# Overview

In just the last few years, the options available to international bandwidth buyers have increased exponentially. Unfortunately, so has the potential for mistakes.

One cautionary tale concerns the fate of those new entrants who were among the first to buy STM-1s (155 Mbps) on an IRU basis when such large chunks of capacity became more widely available. By mid-year 1998, the price of a trans-Atlantic STM-1 IRU had fallen from $16 million to $7-8 million on the new Gemini and AC-1 cables. At that time, it wasn't generally possible to buy an STM-1 on a short-term lease, and the nearest alternative, an E-3 (34 Mbps) was available for an annual lease price of around $1-2m. In other words, an STM-1 IRU, owned for the whole cable lifetime of 25 years, would pay for itself in less than two years when set against leasing the same amount of capacity.

For carriers trying to control the cost of international telephony capacity and for Internet Service Providers (ISPs) struggling with soaring demand, it seemed like a no-brainer. Partly in the belief that it could always resell excess capacity, one fast-growing U.S. carrier splurged on $60 million worth of IRUs. The consequences have been unfortunate.

What this buyer and others had failed to anticipate was the speed at which all bandwidth prices would fall. By July 1999, the same STM-1 circuit purchased for $7 million one year earlier now fetched only $2 million on the informal spot market used by owners to resell capacity. The carrier that had taken advantage of an apparent bargain one year earlier was now stuck with costly IRU capacity. After accounting for the cost of capital, submarine cable operation and maintenance, and backhaul links from the cable landing station to the nearest city telehouse, each STM-1 likely costs around $800,000 per year. Thus, if STM-1 annual leases fall in 2000 to $500,000 as we anticipate, the carrier and others who bought earlier will be saddled with bandwidth costs higher than any new entrant. It will need to sell at a higher price, cut other costs to the bone, sell at a loss on the routes where it owns “expensive” IRUs, or write off the cost of the IRU early, upsetting investors and resulting in a big hit on its balance sheet.

## Logarithmic Network Growth

Planners and forecasters got it wrong primarily because they failed to anticipate fully the transition from linear to logarithmic network growth. Forecasting has become increasingly difficult. The price of bandwidth is a function of supply and demand, and, on both sides of this equation, the number of variables that must be taken into account has multiplied. It now is almost impossible to plan with real accuracy over periods greater than 12 to 18 months—a far cry from the days, not so long ago, when telecommunications strategists operated on ten year planning cycles.

On the supply side, the new variables reflect two primary developments:

- a technological revolution in optoelectronics that has increased international capacity exponentially and driven down costs relentlessly
- a ragged and imperfect transition from monopoly to competition, resulting in many more suppliers and commercial options when buying bandwidth, but only in certain places, and with some unexpected hitches in end-to-end supply

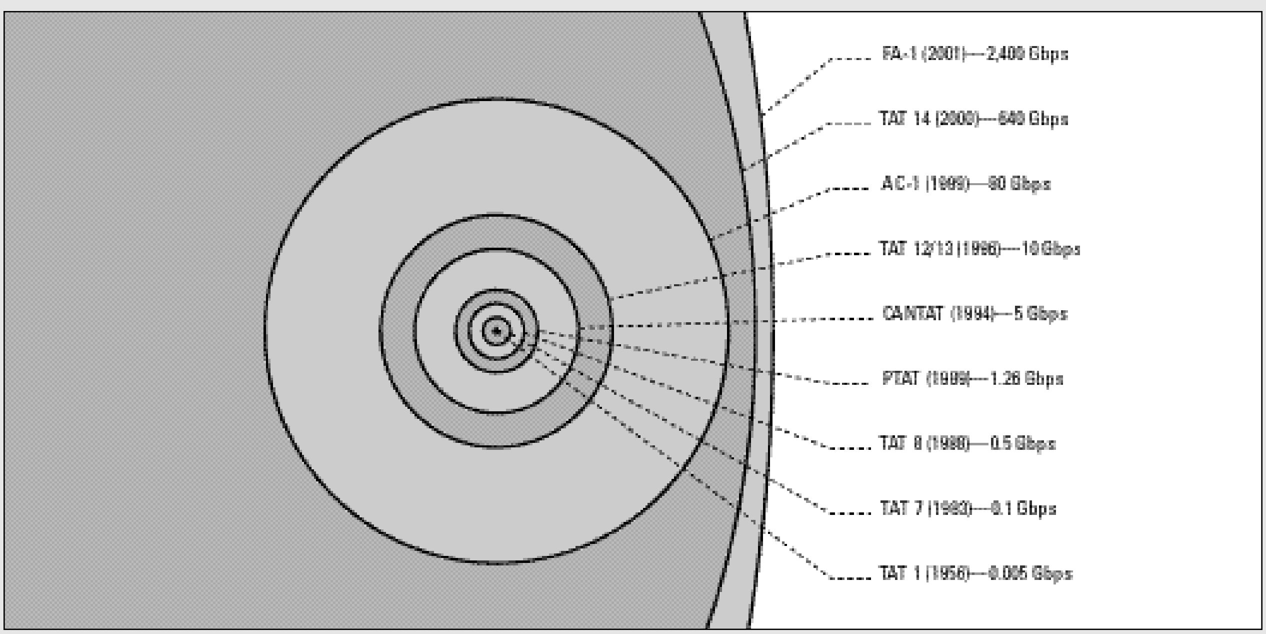
On the demand side, the new variables and uncertainties are in three primary areas:

- explosive growth of new carriers and types of bandwidth buyers
- strong link between demand and price at a time when price is falling rapidly
- unpredictable structural drivers underpinning Internet growth

### Supply: Technological and Regulatory Revolution

The astonishing improvement in the performance of fiber optic cables, both terrestrial and submarine, has fomented a revolution that is still playing itself out in the marketplace. Dense wavelength division multiplexing (DWDM) has been the primary engine of change. DWDM permits a capacity supplier to create dozens of channels over a single fiber simultaneously by dividing light into different wavelengths. Combined with more fiber pairs per cable and higher bit rates per channel, the implementation of DWDM means that capacity on a single, state-of-the-art submarine cable dwarfs bandwidth on all previous systems combined (see Figure 1). The aggregate effect of these new technologies can be gauged on the trans-Atlantic route, where total undersea cable capacity will rise from 23 gigabits

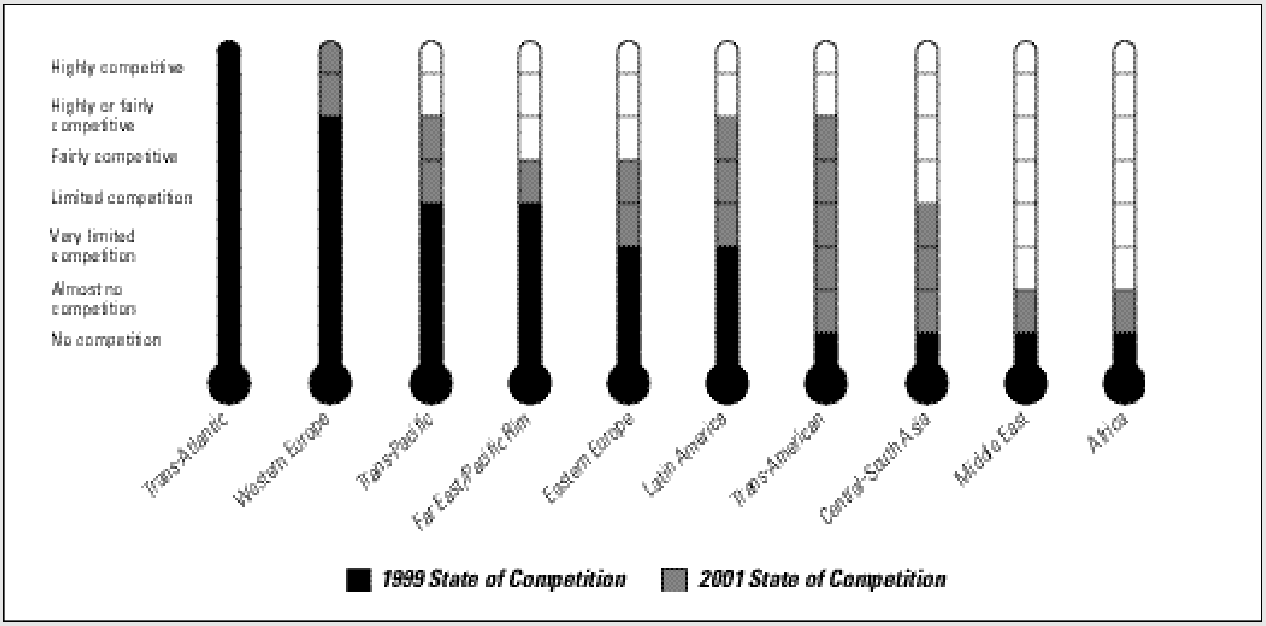
**Figure 1. The Undersea Bandwidth Explosion**




Note: Submarine cables are scaled to capacity when cable was put into service.

Source: TeleGeography, Inc. © TeleGeography, Inc. 2000

**Figure 2. Competition for Telecommunications Bandwidth Heats Up**




Source: TeleGeography, Inc. © TeleGeography, Inc. 2000

per second in 1997 to nearly 5 terabits per second in 2001—a compounded annual growth of about 280 percent.

