0.8%
11. United Kingdom	7.2	0.5%
12. France	6.8	0.5%
13. Thailand	6.5	0.5%
14. Russia	6.2	0.5%
15. Malaysia	6.0	0.4%
16. Italy	5.3	0.4%
17. Indonesia	3.5	0.3%
18. Philippines	3.0	0.2%
19. Netherlands	2.5	0.2%
20. New Zealand	2.0	0.1%
Other	115.5	8.6%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	n.a.	n.a.
Outgoing	1090	1170	1339.1
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: Totals may appear inconsistent with other figures due to rounding.

Hong Kong

Largest Telecommunications Routes, FY 1995/96

Destination	MiTT	Percentage of Outgoing Traffic
1. China	913.6	54.0%
2. United States	101.5	6.0%
3. Taiwan	84.6	5.0%
4. Japan	67.7	4.0%
5. United Kingdom	67.7	4.0%
6. Canada	50.8	3.0%
7. Singapore	50.8	3.0%
8. Australia	50.8	3.0%
9. Philippines	50.8	3.0%
10. Macau	33.8	2.0%
Other	219.9	13.0%

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National Traffic Balance

MiTT	FY 1993/94	1994/95	1995/96
Incoming	1,260.3	1,446.4	1,598.3
Outgoing	1,376.9	1,578.4	1,691.8
Surplus (Deficit)	(116.5)	(132.1)	(93.5)
Total Volume	2,637.2	3,024.8	3,290.2

Note: Data based on billing point of traffic. Route-by-route traffic volumes reflect reported data of Hong Kong Telecom which has been rounded to the nearest percent.. Totals may appear inconsistent with other figures due to rounding. Fiscal year ends 31 March.

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India

Largest Telecommunications Routes, FY 1995/96

Destination	MiTT	Percentage of Outgoing Traffic
1. Saudi Arabia	69.8	20.5%
2. United States	49.9	14.6%
3. United Arab Emirates	32.7	9.6%
4. United Kingdom	25.5	7.5%
5. Singapore	14.3	4.2%
6. Germany	13.2	3.9%
7. Kuwait	9.4	2.7%
8. Canada	8.7	2.5%
9. Oman	7.9	2.3%
10. Hong Kong	7.6	2.2%
11. Pakistan	7.4	2.2%
12. Japan	6.9	2.0%
13. France	5.8	1.7%
14. Australia	5.6	1.6%
15. Italy	5.1	1.5%
16. Sri Lanka	4.6	1.3%
17. Qatar	3.9	1.2%
18. Netherlands	3.3	1.0%
19. Russia	3.3	1.0%
20. Switzerland	3.2	0.9%
Other	53.3	15.6%

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National Traffic Balance

MiTT	FY 1993/94	1994/95	1995/96
Incoming	441.0	615.0	805.4
Outgoing	283.9	314.0	341.4
Surplus (Deficit)	157.1	300.9	464.0
Total Volume	724.8	929.0	1146.8

Note: Data based on billing point of traffic. Outgoing totals and route data do not include calls to Bangladesh and Nepal. Fiscal year ends 31 March. Totals may appear inconsistent with other figures due to rounding.

Indonesia

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Singapore	47.8	23.2%
2. United States	20.6	10.0%
3. Japan	19.9	9.7%
4. Australia	17.5	8.5%
5. Malaysia	13.3	6.5%
6. Hong Kong	12.4	6.0%
7. Taiwan	9.0	4.4%
8. Korea, Rep. of	8.8	4.3%
9. United Kingdom	6.7	3.3%
10. Germany	5.5	2.7%
11. China	4.6	2.2%
12. Netherlands	4.3	2.1%
13. Philippines	3.7	1.8%
14. Saudi Arabia	3.5	1.7%
15. France	3.3	1.6%
16. Thailand	3.1	1.5%
17. India	2.8	1.4%
18. Italy	2.0	1.0%
19. Canada	2.0	1.0%
20. Switzerland	1.3	0.6%
Other	13.8	6.7%

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National Traffic Balance

MiTT	**1993**	**1994**	**1995**
Incoming	201.8	244.7	286
Outgoing	143.8	182.5	205.9
Surplus (Deficit)	58.0	62.2	80
Total Volume	345.6	427.2	492

Note: Totals may appear inconsistent with other figures due to rounding. Data based on billing point of traffic.

Iran

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United Arab Emirates	22.3	10.6%
2. Kuwait	22.3	10.6%
3. Germany	21.2	10.1%
4. United States	17.8	8.5%
5. United Kingdom	10.1	4.8%
6. Pakistan	8.8	4.2%
7. Turkey	7.6	3.6%
8. Sweden	6.8	3.2%
9. Canada	6.3	3.0%
10. Japan	6.1	2.9%
11. France	5.1	2.4%
12. Saudi Arabia	3.8	1.8%
13. Italy	3.6	1.7%
14. Netherlands	3.3	1.6%
15. Qatar	2.7	1.3%
16. Austria	2.1	1.0%
17. Switzerland	2.1	1.0%
18. India	1.8	0.9%
19. Denmark	1.4	0.7%
20. Spain	0.9	0.4%
Other	54.5	25.9%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	n.a.	199
Outgoing	156.5	208.4	210.4
Surplus (Deficit)	n.a.	n.a.	(11)
Total Volume	n.a.	n.a.	409

Note: Data based on billing point of traffic.

Israel

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	66.6	26.4%
2. United Kingdom	20.9	8.3%
3. France	16.1	6.4%
4. Jordan	15.1	6.0%
5. Germany	14.0	5.6%
6. Russia	11.7	4.7%
7. Canada	9.0	3.6%
8. Italy	7.9	3.1%
9. Ukraine	7.5	3.0%
10. Romania	5.9	2.3%
11. Netherlands	5.4	2.1%
12. Switzerland	5.3	2.1%
13. Belgium	4.3	1.7%
14. Turkey	3.8	1.5%
15. Egypt	3.6	1.4%
16. South Africa	3.0	1.2%
17. Australia	2.6	1.0%
18. Dominican Republic	2.6	1.0%
19. Argentina	2.6	1.0%
20. Spain	2.3	0.9%
Other	41.8	16.5%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	309.5	n.a.	345.6
Outgoing	175.5	213.0	252.3
Surplus (Deficit)	134.0	n.a.	93.3
Total Volume	485.0	n.a.	597.9

Note: Data based on billing point of traffic.

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Japan

Largest Telecommunications Routes, FY 1995/96

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	348.9	22.1%
2. China	202.1	12.8%
3. Korea	155.7	9.9%
4. Philippines	139.0	8.8%
5. Taiwan	85.0	5.4%
6. Thailand	68.8	4.4%
7. Brazil	60.4	3.8%
8. Hong Kong	57.8	3.7%
9. United Kingdom	48.0	3.0%
10. Singapore	39.1	2.5%
11. Australia	33.4	2.1%
12. Malaysia	32.3	2.0%
13. Indonesia	27.2	1.7%
14. Germany	25.9	1.6%
15. Canada	23.1	1.5%
16. France	21.0	1.3%
17. Peru	20.7	1.3%
18. Iran	14.7	0.9%
19. Pakistan	12.5	0.8%
20. Italy	11.9	0.8%
Other	149.3	9.5%

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National Traffic Balance

MiTT	FY 1993/94	FY 1994/95	FY 1995/96
Incoming	981.2	1140.6	1321
Outgoing	1411.2	1524.8	1631
Surplus (Deficit)	(429.8)	(384.2)	(310)
Total Volume	2392.4	2665.4	2952

Note: Route data include only IDD calls, while total data include operator assisted calls as well. Fiscal year ends 31 March. Data are for KDD, ITJ, and IDC combined.

Jordan

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Israel	9.8	13.6%
2. Saudi Arabia	8.6	12.0%
3. Iraq	7.9	11.0%
4. Egypt	6.4	9.0%
5. Syria	6.4	8.9%
6. United States	4.4	6.1%
7. United Arab Emirates	4.1	5.7%
8. United Kingdom	2.9	4.0%
9. Kuwait	2.5	3.5%
10. Lebanon	2.4	3.3%
11. Germany	1.4	1.9%
12. Italy	1.1	1.5%
13. Qatar	1.0	1.4%
14. France	1.0	1.4%
15. Oman	0.8	1.1%
16. Yemen	0.8	1.1%
17. Turkey	0.7	1.0%
18. Bahrain	0.7	1.0%
19. Canada	0.6	0.8%
20. Switzerland	0.5	0.6%
Other	7.8	10.9%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	100	114	118.0
Outgoing	50	57	71.7
Surplus (Deficit)	50	57	46.3
Total Volume	150	171	189.7

Notes: Traffic to Israel includes traffic to the West Bank.

Korea, Republic of

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	141	25.3%
2. Japan	126	22.6%
3. China	75	13.5%
4. Hong Kong	23	4.1%
5. Germany	14	2.5%
6. Australia	12	2.2%
7. Philippines	12	2.2%
8. United Kingdom	11	2.0%
9. Indonesia	11	2.0%
10. Canada	10	1.8%
11. Taiwan	9	1.6%
12. Singapore	9	1.6%
13. France	8	1.4%
14. Thailand	8	1.4%
15. Vietnam	6	1.1%
Other	82	14.7%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	510.5	555.2	672
Outgoing	355.4	440.4	557
Surplus (Deficit)	155.1	114.8	115
Total Volume	865.9	995.6	1,229

Note: Data are for Korea Telecom and DACOM combined and are based on billing point of traffic.

Kuwait

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Egypt	21.1	18.4%
2. Saudi Arabia	14.4	12.6%
3. India	12.9	11.2%
4. United Arab Emirates	8.1	7.1%
5. Syria	8.1	7.1%
6. United States	7.8	6.8%
7. Pakistan	7.5	6.5%
8. United Kingdom	7.2	6.3%
9. Jordan	5.8	5.1%
10. Iran	5.3	4.6%
11. Bahrain	3.4	3.0%
12. Lebanon	2.9	2.6%
13. Bangladesh	1.8	1.5%
14. France	1.3	1.2%
15. Germany	1.3	1.2%
16. Qatar	1.2	1.1%
17. Philippines	1.2	1.0%
18. Canada	1.1	0.9%
19. Oman	1.0	0.9%
20. Italy	1.0	0.9%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	127.0	130.2
Outgoing	116.8	120.6	114.5
Surplus (Deficit)	n.a.	6.4	15.7
Total Volume	n.a.	247.6	244.7

Note: Totals may appear inconsistent with other figures due to rounding. Outgoing totals for 1995 excludes traffic to countries outside the top 20 routes, thus overstating the surplus.

Macau

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. China	49.0	45.3%
2. Hong Kong	45.4	42.0%
3. Portugal	3.1	2.8%
4. Taiwan	2.4	2.2%
5. United States	1.2	1.1%
6. Thailand	1.1	1.0%
7. Canada	1.0	0.9%
8. Philippines	0.8	0.8%
9. Australia	0.6	0.5%
10. United Kingdom	0.5	0.4%
11. Singapore	0.4	0.4%
12. Japan	0.4	0.4%
13. Malaysia	0.3	0.3%
14. France	0.2	0.2%
15. Korea, Rep. of	0.2	0.2%
16. Indonesia	0.2	0.1%
17. Vietnam	0.1	0.1%
18. Germany	0.1	0.1%
19. Brazil	0.1	0.1%
Other	1.1	1.1%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	78.0	84.3	90.4
Outgoing	89.9	100.0	108.1
Surplus (Deficit)	(11.9)	(15.7)	(17.7)
Total Volume	167.9	184.3	198.5

Note: Totals may appear inconsistent with other figures due to rounding. Data based on billing point of traffic.

Malaysia

Largest Telecommunications Routes, FY 1995/96

Destination	MiTT	Percentage of Outgoing Traffic
1. Singapore	184.0	45.1%
2. Japan	26.0	6.4%
3. United Kingdom	22.3	5.5%
4. Indonesia	21.1	5.2%
5. Australia	19.9	4.9%
6. United States	17.2	4.2%
7. Hong Kong	15.8	3.9%
8. Thailand	12.9	3.2%
9. Taiwan	12.0	2.9%
10. India	9.3	2.3%
11. Philippines	9.3	2.3%
12. China	7.6	1.9%
13. Bangladesh	5.2	1.3%
14. Germany	5.1	1.2%
15. Korea, Rep. of	4.3	1.1%
16. Canada	2.9	0.7%
17. New Zealand	2.9	0.7%
18. Brunei	2.6	0.6%
19. France	2.3	0.6%
20. Pakistan	2.1	0.5%
Other	23.5	5.8%

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National Traffic Balance

MiTT	FY 1993/94	1994/95	1995/96
Incoming	304.2	399.7	442.0
Outgoing	258.1	342.3	408.3
Surplus (Deficit)	46.1	57.4	33.7
Total Volume	562.3	742.0	850.3

Notes: Traffic is for Telekom Malaysia only. Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding. Fiscal year ends 31 March.

Morocco

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. France	57.7	44.5%
2. Spain	11.4	8.8%
3. Italy	7.1	5.5%
4. Belgium	6.0	4.6%
5. Germany	5.7	4.4%
6. Netherlands	5.2	4.0%
7. United States	4.6	3.5%
8. Saudi Arabia	4.2	3.2%
9. United Kingdom	2.8	2.2%
10. Switzerland	2.3	1.8%
11. Canada	2.3	1.8%
12. Tunisia	2.0	1.5%
13. Algeria	1.9	1.5%
14. United Arab Emirates	1.2	0.9%
15. Egypt	1.0	0.8%
16. Libya	0.7	0.5%
17. Portugal	0.6	0.5%
18. Denmark	0.5	0.4%
19. Sweden	0.5	0.4%
20. Senegal	0.4	0.3%
Other	11.8	9.1%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	n.a.	265
Outgoing	125.1	130.0	129.7
Surplus (Deficit)	n.a.	n.a.	135
Total Volume	n.a.	n.a.	394

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding.

New Zealand

Largest Telecommunications Routes, FY 1995/96

Destination	MiTT	Percentage of Outgoing Traffic
1. Australia	142	45.5%
2. United Kingdom	37	11.9%
3. United States	26	8.3%
4. Hong Kong	7	2.2%
5. Japan	7	2.2%
6. Canada	6	1.9%
7. Fiji	5	1.6%
8. Singapore	5	1.6%
9. Malaysia	5	1.6%
10. Taiwan	4	1.3%
11. Western Samoa	4	1.3%
12. Germany	3	1.0%
13. China	3	1.0%
14. India	3	1.0%
15. South Africa	2	0.6%
Other	53	17.0%

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National Traffic Balance

MiTT	FY 1993/94	1994/95	1995/96
Incoming	227	263	327
Outgoing	211	261	312
Surplus (Deficit)	16	2	15
Total Volume	438	524	639

Note: Data rounded to the nearest million minutes for Telecom New Zealand and Clear Communications Ltd. combined. Fiscal year ends 31 March.

Pakistan

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United Arab Emirates	10.6	16.0%
2. United Kingdom	9.4	14.3%
3. United States	9.1	13.8%
4. Saudi Arabia	6.3	9.5%
5. Italy	3.3	5.1%
6. Japan	2.4	3.6%
7. Germany	2.4	3.6%
8. Canada	1.6	2.5%
9. Hong Kong	1.2	1.9%
10. France	1.1	1.6%
11. Australia	0.9	1.4%
12. Turkey	0.8	1.2%
13. Switzerland	0.7	1.0%
14. Korea, Rep. of	0.5	0.7%
15. Bahrain	0.4	0.6%
16. Malaysia	0.3	0.4%
17. Belgium	0.2	0.3%
Other	14.9	22.6%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	305.7	n.a.	362.1
Outgoing	56.5	61.4	65.9
Surplus (Deficit)	249.2	n.a.	296.1
Total Volume	362.2	n.a.	428.0

Note: Traffic to India and Bangladesh is excluded from route data. Totals may appear inconsistent with other figures due to rounding.

Philippines

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	62	35.6%
2. Japan	28	16.1%
3. Hong Kong	16	9.2%
4. Canada	12	6.9%
5. Australia	9	5.2%
6. Singapore	7	4.0%
7. Taiwan	7	4.0%
8. Korea, Rep. of	5	2.9%
9. Saudi Arabia	5	2.9%
10. United Kingdom	4	2.3%
11. Malaysia	3	1.7%
12. Italy	3	1.7%
Other	13	7.5%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	617	691
Outgoing	164	160	174
Surplus (Deficit)	n.a.	457	517
Total Volume	n.a.	777	865

Note: Data are rounded to the nearest million minutes. Totals may appear inconsistent with other figures due to rounding.

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Qatar

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. India	12.9	17.0%
2. United Arab Emirates	11.8	15.6%
3. Egypt	8.7	11.4%
4. Saudi Arabia	6.3	8.3%
5. United Kingdom	4.6	6.0%
6. Bahrain	4.4	5.7%
7. Pakistan	4.0	5.3%
8. United States	2.2	2.9%
9. Jordan	1.8	2.4%
10. Bangladesh	1.8	2.4%
11. Kuwait	1.7	2.2%
12. Iran	1.4	1.8%
13. Oman	1.2	1.6%
14. France	1.2	1.6%
15. Philippines	1.1	1.5%
16. Sudan	1.0	1.3%
17. Syria	0.9	1.2%
18. Lebanon	0.9	1.2%
19. Italy	0.8	1.0%
20. Sri Lanka	0.7	0.9%
Other	6.5	8.6%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	n.a.	52.6
Outgoing	58.3	62.7	75.8
Surplus (Deficit)	n.a.	n.a.	(23.2)
Total Volume	n.a.	n.a.	128.4

Note: Totals may appear inconsistent with other figures due to rounding.

Saudi Arabia

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. Egypt	137.3	27.5%
2. Pakistan	56.3	11.3%
3. India	52.2	10.5%
4. Syria	21.3	4.3%
5. Yemen	17.1	3.4%
6. Jordan	16.2	3.2%
7. United Kingdom	15.9	3.2%
8. United States	14.3	2.9%
9. Bahrain	14.1	2.8%
10. United Arab Emirates	13.2	2.6%
11. Philippines	13.0	2.6%
12. Kuwait	11.1	2.2%
13. Sudan	10.9	2.2%
14. Lebanon	10.8	2.2%
15. Morocco	9.4	1.9%
16. Bangladesh	9.1	1.8%
17. Turkey	8.9	1.8%
18. France	7.9	1.6%
19. Germany	5.4	1.1%
20. Qatar	3.1	0.6%
Other	51.6	10.3%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	n.a.	n.a.
Outgoing	454.9	477	499.1
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Note: Totals may appear inconsistent with other figures due to rounding.

Singapore

Largest Telecommunications Routes, FY 1995/96

Destination	MiTT	Percentage of Outgoing Traffic
1. Malaysia	218	28.2%
2. Indonesia	64	8.3%
3. Hong Kong	62	8.0%
4. United States	51	6.6%
5. Japan	47	6.1%
6. China	35	4.5%
7. Australia	34	4.4%
8. Thailand	33	4.3%
9. United Kingdom	29	3.8%
10. Philippines	28	3.6%
11. India	28	3.6%
12. Taiwan	27	3.5%
13. Germany	12	1.6%
14. Korea, Rep. of	11	1.4%
15. France	7	0.9%
16. Brunei	7	0.9%
Other	80	10.3%

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National Traffic Balance

MiTT	FY 1993/94	1994/95	1995/96
Incoming	n.a.	n.a.	n.a.
Outgoing	480	643	773
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Notes: Fiscal year ends 31 March. Totals may appear inconsistent with other figures due to rounding.

South Africa

Largest Telecommunications Routes, 1994

Destination	MiTT	Percentage of Outgoing Traffic
1. United Kingdom	40.9	15.6%
2. Namibia	29.9	11.4%
3. Zimbabwe	21.6	8.2%
4. United States	20.2	7.7%
5. Botswana	14.0	5.3%
6. Mozambique	11.7	4.5%
7. Germany	11.7	4.5%
8. Swaziland	11.0	4.2%
9. Lesotho	7.9	3.0%
10. Australia	6.6	2.5%
11. Portugal	4.4	1.7%
12. France	4.4	1.7%
13. Canada	3.9	1.5%
14. Netherlands	3.8	1.4%
15. Italy	3.7	1.4%
16. Israel	3.6	1.4%
17. Switzerland	3.6	1.4%
18. Zambia	3.5	1.3%
19. Malawi	2.5	1.0%
20. Taiwan	2.4	0.9%
Other	51.4	19.6%

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National Traffic Balance

MiTT	1992	1993	1994
Incoming	n.a.	n.a.	n.a.
Outgoing	221.7	255.1	262.6
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a	n.a.	n.a.

Note: Totals may appear inconsistent with other figures due to rounding.

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Sri Lanka

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. India	4.0	14.5%
2. United Kingdom	3.0	10.9%
3. Singapore	2.3	8.4%
4. United States	1.8	6.5%
5. Japan	1.7	6.2%
6. Hong Kong	1.5	5.5%
7. Australia	1.2	4.4%
8. Germany	1.2	4.4%
9. Korea, Rep. of	1.0	3.6%
10. United Arab Emirates	0.9	3.3%
11. Italy	0.7	2.5%
12. France	0.6	2.2%
13. Saudi Arabia	0.6	2.2%
14. Canada	0.6	2.2%
15. Pakistan	0.5	1.8%
16. Maldives	0.5	1.8%
17. Kuwait	0.5	1.8%
18. Malaysia	0.5	1.8%
19. Thailand	0.5	1.8%
20. Switzerland	0.4	1.5%
Other	3.5	12.7%

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	65.0	78.7	92.0
Outgoing	19.5	23.7	27.5
Surplus (Deficit)	45.5	55.0	64.5
Total Volume	84.5	102.4	119.5

Note: Data based on billing point of traffic. Totals may appear inconsistent with other figures due to rounding.

Syria

Largest Telecommunications Routes, 1994

Destination	MiTT	Percentage of Outgoing Traffic
1. Lebanon	4.7	11.7%
2. Jordan	4.6	11.6%
3. Kuwait	4.1	10.3%
4. United States	2.5	6.3%
5. Russia	2.3	5.7%
6. France	2.3	5.7%
7. Egypt	2.3	5.6%
8. Germany	1.8	4.6%
9. Saudi Arabia	1.7	4.4%
10. United Kingdom	1.5	3.8%
Other	12.2	30.5%

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National Traffic Balance

MiTT	**1993**	**1994**	**1995**
Incoming	59.3	78	n.a.
Outgoing	36.7	40	66
Surplus (Deficit)	22.6	38	n.a.
Total Volume	96.0	118	n.a.

Note: Totals may appear inconsistent with other figures due to rounding. Route data for 1995 unavailable as of this printing.

Taiwan

Largest Telecommunications Routes, FY 1995/96

Destination	MiTT	Percentage of Outgoing Traffic
1. China	140.9	23.8%
2. United States	111.0	18.7%
3. Hong Kong	75.5	12.7%
4. Japan	66.4	11.2%
5. Thailand	22.2	3.7%
6. Philippines	20.3	3.4%
7. Canada	20.2	3.4%
8. Singapore	17.6	3.0%
9. Malaysia	11.7	2.0%
10. Indonesia	11.6	2.0%
11. Australia	11.3	1.9%
12. Vietnam	9.0	1.5%
13. United Kingdom	8.1	1.4%
14. Germany	8.0	1.3%
15. Korea, Rep. of	7.7	1.3%
16. France	4.7	0.8%
17. New Zealand	4.3	0.7%
18. Italy	2.9	0.5%
19. Macau	2.6	0.4%
20. South Africa	2.5	0.4%
Other	34.4	5.8%

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National Traffic Balance

MiTT	FY 1993/94	FY 1994/95	FY 1995/96
Incoming	490.8	613.5	545.3
Outgoing	440.7	498.5	592.8
Surplus (Deficit)	50.1	115.0	(47.5)
Total Volume	931.5	1,112.0	1,138.1

Note: Data based on billing point of traffic. Fiscal year ends March 31. Totals may appear inconsistent with other figures due to rounding.

Thailand

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. United States	36.0	16.4%
2. Japan	35.5	16.2%
3. Singapore	22.8	10.4%
4. Hong Kong	16.3	7.5%
5. Taiwan	13.9	6.3%
6. United Kingdom	11.7	5.4%
7. Australia	9.3	4.2%
8. China	8.1	3.7%
9. Germany	7.9	3.6%
10. Korea, Rep. of	6.4	2.9%
11. France	4.7	2.2%
12. India	4.5	2.1%
13. Italy	3.6	1.6%
14. Burma	3.3	1.5%
15. Indonesia	3.1	1.4%
16. Philippines	3.0	1.4%
17. Switzerland	2.8	1.3%
18. Canada	2.7	1.2%
19. Vietnam	2.4	1.1%
20. Netherlands	2.3	1.1%
Other	18.4	8.4%

MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes for public voice circuits.

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	218.7	313.3	277.7
Outgoing	161.8	173.2	218.8
Surplus (Deficit)	56.9	140.1	58.9
Total Volume	380.5	486.5	496.5

Note: Totals may appear inconsistent with other figures due to rounding.

United Arab Emirates

Largest Telecommunications Routes, 1995

Destination	MiTT	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%

MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes for public voice circuits.

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	n.a.	n.a.
Outgoing	359.0	428.2	503.6
Surplus (Deficit)	n.a.	n.a.	n.a.
Total Volume	n.a.	n.a.	n.a.

Vietnam

Largest Telecommunications Routes, 1995

Destination	MiTT	Percentage of Outgoing Traffic
1. China	6.0	17.1%
2. Taiwan	3.0	8.5%
3. United States	3.0	8.5%
4. Philippines	2.0	5.7%
5. Hong Kong	2.0	5.7%
6. France	2.0	5.7%
7. Korea, Rep. of	1.5	4.3%
8. Singapore	1.5	4.3%
9. Thailand	1.5	4.3%
10. Germany	1.0	2.8%
Other	11.5	32.8%

MiTT is Minutes of Telecommunications Traffic. Data are in millions of minutes for public voice circuits.

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National Traffic Balance

MiTT	1993	1994	1995
Incoming	n.a.	n.a.	170.3
Outgoing	14	24	35.1
Surplus (Deficit)	n.a.	n.a.	135.2
Total Volume	n.a.	n.a.	205.4

Note: Data rounded to the nearest million minutes.

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Methodology and Sources

The traffic statistics in *TeleGeography 1996/97* 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. *Direction of Traffic 1996*, jointly compiled by TGI and the International Telecommunication Union (ITU), was also consulted.

Traffic volumes in *TeleGeography 1996/97* 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 includes voice as well as non-voice (facsimile, data) traffic. For the origins of MiTT and its various applications (economic forecasting, competition policy, geography), see G. Staple and M. Mullins, "Telecom Traffic Statistics—MiTT Matter," *Telecommunications Policy*, Vol. 14, No. 2, June 1989; and G. Staple "The new demand for telecoms traffic data: from MiTT to maps," *Telecommunications Policy*, Vol. 20, No. 9, October 1996.

Calling Card Traffic

Historically, 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 credit and debit cards 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.

Unless otherwise stated in the notes to a table, the outbound MiTT reported for countries in *TeleGeography 1996/97* refers to outbound traffic originated in the reporting country even if it is billed in another country.

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 includes Home Country direct traffic originating in third countries (e.g., a call originated in Italy to a U.S. number and billed to a U.S. calling card). For these and other reasons (such as different fiscal years), the national statistics in TeleGeography are not directly comparable, and 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 Country Direct call from Spain to the U.S. which is billed to a U.S. calling card is reported here as outbound U.S. MiTT; the same call also is reported as outbound MiTT by Spain.

Third-Country Routing

The growing volume of traffic routed via a third country using Home Country Beyond and "call back" services is also making national traffic statistics harder to interpret. A Home Country Beyond call may originate in Country A, be billed to a calling card in Country B and terminate in Country C. Similarly, a call routed via a "call back" service may be placed by a subscriber in Country A, but originate in Country B and terminate in Country C. In both cases, the calls from Country A to Country C generally will not be counted in Country A's outbound MiTT but may be reflected by an increased volume of MiTT from Country B to Country C.

Accordingly, in countries where Home Country Beyond 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., where the calls are being refiled or hubbed.

To assist readers in making such comparisons, the U.S. tables in *TeleGeography 1996/97* have been expanded to provide 1994 and 1995 route-by-route statistics for over sixty countries.

Resellers

The MiTT data in this report includes traffic carried by resellers of international switched voice services. Such traffic is counted as part of the MiTT for the facilities based carrier whose facilities are resold.

Traffic carried by International Simple Resale (ISR) carriers is excluded, unless otherwise stated. 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.

The report also excludes transit traffic—that is, traffic which merely passes through a given country, but is not refiled via the switched network in the reporting country.

Other Factors

There may also be other reasons (beyond those referred to above) which cause inbound traffic data on a given route to differ from the outbound traffic data for the originating country. For example, neighboring countries may not classify local cross border traffic in the same way (i.e., one country may count all such traffic as international, while the other does not.) In any event, the route-by-route traffic data reported in TeleGeography for each country generally is based upon the survey data supplied to TeleGeography by the originating country, not the terminating country.

Some differences exist between the historical statistics (1994 or earlier) reported in *TeleGeography 1996/97* and data stated in prior reports or Direction of Traffic. The variations reflect corrections and/or revised data subsequently provided to TeleGeography. In addition, rounding may cause the figures on total national traffic and surpluses and deficits to appear inconsistent with other national data. ◆

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Blue Pages

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International Dialing Codes, by Number

1	Canada
	United States
1-242	Bahamas
1-246	Barbados
1-268	Antigua & Barbuda
1-345	Cayman Islands
1-441	Bermuda
1-664	Montserrat
1-758	St. Lucia
1-787	Puerto Rico
1-809	Anguilla, British Virgin Islands, Dominica, Dominican Republic, Grenada, Jamaica, St. Vincent & the Grenadines, Trinidad & Tobago, Turks & Caicos, U.S. Virgin Islands
1-869	St. Kitts & Nevis Islands
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
243	Zaire
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
259	Zanzibar
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
33-93	Monaco
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 (reserved)
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
42	Czech Republic
42	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
670	Northern Marianas
671	Guam
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
	Kyrgyzstan
	Russia
	Tajikistan
	Turkmenistan
	Uzbekistan
81	Japan
82	South Korea
84	Vietnam
850	North Korea
852	Hong Kong
853	Macau
855	Cambodia
856	Laos
86	China
871	Inmarsat East Atlantic
872	Inmarsat Pacific
873	Inmarsat Indian
874	Inmarsat West Atlantic
880	Bangladesh
886	Taiwan
90	Turkey
91	India
92	Pakistan
93	Afghanistan
94	Sri Lanka
95	Myanmar (Burma)
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
994	Azerbaijan
995	Georgia

International Dialing Codes, by Country

- **Afghanistan** 93
- **Albania** 355
  - Tirana 42
- **Algeria** 213
  - Algiers 2
- **American Samoa** 684
- **Andorra** 376
- **Angola** 244
  - Luanda 2
- **Anguilla** 1-809
- **Antigua & Barbuda** 1-268
- **Argentina** 54
  - Buenos Aires 1
- **Armenia** 374
  - Yerevan 8852
- **Aruba** 297
- **Ascension Island** 247
- **Australia** 61
  - Canberra 62
  - Melbourne 3
  - Sydney 2
- **Australian Territories** 672
- **Austria** 43
  - Vienna 1
- **Azerbaijan** 994
  - Baku 8922
- **Bahamas** 1-809
- **Bahrain** 973
- **Bangladesh** 880
  - Dhaka 2
- **Barbados** 1-809
- **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** 1-809
- **Brunei** 673
  - Bandar Seri Begawan 2
- **Bulgaria** 359
  - Sofia 2
- **Burkina Faso** 226
- **Burundi** 257
- **Cambodia** 855
- **Cameroon** 237
- **Canada** 1
  - Montreal 514
  - Ottawa 613
  - Toronto 416
- **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
- **Costa Rica** 506
- **Croatia** 385
  - Zagreb 1
- **Cuba** 53
  - Havana 7
- **Cyprus** 357
  - Nicosia 2
- **Czech Republic** 42
  - Prague 2
- **Denmark** 45
- **Diego Garcia** 246
- **Djibouti** 253
- **Dominica** 1-809
- **Dominican Republic** 1-809
- **Ecuador** 593
  - Quito 2
- **Egypt** 20
  - Cairo 2
- **El Salvador** 503
- **Equitorial 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
- **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
- **Greece** 30
  - Athens 1
- **Greenland** 299
- **Grenada** 1-809
- **Guadeloupe** 590
- **Guam** 671
- **Guatemala** 502
  - Guatemala City 2
- **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**
  - East Atlantic 871
  - West Atlantic 874
  - Pacific 872
  - Indian 873
- **Iran** 98
  - Tehran 21
- **Iraq** 964
  - Baghdad 1
- **Ireland** 353
  - Dublin 1
- **Israel** 972
  - Jerusalem 2
  - Tel Aviv 3
- **Italy** 39
  - Rome 6
  - Milan 2
- **Ivory Coast** 225
- **Jamaica** 1-809
- **Japan** 81
  - Osaka 6
  - Tokyo 3
- **Jordan** 962
  - Amman 6
- **Kazakhstan** 7
  - Alma Ata 3272
- **Kenya** 254
  - Nairobi 2
- **Kiribati** 686
- **Kuwait** 965
- **Kyrgyzstan** 7
  - 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
  - Antananarivo 2
- **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
- **Micronesia** .691
- **Moldova** .373
  - Chisinau .422
- **Monaco** .33-93
- **Mongolia** .976
- **Montserrat** .1-664
- **Morocco** .212
  - Casablanca .2
  - Rabat .7
- **Mozambique** .258
  - Maputo .1
- **Myanmar (Burma)** .95
- **Namibia** .264
  - Windhoek .61
- **Nauru** .674
- **Nepal** .977
  - Kathmandu .1
- **Netherlands** .31
  - Amsterdam .20
- **Netherlands Antilles** .599
- **Nevis Islands** .1-869
- **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
  - Pyongyang .2
- **Northern Marianas** .670
  - Saipan .322
- **Norway** .47
  - 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** .1-809
- **Qatar** .974
- **Reunion Island** .262
- **Romania** .40
  - Bucharest .1
- **Russia** .7
  - Moscow .095
  - St. Petersburg .812
- **Rwanda** .250
- **St. Kitts** .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** .42
  - 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 .1
  - Barcelona .3
- **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** .1-809
- **Tunisia** .216
  - Tunis .1
- **Turkey** .90
  - Ankara .4
  - Istanbul .1
- **Turkmenistan** .7
  - Ashkhabad .3632
- **Turks & Caicos** .1-809
- **Tuvalu** .688
- **Uganda** .256
  - Kampala .41
- **Ukraine** .380
  - Kiev .44
- **United Arab Emirates** .971
  - Abu Dhabi .2
  - Dubai .4
- **United Kingdom** .44
  - London .171/181
  - Manchester .161
- **United States** .1
  - Chicago .312/630
  - Houston .713
  - Los Angeles .213
  - Miami .305
  - New York .212/718
  - Washington .202
- **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 .51
- **Yugoslavia** .381
  - Belgrade .11
- **Zaire** .243
  - Kinshasa .12
- **Zambia** .260
  - Lusaka .1
- **Zanzibar (Tanzania)** .259
- **Zimbabwe** .263
  - Harare .4

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North American Area Codes, by State and Province

Alabama
- Birmingham 205
- Montgomery 334

Alaska 907
Alberta 403
Arizona
- Phoenix 602
- Tucson 520

Arkansas 501
Bahamas 242
Barbados 246
Bermuda 441
British Columbia
- Victoria 250
- Vancouver 604

California
- Anaheim 714
- Bakersfield 805
- Burbank ......818/562[1]
- Fresno 209
- Long Beach ...310/562[1]
- Los Angeles ...213/562[1]
- Oakland 510
- Riverside 909
- Sacramento 916
- San Diego ....619/760[3]
- San Francisco 415
- San Jose 408
- Santa Rosa 707

Caribbean 809
Colorado
- Colorado Springs ...719
- Denver 303
- Ft. Collins 970

Connecticut
- Bridgeport 203
- Hartford 860

Delaware 302
District of Columbia
- Washington 202

Florida
- Ft. Myers 941
- Gainesville 352
- Jacksonville 904
- Miami 305/954
- Orlando 407
- Tampa 813

Georgia
- Athens 706
- Atlanta 404
- Marietta 770
- Savannah 912

Hawaii 808
Idaho 208
Illinois
- Aurora 630
- Cairo 618
- Chicago 312
- Chicago 773
- Evanston 847
- Oak Brook 708
- Peoria 309
- Rockford 815
- Springfield 217

Indiana
- Evansville 812
- Gary 219
- Indianapolis ...317/765[2]

Iowa
- Council Bluffs 712
- Des Moines 515
- Dubuque 319

Kansas
- Topeka 913
- Wichita 316

Kentucky
- Dade Park 812
- Lexington 606
- Louisville 502

Louisiana
- New Orleans 504
- Shreveport 318

Maine 207
Manitoba 204
Maryland
- Baltimore 410
- Rockville 301

Massachusetts
- Boston 617
- Springfield 413
- Worcester 508

Michigan
- Detroit 313
- Flint 810
- Grand Rapids 616
- Lansing 517
- Sault Ste. Marie ...906

Minnesota
- Duluth 218
- Minneapolis 612
- Rochester 507
- St. Cloud 320

Mississippi 601
Missouri
- Jefferson 573
- Kansas City 816
- St. Louis 314
- Springfield 417

Montana 406
Nebraska
- North Platte 308
- Omaha 402

Nevada 702
New Brunswick 506
New Hampshire 603
New Jersey
- Elizabeth 908
- Newark 201
- Trenton 609

New Mexico 505
New York
- Albany 518
- Bronx, Queens .718/917
- Buffalo 716
- Hempstead 516
- Ithaca 607
- Manhattan 212/917
- Syracuse 315
- White Plains 914

Newfoundland 709
North Carolina
- Charlotte 704
- Greensboro 910
- Raleigh 919

North Dakota 701
Nova Scotia & Prince Edward Island 902
Ohio
- Cincinnati 513/937
- Cleveland 216
- Columbus 614
- Toledo 419

Oklahoma
- Oklahoma City 405
- Tulsa 918

Ontario
- Ft. William 807
- London 519
- North Bay 705
- Ottawa 613
- Toronto 416

Oregon
- Eugene 541
- Portland 503

Pennsylvania
- Altoona 814
- Harrisburg 717
- Philadelphia 215
- Pittsburgh 412

Puerto Rico 787
Quebec
- Montreal 514
- Quebec 418
- Sherbrooke 819

Rhode Island 401
Saskatchewan 306
South Carolina
- Charleston 803
- Greenville 864

South Dakota 605
Tennessee
- Memphis 901
- Nashville 615
- Knoxville 423

Texas
- Amarillo 806
- Austin 512
- Dallas 214/972
- El Paso 915
- Fort Worth 817
- Galveston 409
- Houston 713/281
- San Antonio 210
- Tyler 903

Utah 801
Vermont 802
Virginia
- Alexandria 703
- Richmond 804
- Roanoke 540
- Norfolk 757

Washington
- Olympia 360
- Seattle 206
- Spokane 509

West Virginia 304
Wisconsin
- Madison 608
- Milwaukee 414
- Eau Claire 715

Wyoming 307

Two codes separated by a slash (e.g., in Dallas, Texas) indicate an overlay; multiple codes are used for the same geographic area.

[1] 25 January 1997 [2] 1 February 1997 [3] 22 March 1997

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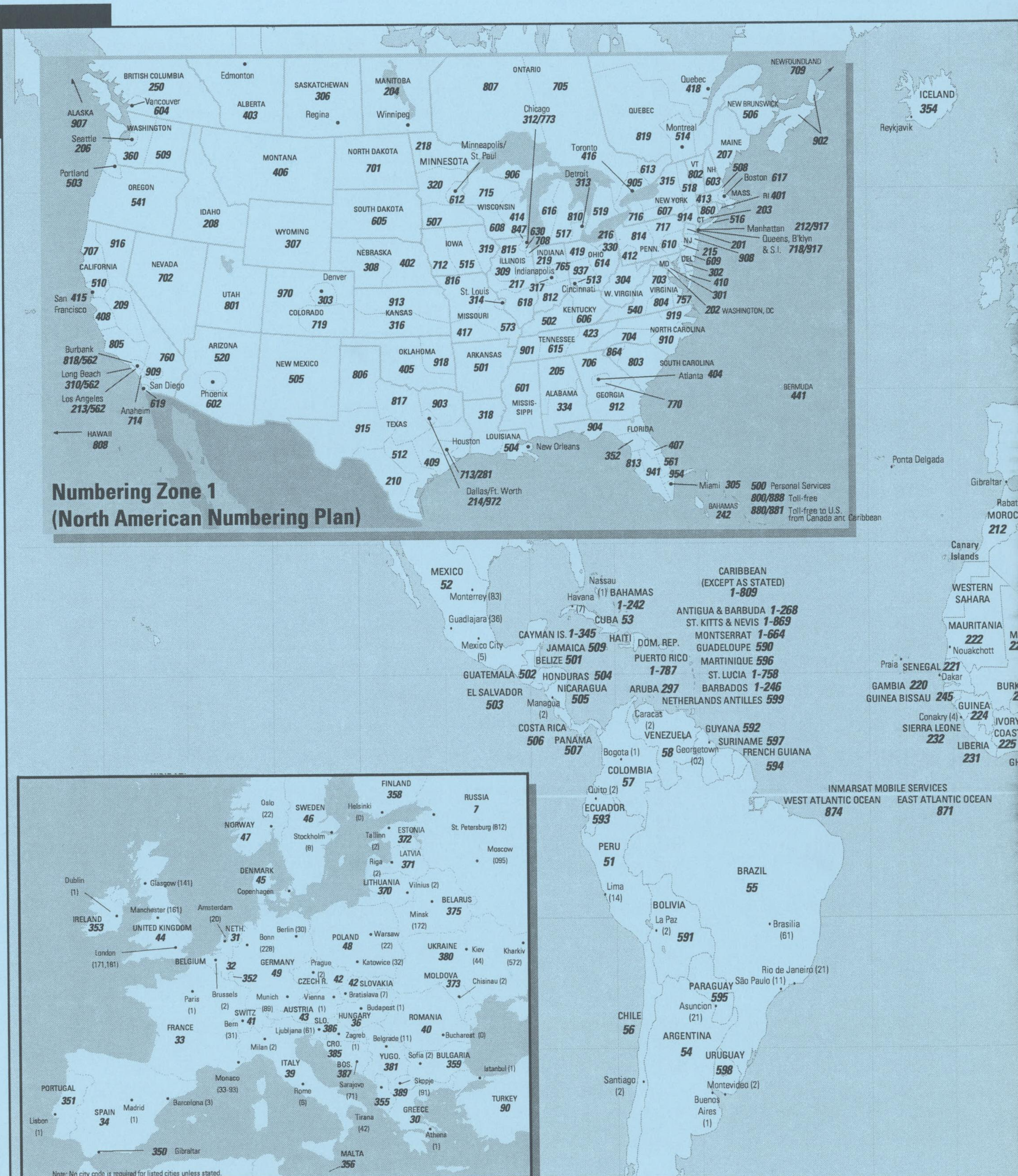
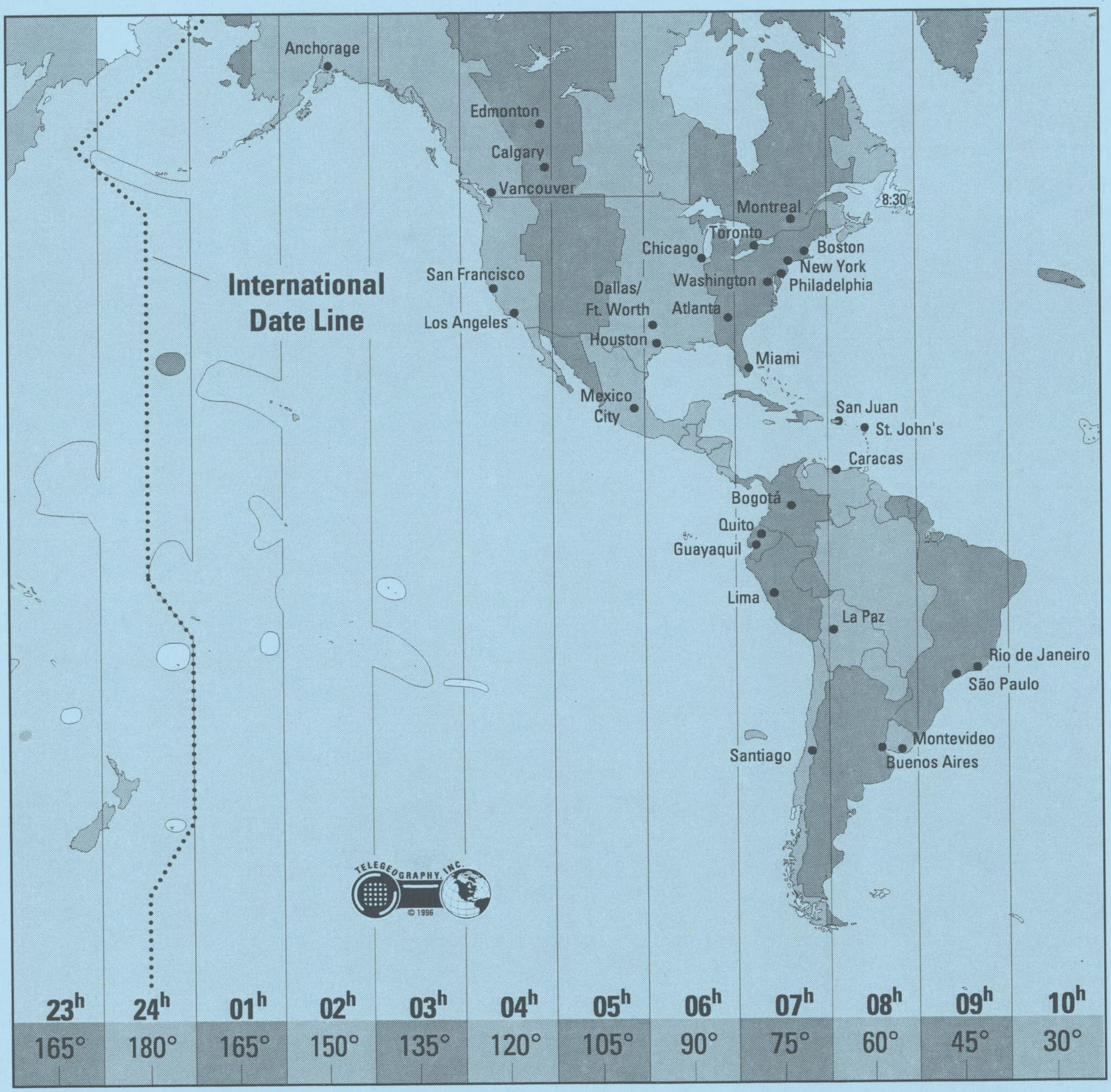
North American Area Codes, by Number

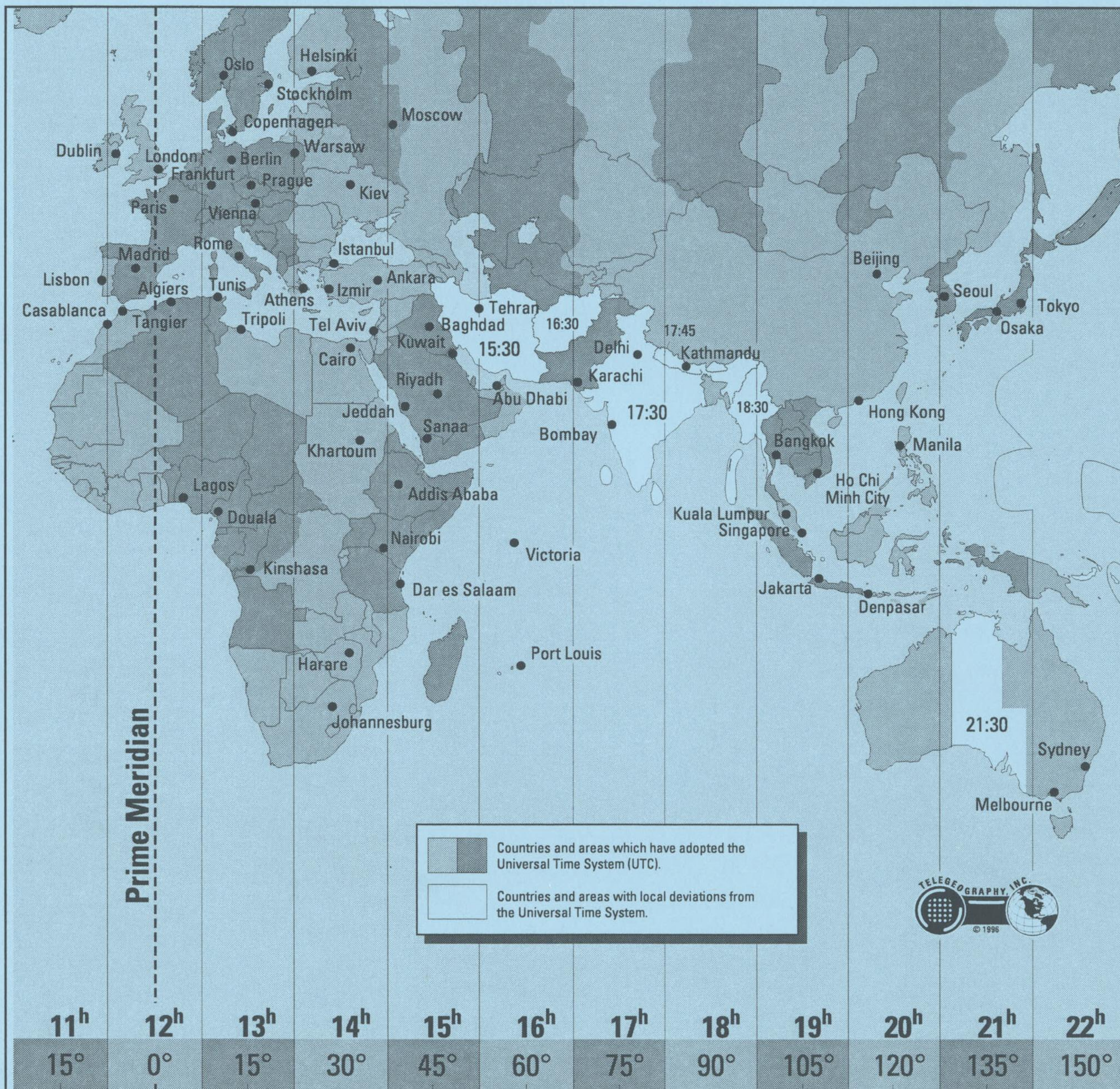
201 New Jersey
202 District of Columbia
203 Connecticut
204 Manitoba
205 Alabama
206 Washington
207 Maine
208 Idaho
209 California
210 Texas
212 New York City
213 California
214 Texas
215 Pennsylvania
216 Ohio
217 Illinois
218 Minnesota
219 Indiana
242 Bahamas
246 Barbados
250 British Columbia
268 Antigua & Barbuda
281 Texas
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
330 Ohio
334 Alabama
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
412 Pennsylvania
413 Massachusetts
414 Wisconsin
415 California
416 Ontario
417 Missouri
418 Quebec
419 Ohio
423 Tennessee
441 Bermuda
500 Personal Communication Services (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
540 Virginia
541 Oregon
555 Public Information Services
561 Florida
562 California (25 Jan. 97)
573 Missouri
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
612 Minnesota
613 Ontario
614 Ohio
615 Tennessee
616 Michigan
617 Massachusetts
618 Illinois
619 California
630 Illinois
664 Montserrat
701 North Dakota
702 Nevada
703 Virginia
704 North Carolina
705 Ontario
706 Georgia
707 California
708 Illinois
709 Newfoundland
710 U.S. Government Emergency Telecommunications Service
712 Iowa
713 Texas
714 California
715 Wisconsin
716 New York
717 Pennsylvania
718 New York City
719 Colorado
757 Virginia
758 St. Lucia
760 San Diego (3 March 97)
765 Indiana (1 Feb. 97)
770 Georgia
773 Illinois
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 Puerto Rico and Caribbean
810 Michigan
812 Indiana/Kentucky
813 Florida
814 Pennsylvania
815 Illinois
816 Missouri
817 Texas
818 California
819 Quebec
847 Illinois
860 Connecticut
864 South Carolina
869 St. Kitts & Nevis
880 Toll-free services
881 Toll-free services
888 Toll-free services
900 Information Services
901 Tennessee
902 Nova Scotia and Prince Edward Island
903 Texas
904 Florida
905 Ontario
906 Michigan
907 Alaska
908 New Jersey
909 California
910 North Carolina
912 Georgia
913 Kansas
914 New York
915 Texas
916 California
917 New York City
918 Oklahoma
919 North Carolina
937 Cincinnati
941 Florida
970 Colorado
972 Texas


Numbering Zone 1
(North American Numbering Plan)
BRITISH COLUMBIA 250
Vancouver 604
ALASKA 907
WASHINGTON
Seattle 206
360 509
Portland 503
OREGON 541
Edmonton
ALBERTA 403
SASKATCHEWAN 306
Regina
MANITOBA 204
Winnipeg
ONTARIO
807 705
Quebec 418
QUEBEC
NEWFOUNDLAND 709
NEW BRUNSWICK 506
902
Chicago 312/773
819
Montreal 514
MAINE 207
Toronto 416
Detroit 313
613
905
315
VT 802
NH 603
508
Boston 617
MASS.
RI 401
518
NEW YORK 607
413
860 CT
203
516
914
Manhattan 212/917
Queens, B'klyn & S.I. 718/917
201
908
NJ
215
609
DEL
302
MD
410
301
202 WASHINGTON, DC
MONTANA 406
NORTH DAKOTA 701
218
MINNESOTA
Minneapolis/St. Paul 612
320
715
906
WISCONSIN 414
616
810
519
716
717
814
PENN. 610
412
216
330
OHIO
419
614
937
513
Cincinnati
304
W. VIRGINIA
703
VIRGINIA
804
757
540
919
IDAHO 208
SOUTH DAKOTA 605
507
608
847
630
708
517
815
319
IOWA
INDIANA 219
ILLINOIS
765
309
Indianapolis 317
217
618
812
St. Louis 314
KENTUCKY 606
502
MISSOURI 573
417
NORTH CAROLINA 910
704
TENNESSEE 615
423
901
864
803
SOUTH CAROLINA
Atlanta 404
770
706
GEORGIA 912
ALABAMA 334
205
601
MISSISSIPPI
318
LOUISIANA 504
New Orleans
904
FLORIDA
352
407
813
561
941
954
Miami 305
BAHAMAS 242
BERMUDA 441
500 Personal Services
800/888 Toll-free
880/881 Toll-free to U.S. from Canada and Caribbean
WYOMING 307
NEBRASKA 308
402
712
515
816
913
KANSAS 316
707
916
CALIFORNIA 510
NEVADA 702
UTAH 801
970
Denver 303
COLORADO 719
San Francisco 415
209
408
805
760
Burbank 818/562
Long Beach 310/562
Los Angeles 213/562
909
San Diego 619
Anaheim 714
ARIZONA 520
Phoenix 602
NEW MEXICO 505
806
OKLAHOMA 405
918
ARKANSAS 501
817
903
TEXAS
915
512
409
210
Houston 713/281
Dallas/Ft. Worth 214/972
HAWAII 808
ICELAND 354
Reykjavik
MEXICO 52
Monterrey (83)
Gudlajara (36)
Mexico City (5)
GUATEMALA 502
EL SALVADOR 503
BELIZE 501
HONDURAS 504
NICARAGUA 505
Managua (2)
COSTA RICA 506
PANAMA 507
CAYMAN IS. 1-345
JAMAICA 509
CUBA 53
Havana (7)
Nassau (1) BAHAMAS 1-242
HAITI
DOM. REP.
PUERTO RICO 1-787
ARUBA 297
CARIBBEAN (EXCEPT AS STATED) 1-809
ANTIGUA & BARBUDA 1-268
ST. KITTS & NEVIS 1-869
MONTSERRAT 1-664
GUADELOUPE 590
MARTINIQUE 596
ST. LUCIA 1-758
BARBADOS 1-246
NETHERLANDS ANTILLES 599
Caracas (2)
VENEZUELA 58
GUYANA 592
Georgetown (02)
SURINAME 597
FRENCH GUIANA 594
Bogota (1)
COLOMBIA 57
Quito (2)
ECUADOR 593
PERU 51
Lima (14)
BRAZIL 55
Brasilia (61)
BOLIVIA
La Paz (2) 591
Rio de Janeiro (21)
São Paulo (11)
PARAGUAY 595
Asuncion (21)
CHILE 56
Santiago (2)
ARGENTINA 54
URUGUAY 598
Montevideo (2)
Buenos Aires (1)
INMARSAT MOBILE SERVICES
WEST ATLANTIC OCEAN 874
EAST ATLANTIC OCEAN 871
Ponta Delgada
Gibraltar
Rabat
MOROCCO 212
Canary Islands
WESTERN SAHARA
MAURITANIA 222
Nouakchott
SENEGAL 221
Praia
Dakar
GAMBIA 220
GUINEA BISSAU 245
GUINEA 224
Conakry (4)
SIERRA LEONE 232
IVORY COAST 225
LIBERIA 231
FINLAND 358
Oslo (22)
SWEDEN 46
Helsinki (0)
RUSSIA 7
NORWAY 47
Stockholm (8)
Tallinn (2)
ESTONIA 372
St. Petersburg (812)
Moscow (095)
LATVIA
Riga (2) 371
DENMARK 45
Copenhagen
LITHUANIA 370
Vilnius (2)
Dublin (1)
Glasgow (141)
IRELAND 353
Manchester (161)
UNITED KINGDOM 44
Amsterdam (20)
NETH. 31
BELARUS 375
Minsk (172)
Berlin (30)
Bonn (228)
POLAND 48
Warsaw (22)
UKRAINE 380
Kiev (44)
Kharkiv (572)
London (171,181)
BELGIUM 32
352
GERMANY 49
Prague (2)
CZECH R. 42
Katowice (32)
42 SLOVAKIA
Bratislava (7)
MOLDOVA 373
Chisinau (2)
Paris (1)
Brussels (2)
Munich (89)
Vienna (1)
AUSTRIA 43
SWITZ 41
Bern (31)
SLO. 386
Ljubljana (61)
HUNGARY 36
Budapest (1)
ROMANIA 40
Bucharest (0)
FRANCE 33
Zagreb (1)
CRO. 385
Belgrade (11)
Milan (2)
ITALY 39
BOS. 387
Sarajevo (71)
YUGO. 381
Sofia (2) BULGARIA 359
Istanbul (1)
Monaco (33-93)
Rome (6)
Skopje (91) 389
TURKEY 90
355
Tirana (42)
GREECE 30
Athens (1)
PORTUGAL 351
SPAIN 34
Madrid (1)
Barcelona (3)
Lisbon (1)
350 Gibraltar
MALTA 356
Note: No city code is required for listed cities unless stated.

World Telephone Codes


Anchorage
Edmonton
Calgary
Vancouver
International Date Line
San Francisco
Los Angeles
Dallas/ Ft. Worth
Houston
Chicago
Toronto
Montreal
Boston
New York
Philadelphia
Washington
Atlanta
Miami
8:30
Mexico City
San Juan
St. John's
Caracas
Bogotá
Quito
Guayaquil
Lima
La Paz
Rio de Janeiro
São Paulo
Montevideo
Buenos Aires
Santiago
TELEGEOGRAPHY, INC.
© 1996
23h 24h 01h 02h 03h 04h 05h 06h 07h 08h 09h 10h
165° 180° 165° 150° 135° 120° 105° 90° 75° 60° 45° 30°

Time Zones


Oslo
Helsinki
Stockholm
Moscow
Copenhagen
Dublin
London
Berlin
Warsaw
Frankfurt
Prague
Kiev
Paris
Vienna
Madrid
Rome
Istanbul
Lisbon
Algiers
Tunis
Izmir
Ankara
Casablanca
Athens
Tangier
Tripoli
Tel Aviv
Tehran
Baghdad
16:30
17:45
Kuwait
15:30
Delhi
Kathmandu
Cairo
Karachi
Riyadh
Abu Dhabi
Jeddah
17:30
18:30
Sanaa
Bombay
Khartoum
Bangkok
Beijing
Seoul
Tokyo
Osaka
Hong Kong
Manila
Ho Chi Minh City
Lagos
Addis Ababa
Douala
Kuala Lumpur
Singapore
Nairobi
Victoria
Kinshasa
Dar es Salaam
Jakarta
Denpasar
Port Louis
Harare
Johannesburg
21:30
Sydney
Melbourne
Prime Meridian
Countries and areas which have adopted the Universal Time System (UTC).
Countries and areas with local deviations from the Universal Time System.
TeleGeography, Inc.
© 1996
11h 12h 13h 14h 15h 16h 17h 18h 19h 20h 21h 22h
15° 0° 15° 30° 45° 60° 75° 90° 105° 120° 135° 150°

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Political Geography

EUROPE
1. NETHERLANDS
2. BELGIUM
3. LUXEMBOURG
4. CZECH REPUBLIC
5. SLOVAK REPUBLIC
6. SWITZERLAND
7. LIECHTENSTEIN
8. AUSTRIA
9. HUNGARY
10. SLOVENIA
11. CROATIA
12. BOSNIA
13. YUGOSLAVIA
14. ALBANIA
15. MACEDONIA (F.Y.R.)
16. MOLDOVA

ASIA
17. GEORGIA
18. ARMENIA
19. AZERBAIJAN
20. TURKMENISTAN
21. UZBEKISTAN
22. TAJIKISTAN
23. KYRGYZSTAN

AFRICA
24. BURKINA FASO
25. TOGO
26. EQUATORIAL GUINEA

National Telecommunications Indicators (A-L)

	Population 1995 (millions)	Area (Miles^2 thous.)	Main Lines 1995 (millions)	Main Lines 1990 (millions)	Lines/100 people 1995	Cellular phones 1995 (thous.)	Fax machines 1995(thous.)	PCs 1995 (thous.)
Algeria	27.9	920.0	1.2	0.8	4.0	4.7	5.2	n.a.
Argentina (a)	34.6	1068.0	5.5	3.1	16.0	340.7	n.a.	850
Australia	18.0	2968.0	9.2	7.8	51.0	2304.9	450.0*	5200
Austria	8.0	32.4	3.7	3.2	47.0	383.5	n.a.	1000
Bahrain (a)	0.6	<1	0.1	0.1	24.0	27.6	5.1	n.a.
Bangladesh	119.8	56.0	n.a.	0.2	n.a.	n.a.	2.0*	n.a.
Belgium (a)	10.1	11.8	4.6	3.9	46.0	235.0	n.a.	1400
Bolivia (a)	7.4	424.0	n.a.	n.a.	n.a.	7229.0	n.a.	n.a.
Brazil	161.6	3286.0	12.0	9.4	7.0	1285.5	n.a.	2100
Bulgaria	8.4	43.0	n.a.	2.2	n.a.	n.a.	n.a.	n.a.
Canada (a,c)	29.5	3852.0	n.a.	15.3	n.a.	2560.0	n.a.	5100*
Chile	14.3	292.0	1.9	0.9	13.0	197.3	n.a.	540
China	1201.0	3705.0	40.7	6.9	3.0	3629.0	270.0	2600
Colombia (a)	36.9	440.0	3.9	2.4	10.0	274.6	79.7*	630
Croatia (a)	4.8	21.8	1.3	0.8	27.0	33.7	28.4*	n.a.
Cyprus	0.7	3.6	0.3	0.2	47.0	44.4	n.a.	n.a.
Czech Republic (a)	10.3	30.0	2.4	1.6	23.0	50.0	71.3	450*
Denmark	5.2	16.6	3.2	2.9	61.0	819.3	n.a.	1414
Dominican Rep. (a)	7.8	18.8	n.a.	0.3	n.a.	n.a.	n.a.	n.a.
Ecuador	11.5	109.0	0.7	0.5	6.0	53.0	n.a.	n.a.
Egypt	58.7	387.0	2.7	1.7	5.0	7.4	21.6*	194*
Estonia (a)	1.5	17.0	0.4	0.3	28.0	30.4	13.0	n.a.
Finland	5.1	131.0	2.8	2.7	55.0	1017.6	132.0	810*
France	58.1	213.0	32.4	28.1	56.0	1379.0	1200.0*	9300
Germany	81.9	138.0	40.4	31.9	49.0	3500.0	1446.6*	13,500
Greece	10.5	51.0	5.2	3.9	49.0	273.0	n.a.	350
Hong Kong (a,b)	6.2	<1	3.3	2.5	53.0	763.2	284.9*	660*
Hungary (a)	10.2	35.9	1.9	1.0	19.0	265.0	n.a.	400
Iceland (a)	0.3	40.0	0.1	0.1	56.0	30.0	n.a.	n.a.
India (a,b,d)	929.3	1269.0	11.9	5.1	1.3	135.5	50.0*	1000
Indonesia (a)	193.3	735.0	3.3	1.1	2.0	218.6	55.0*	530*
Iran (a)	64.1	636.0	n.a.	2.2	n.a.	n.a.	30.0*	n.a.
Ireland (a,b)	3.6	27.1	1.3	1.0	37.0	158.0	n.a.	490*
Israel (a)	5.5	10.3	2.3	1.6	42.0	n.a.	n.a.	n.a.
Italy	56.9	116.0	24.8	22.4	44.0	3863.0	n.a.	4800
Japan (b)	125.1	146.0	61.0	54.5	49.0	10204.0	6000.0*	19,000
Jordan	4.3	34.0	0.3	0.2	7.0	11.5	31.0*	n.a.
Korea, Republic of (a)	44.8	38.2	18.6	13.3	41.0	1641.0	375.0*	5000*
Kuwait	1.6	6.9	0.4	0.3	23.0	117.6	35.0	n.a.
Luxembourg	0.4	1.0	0.2	0.2	56.0	26.8	n.a.	n.a.

Source: International Telecommunication Union

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International Telephone Traffic

Outgoing mMiTT			Incoming mMiTT			Surplus/(Deficit)	
1994	1995	Change 94-95	1994	1995	Change 94-95	1994	1995
80.0	79.0	-1.3%	n.a.	n.a.	n.a.	n.a.	n.a.
175.0	179.4	2.6%	252.6	299.4	18.5%	77.7	119.9
852.0	1024.0	20.2%	n.a.	n.a.	n.a.	n.a.	n.a.
819.2	901.1	10.0%	774.5	n.a.	n.a.	(44.7)	n.a.
86.8	88.7	2.2%	n.a.	299.4	n.a.	n.a.	210.6
22.1	33.0	49.4%	n.a.	122.1	n.a.	n.a.	89.1
1049.0	1105.7	5.4%	1093.9	1172.0	7.1%	44.9	66.3
18.0	20.8	15.6%	n.a.	49.2	n.a.	n.a.	28.4
199.0	319.4	60.5%	408.0	495.5	21.4%	209.0	176.1
82.7	85.0	2.8%	n.a.	n.a.	n.a.	n.a.	n.a.
861.2	897.9	4.3%	543.8	603.4	11.0%	(317.4)	(294.5)
73.5	136.9	86.3%	n.a.	n.a.	n.a.	n.a.	n.a.
1170	1390	7.3%	n.a.	n.a.	n.a.	n.a.	n.a.
120.3	127.3	5.8%	302.8	351.5	16.1%	182.5	224.2
185.5	210.7	13.6%	240.2	309.0	28.6%	54.8	98
106.6	117.4	10.2%	79.0	87.3	10.4%	(27.6)	(30.2)
157.6	186.8	18.5%	210.0	223.7	6.5%	52.4	36.9
488.4	532.6	9.0%	500.9	551.0	10.0%	12.4	18.4
63.5	85.4	34.5%	404.0	424.1	5.0%	340.5	338.7
36.4	37.2	2.3%	128.6	154.8	20.4%	92.2	117.6
80.0	99.8	24.8%	n.a.	376.1	n.a.	n.a.	276.3
48.1	53.0	10.2%	50.8	56.0	10.2%	2.7	3.0
259.0	315.4	21.8%	285.0	345.0	21.1%	26.0	29.6
2602.5	2804.6	7.8%	2739.5	2958.9	8.0%	137.0	154.3
5147.1	5244.0	1.9%	3881.2	n.a.	n.a.	(1,265.9)	n.a.
422.7	467.9	10.7%	441.2	505.4	14.5%	18.6	37.4
1578.4	1691.8	7.2%	1446.4	1598.3	10.5%	(132.1)	(93.5)
236.6	247.5	4.6%	211.9	243.7	15.0%	(24.7)	(3.8)
26.0	28.9	11.5%	25.5	28.4	11.2%	(0.4)	(0.6)
314.0	341.4	8.7%	615.0	805.4	31.0%	301.0	464.0
182.5	205.9	12.8%	244.7	286.0	16.9%	62.2	80.0
208.4	210.4	0.9%	n.a.	199.0	n.a.	n.a.	11.1
323.7	407	25.7%	442.9	n.a.	n.a.	119.2	n.a.
213.0	252.3	18.5%	n.a.	345.6	n.a.	n.a.	93.3
1708.0	1908.2	11.7%	1864.0	1999.8	7.3%	156.0	91.6
1524.8	1631	6.2%	1140.6	1321	15.8%	(384.2)	(310)
57.0	71.7	25.7%	114.0	118.0	3.5%	57.0	46.3
440.4	557	26.5%	555.2	672.0	21.0%	114.8	115
120.6	n.a.	n.a.	127.0	130.2	2.6%	6.4	n.a.
213.5	232.2	8.8%	145.2	174.5	20.2%	(68.3)	(57.7)

See individual country tables for carriers and routes included in outgoing and incoming traffic totals.

a. International MiTT based on billing point of traffic.
b. International traffic for year ending 31 March.
c. Traffic data exclude U.S. route.
d. Traffic data exclude some carriers or routes. (See country table for details.)
* Data for 1994.

Source: TeleGeography, Inc.

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National Telecommunications Indicators (M-Z)

	Population 1995 (millions)	Area (Miles^2 thous.)	Main Lines 1995 (millions)	Main Lines 1990 (millions)	Lines/100 people 1995	Cellular phones 1995 (thous.)	Fax machines 1995 (thous.)	PCs 1995 (thous.)
Macau (a)	0.4	<1	0.1	0.1	37.0	30.6	7.2*	n.a.
Macedonia, TFYR (a)	n.a.	10.0	n.a.	0.3	n.a.	n.a.	1.8*	n.a.
Malaysia (b,d)	20.1	127.0	3.3	1.6	17.0	872.8	571.7*	640*
Mexico (a)	91.8	756.0	8.8	5.4	10.0	642.0	n.a.	2400
Moldova	4.3	13.0	0.6	0.5	13.0	0.0	n.a.	n.a.
Morocco (a)	26.9	172.0	1.1	0.4	4.0	29.5	13.8*	n.a.
Netherlands (a)	15.5	16.2	8.1	6.9	53.0	513.0	n.a.	3100
New Zealand (b)	3.5	104.0	1.7	1.5	49.0	388.0	50.0*	669*
Norway (a)	4.3	125.0	2.4	2.1	56.0	982.0	n.a.	1193
Pakistan	129.7	307.0	n.a.	0.8	n.a.	n.a.	8.0*	n.a.
Paraguay	4.9	157.0	n.a.	0.1	n.a.	15.8	n.a.	n.a.
Peru (a)	23.7	496.0	1.1	0.6	5.0	73.5	n.a.	n.a.
Philippines	67.5	116.0	1.4	0.6	2.0	492.7	35.0*	n.a.
Poland (a)	38.6	121.0	5.7	3.3	15.0	75.0	n.a.	1100
Portugal	9.9	35.7	3.6	2.4	36.0	340.0	n.a.	600
Qatar	0.5	4.2	0.1	0.1	27.0	18.5	9.8*	n.a.
Russia (d)	147.3	6592.0	25.0	20.7	17.0	88.5	n.a.	2600
Saudi Arabia	17.9	830.0	1.9	1.2	11.0	16.0	n.a.	n.a.
Singapore (b)	2.9	<1	1.4	1.1	47.0	291.8	n.a.	430*
Slovak Republic	5.4	19.0	1.1	0.7	21.0	12.3	37.9*	n.a.
Slovenia	2.9	7.8	0.6	0.4	31.0	27.0	15.5	n.a.
South Africa	41.4	471.0	3.9	3.3	9.0	535.0	340.0*	875*
Spain	39.2	195.0	15.1	12.6	39.0	944.0	n.a.	3200
Sri Lanka (a)	18.1	25.3	0.2	0.1	1.0	51.3	30.0*	n.a.
Sweden (a)	8.8	174.0	6.0	5.8	68.0	2025.0	n.a.	1700
Switzerland (a)	7.0	15.9	4.3	3.9	61.0	447.2	197.0	2450
Syria	14.6	71.0	0.9	0.5	6.0	n.a.	5.0	n.a.
Taiwan (a,b)	21.3	13.9	9.2	6.3	43.0	770.4	430.0*	1773
Thailand	58.7	198.0	3.5	1.3	6.0	1087.5	60.0*	680*
Tunisia	8.9	63.0	0.5	0.3	6.0	3.2	2.7	44*
Turkey	61.9	301.0	13.2	6.9	21.0	436.5	87.6	n.a.
United Arab Emirates	2.4	32.3	0.7	0.4	29.0	128.5	30.4	n.a.
United Kingdom (b,d)	58.5	94.0	n.a.	25.8	n.a.	5737.0	n.a.	10,900
United States (a)	263.1	3619.0	165.0	136.3	63.0	33785.6	14052.0*	86,300
Uruguay (a)	3.2	68.0	0.6	0.4	20.0	40.0	n.a.	n.a.
Venezuela (a)	21.7	352.0	2.5	1.5	11.0	n.a.	n.a.	370
Vietnam	73.5	127.0	0.4*	n.a.	17.4*	13.2*	7*	n.a.
Yugoslavia	10.5	39.5	2.0	1.7	19.0	n.a.	15.0	n.a.

Source: International Telecommunication Union

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International Telephone Traffic

Outgoing mMiTT			Incoming mMiTT			Surplus/(Deficit)	
1994	1995	Change 94-95	1994	1995	Change 94-95	1994	1995
100.0	108.1	8.1%	84.3	90.4	7.2%	(15.7)	(17.7)
35.1	35.5	1.3%	78.3	74.0	-5.5%	43.2	38.5
342.3	408.3	19.3%	399.7	442.0	10.6%	57.4	33.7
844.1	950.0	12.5%	1829.4	2114.0	15.6%	985.3	1,164.0
73.9	66.0	-10.6%	n.a.	n.a.	n.a.	n.a.	n.a.
130	129.7	-0.1%	n.a.	265.0	n.a.	n.a.	135.3
1345.8	1458.7	8.4%	1290.9	1453.0	12.6%	(54.9)	(5.7)
261	312.0	35.7%	263	327.0	35.7%	2.0	15.0
395.5	431.5	9.1%	352.0	373.2	6.0%	(43.5)	(58.3)
61.4	65.9	7.4%	n.a.	362.1	n.a.	n.a.	296.1
18.1	19.4	7.2%	30.6	n.a.	n.a.	12.5	n.a.
51.0	66.7	30.8%	178.6	195.4	9.4%	127.6	128.7
160.0	174.0	8.7%	617.0	691.0	12.0%	457.0	517.0
356.6	381.4	7.0%	643.8	649.3	0.9%	287.2	267.9
262.4	283.9	8.2%	467.8	525.0	12.2%	205.4	241.1
62.7	75.8	20.9%	n.a.	52.6	n.a.	n.a.	(23.2)
229.2	287.4	25.4%	365.0	448.1	22.8%	135.8	160.7
477	499.1	0.0%	n.a.	n.a.	n.a.	n.a.	n.a.
643.0	773.0	20.2%	n.a.	n.a.	n.a.	n.a.	n.a.
52.5	58.8	12.1%	68.5	81.6	19.2%	16.0	22.8
90.6	100.6	11.0%	83.2	121.2	45.6%	(7.4)	20.6
262.6	280.0	6.6%	n.a.	n.a.	n.a.	n.a.	n.a.
948.3	1024.6	8.0%	969.9	1076.4	11.0%	21.6	51.8
23.7	27.5	16.0%	78.7	92.0	16.9%	55.0	64.5
802.0	900.0	12.2%	n.a.	n.a.	n.a.	n.a.	n.a.
1649.3	1778.4	7.8%	1353.0	1439.3	6.4%	(296.3)	(339.1)
40.0	66	65%	78.0	n.a.	n.a.	38.0	n.a.
498.5	592.8	18.9%	613.5	545.3	-11.1%	115.0	(47.5)
173.2	218.8	26.3%	313.3	277.7	-11.4%	140.1	58.9
64.0	69.9	9.2%	n.a.	n.a.	n.a.	n.a.	n.a.
284.3	373.6	31.4%	601.4	705.0	17.2%	317.1	331.5
428.2	503.6	17.6%	n.a.	n.a.	n.a.	n.a.	n.a.
3507.0	4016.0	14.5%	3577.0	4021.0	12.4%	70.0	5.0
13200.3	15623.0	18.4%	6133.1	7010.6	14.3%	(9,502.3)	(8,623.0)
46.3	49.9	7.8%	67.7	73.9	9.2%	21.4	24.0
141.3	129.1	-8.6%	164.3	186.6	13.6%	23.0	57.4
24.0	35.1	46.4%	n.a.	170.3	n.a.	n.a.	135.2
181.9	212.8	17.0%	229.0	296.0	29.3%	47.1	83.2

See individual country tables for carriers and routes included in outgoing and incoming traffic totals.

a. International MiTT based on billing point of traffic.
b. International traffic for year ending 31 March.
c. Traffic data exclude U.S. route.
d. Traffic data exclude some carriers or routes. (See country table for details.)
* Data for 1994.

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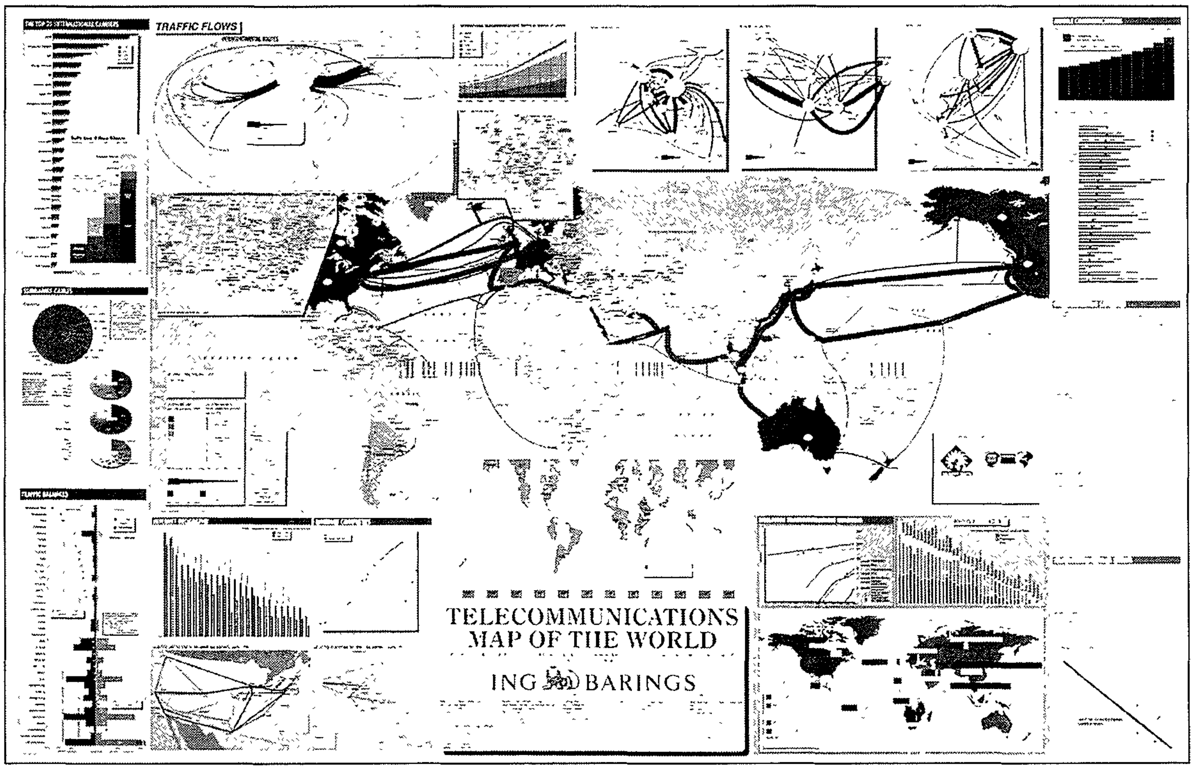


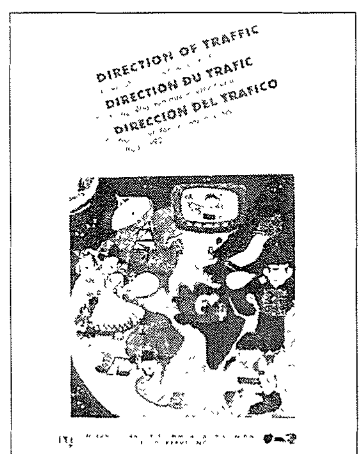
Telecommunications Map of the World

TeleGeography, Inc./Petroleum Economist, May 1996

Submarine cable capacity, satellite locations, traffic flows and over 400 national and city dialing codes make this full color poster a practical business tool as well as an attractive wall decoration. Border illustrations detail the world's top carriers, national traffic balances, cellular vs. wireline subscribers by country, Internet backbone networks, satellite footprints and the installed base of various communication terminals. Size is approx. 32" × 54" (.9 m × 1.4 m). Map is shipped folded.
ISBN 1-86186-005-6

Direction of Traffic 1996

TeleGeography, Inc./ITU, November1996



With nine years (1986-1994) of traffic data and five years of tariff data for 55 countries, *Direction of Traffic 1996* is the definitive study of recent trends in international telecommunications. In addition to the statistics, a comprehensive analysis (paper edition only) answers some of the most basic and yet thorniest questions about the pricing and volume of international calls:

- In an era of rapid technological advance, why do calls still cost so much?
- How low can international tariffs go?
- How much does it really cost to complete an international call?
- What are the effects of resale, call-back, Internet telephony, and other new regimes?

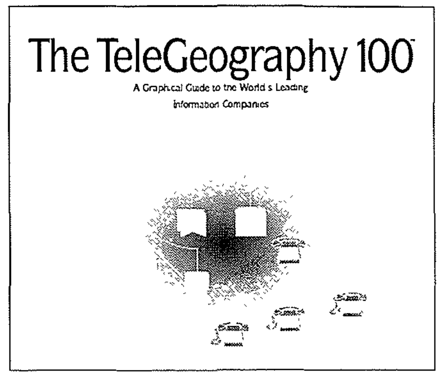
As the old regime of monopoly carriers and half-circuits collapses, this report sketches the new world. 200 pages. ISBN 92-61-06291-1.

Direction of Traffic 1996 Supplemental Diskette

A supplemental diskette contains even more detailed route-by-route traffic breakdowns for over 100 countries. Pick a set of originating and terminating countries, choose a time series, and then with one click the data is ready for analysis. Add one more step and the data can be exported to Excel, Quattro or Lotus. Requirements: MS DOS 2.1 (or Windows). *This version does not have the essay, forecasts, or traffic totals found in the printed version.*

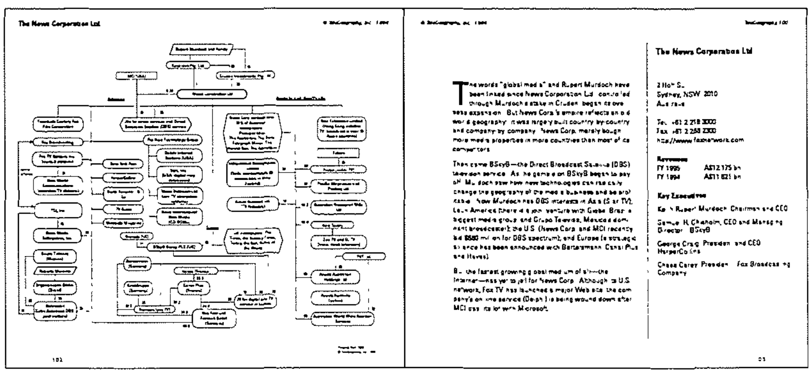
The TeleGeography 100

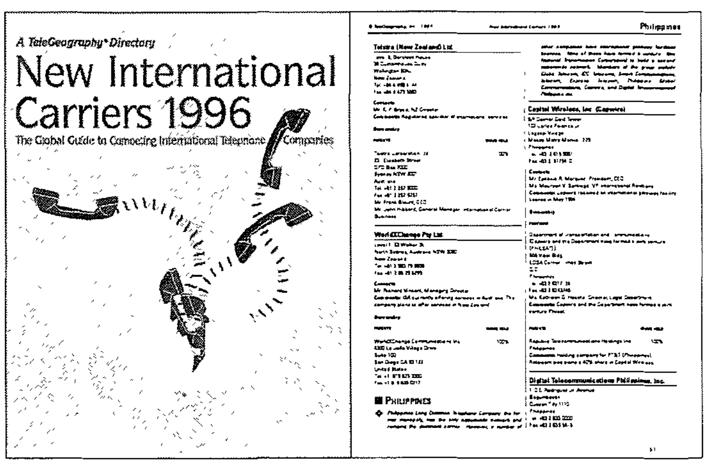
TeleGeography, Inc., May 1996



> *"It is an essential reference for anybody hoping to understand the bewildering tangle of alliances and partnerships which characterise the electronics industries today." —Alan Cane,* The Financial Times

An up-to-date guide on who owns what in the global information economy. Specially researched ownership charts for over 100 top entertainment, telecoms, computer and equipment companies make sense of the hundreds of mergers, demergers, acquisitions, joint ventures and alliances which characterize today's digital marketplace. The report covers all the main telco and cable TV mergers triggered by the new U.S. communications law. See at a glance why the world's largest auto manufacturer is also a leading player in satellites and computer systems. Track the expanding reach of telco alliances, such as WorldPartners, Concert and Global One. See how Internet projects link telcos, software companies, broadcasters and telcos worldwide. Charts show all major corporate subsidiaries and affiliates as well as allies and partners. There is also a comprehensive cross index covering more than 2000 companies identified in the report. Contact information for the TeleGeography 100, annual revenues, key executives and a precis of each company's strategic significance are also provided. 247 pages. ISBN 1-886142-06-8.





New International Carriers 1996

TeleGeography, Inc., September 1996

The first (and only) comprehensive directory of the world's newest international telephone companies has contact information on over 500 carriers and prospective market entrants in 33 countries, including the U.S., Canada, Mexico, Chile, the U.K., Germany, Russia, Japan, Australia, and the Philippines. The directory covers all new international facilities-based telephone carriers, announced market entrants, global mobile satellite companies, ISR carriers, private satellite and cable companies, and global telephone alliances, as well as IVAN providers in Japan and Hong Kong. Addresses, telephone/fax numbers and contact names are included for each carrier. Major stockholders and affiliates are also listed (with contact details). A special charts section profiles the ownership interests of important new carriers as well as the global telephone alliances. Market entry rules and national regulators are also listed. 200 pages. ISBN 1-886142-05-X.

Competitive markets included:

Australia	Denmark	Hong Kong	Korea	Portugal	Uganda
Belgium	Dominican Republic	Indonesia	Malaysia	Russia	United Kingdom
Bermuda	Finland	Ireland	Mexico	South Africa	United States
Canada	France	Israel	Netherlands	Spain	
Chile	Germany	Italy	New Zealand	Sweden	
China	Ghana	Japan	Philippines	Switzerland	

"'City of darkness.' Between the walls of the world."...

"It's a MUD, right?" Something like a larger, permanent version of the site the Tokyo chapter had erected for the meeting, or the tropical forest Kelsey and Zona had put up. But people played games in MUDs; they made up characters for themselves and pretended. Little kids did it, and lonely people.

"No," he said, "not a game." They were inside now, smoothly accelerating, and the squirming density of the thing was continual visual impact, an optical drumming. "Tai Chang Street." Walls scrawled and crawling with scrolling messages, spectral doorways passing like cards in a shuffled deck.... Fractal filth, bit-rot, the corridor of their passage tented with crazy swoops of faintly flickering lines of some kind. "Alms House Backstreet." A sharp turn. Another. Then they were ascending a maze of twisting stairwells, still accelerating, and Chia took a deep breath and closed her eyes.... when she opened [them] they were in a much cleaner but no larger version of [Masahiko's] room behind the kitchen in the restaurant...

* * *

Chia looked around at the reproduction of his tiny room. "Why don't you have a bigger site?" Instantly worried that it was because he was Japanese, and maybe they were just used to that. But still it was about the smallest virtual space she could remember having been in, and it wasn't like a bigger one cost more, not unless you were like Zona and wanted yourself a whole country.

"The Walled City is a concept of scale. Very important. Scale is place, yes? Thirty-three thousand people inhabited original. Two-point-seven hectares. As many as fourteen stories."

None of which made any sense to Chia. "I have to port, okay?"

"Of course," he said, and gestured toward her Sandbenders..."

* * *

The bit-mapped fish swam back and forth.... She looked at the door to her bedroom and found herself wondering what she'd find there if she gestured for it.... She looked at her stack of Lo/Rez albums beside the lithographed lunch box, her virtual Venice beside that. Even her Music Master would seem like company now. She opened it, watching the Piazza decompress like some incredibly intricate paper pop-up book on fast-forward, facades and colonnades springing up around her, with the hour before a winter's dawn for backlight.

Turning from the water, where the prows of black gondolas bobbed like marks in some lost system of musical notation, she lifted her finger and shot forward into the maze, thinking as she did that this place had been as strange, in its way, as Masahiko's Walled City, and what was that all supposed to be about anyway?...

Chia closed her eyes and counted to three. Made herself feel the carpeted floor she sat on in the Hotel Di. She opened her eyes.

At the end of the narrow Venetian street, down the tilted, stepped cobbles, where it opened out into a small square or plaza, an unfamiliar figure stood beside the central fountain.

She pulled the goggles off without bothering to close Venice.

Masahiko sat opposite her, his legs crossed, the black cups sucked up against his eyes. His lips were moving, silently, and his hands, on his knees, in their black tip-sets, traced tiny finger-patters in the air...."

Excerpted from Idoru (G. P. Putnam's Sons, New York, 1996)

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Gibson's Geographica

Whether the setting is on-line or off, the striking landscapes in William Gibson's books provide a compelling geographical vision of tomorrow. Since the first novel, Neuromancer (1984), which introduced the world to cyberspace—a word Gibson coined—his work has been marked by a unique attention to place. Though often (mis)labeled a science fiction writer, Gibson's ability to invest everyday settings with a life force of their own has more in common with such early modern stylists as Joseph Conrad and Franz Kafka.

The places which Gibson animates are decidedly post-modern, however. Gibson has also mastered the art of simultaneously fast-forwarding many different domains—the physical and the virtual, the economic and the social.

For example, in Virtual Light (1993) and Idoru (1996) we learn that most large countries have long ago splintered into private economic zones and metroplexes. Earthquakes have shattered San Francisco and Tokyo. The seas have flooded Venice. And personal "home pages" have been transformed into 3-D homes.

The following excerpt from Idoru, introduces some of Gibson's geographica, including a new city of bits—Hak Nam, the Walled City—"of the Net, but not on it."

Chia, a fourteen year old from Seatac (Seattle/Tacoma) has been sent to Japan by the Lo/Rez fan club to find our whether the lead singer, Rez, is really in love with Rei Toei, a beguiling software projection who has captivated local audiences. Her guide to the intrigue surrounding Rez's near fatal attraction is seventeen year old Masahiko. Chia is staying with his sister.

* * *

Chia and Masahiko sat facing one another on the white carpet.... Chia had her Sandbenders across her knees and was working her fingers into her tip-sets. Masahiko's computer was on the carpet in front of him; he'd put its control-face back on and peeled a very compact pair of tip-sets out of the back of the cube, along with two small black oval cups on fine lengths of optical cable. Another length of the cable ran from his computer to a small open hatch at the back of the Sandbenders.

"Okay," Chia said, settling the last of her tips, "let's go. I've got to get hold of somebody..."

"Yes," he said. He picked up the black cups, one in either hand, and placed them over his eyes...

Chia reached up and pulled her own glasses down, over her eyes. "What do I—"

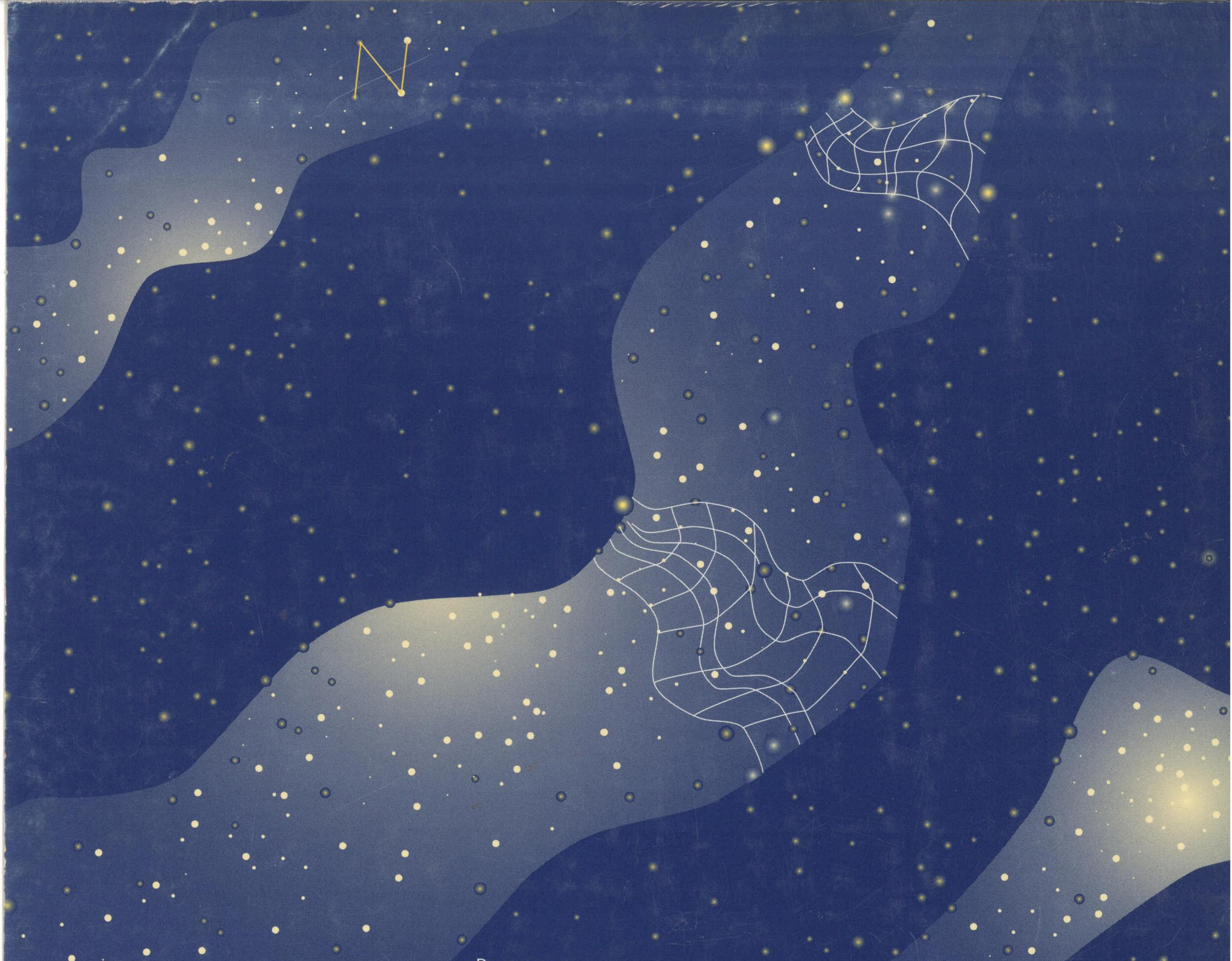
Something at the core of things moved simultaneously in mutually impossible directions. it wasn't even like porting. Software conflict? Faint impression of light through a fluttering of rags.

And then the thing before her: building or biomass or cliff face looming there, in countless unplanned strata, nothing about it even or regular. Accreted patchwork of shallow random balconies, thousands of small windows throwing back blank silver rectangles of fog. Stretching either way to the periphery of vision, and on the high, uneven crest of that ragged facade, a black fur of twisted pipe, antennas sagging under vine growth of cable. And past this scribbled border, a sky where colors crawled like gasoline on water.

"Hak Nam," he said, beside her.

"What is it?"

(over)



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