Technological change spurred the vast increases in available bandwidth and the consequent collapse of international capacity prices. But prices would not have fallen as quickly as they did if a second, equally momentous shift in the bandwidth industry had not occurred: the move from telco monopoly suppliers to competitive, private bandwidth providers.

Until a few years ago, telecommunications bandwidth was one of the simplest products in the world, and its supply, effectively, a monopoly. If you needed two megabits per second of capacity between Paris and Frankfurt, you ordered a 2 Mbps "half circuit" from France Télécom, and a 2 Mbps matching half circuit from Deutsche Telekom. Several months later, you were connected. Much the same was true if you ordered a circuit from Milan to Zurich, or London to Tokyo—only the names of the suppliers changed.

In this environment, bandwidth buyers needed the kind of skills usually found among experienced foreign embassy officials: infinite patience, subtle negotiating powers, and good personal contacts. Negotiations focused on ensuring that a product was delivered on time, that it worked, and that when the network went down it came back up as quickly as possible. Negotiations rarely focused on price, since the price—generally far above underlying cost—was fixed by the monopoly owners. Typically, it would take anywhere from two to six months to deploy a circuit.

Government action changed the model forever. Widespread liberalization in the late 1990s let loose a horde of new suppliers that promised end-to-end bandwidth at competitive prices. A booming stock market—plus the huge interest in telecommunications generated by the Internet—has seen investors chasing after opportunities in the international telecommunications market. That's made it easier for new entrants to raise money, resulting in a major construction boom. On the U.S.-Latin American route alone, suppliers plan to build nine major submarine cable systems in the next two years. Competition is now established in western Europe and the Atlantic Ocean region. In other regions, it's coming soon, and by 2002, few areas without alternative suppliers of bandwidth will remain (see Figure 2).

However, as is generally the case when competition arrives, the supply-side picture has become far more complicated. It isn't just the number of new sellers, but the multitude of new purchase options that threaten confusion for customers (see Figure 3). Instead of knowing merely where a supplier connects, a buyer must have a clear understanding of the kinds of products and service options available. Where markets have become competitive, suppliers are more flexible on price, and the options are widening fast. Everything is negotiable, usually right up to the wire.

## Demand: Uncertain Drivers

Although market liberalization has unleashed a host of new bandwidth suppliers, it also has sparked an explosion of new companies who need their services. The number of carriers worldwide authorized to provide facilities-based international

**Figure 3. The Old and New World of Telecommunications Bandwidth**

| Element | Old World | New World |
|---|---|---|
| Length of contract | 1, 3, or 5 years. | 1 to 25 years; shorter leases including bandwidth on demand are also in prospect. |
| Discounting | Generally no more than 5%, mainly for length of contract. | Steep discounts on volume and contract length; few published prices, so everything is negotiable. |
| Regular Price Reviews in Longer Contracts | Did not exist. | Becoming widely negotiated by major buyers, often linked to an industry index or some other independent measure. |
| Forward Pricing | Did not exist. | Beginning to be used by some suppliers (e.g. in a ten year contract, the average yearly price is based on the market price four years' hence). |
| Options on Future Bandwidth at an Agreed Price | Did not exist. | Under consideration by some suppliers. |
| Network-Based Pricing | Did not exist. Only point to point pricing was available. | Becoming widely available. Some suppliers offer to price on the basis of the whole network, with no penalties for shifting bandwidth to different locations. |
| Flexibility on Payment Terms | None. Most contracts called for payment in advance yearly or quarterly. | Increasing; on longer ownership or IRU contracts, cash-starved buyers can often delay part of the payment. |

Source: TeleGeography, Inc. © TeleGeography, Inc. 2000

services quadrupled in just three years—from 470 in mid-year 1996 to 1,760 in July 1999. Perhaps more importantly, changing market conditions have created entire new classes of buyers (local exchange carriers, mobile operators, international ISPs).

The macro effect of increases in the sheer number of bandwidth buyers makes future aggregate demand difficult to predict. Even on a micro level, accurate network requirement forecasts for an individual buyer can prove unreliable. When telephony dominated telecommunications, traffic forecasting was relatively straightforward. Historical data provided a fairly reliable guide to future demand, and the sources and destinations of traffic were predictably linked to populations, wealth and commercial activity. Not so in the Internet Protocol (IP) era. One reason has to do with the relationship between price and demand. Many network providers—especially ISPs—report that demand for their bandwidth is fairly elastic. That is, a cut in prices spurs an equal or greater rate of increased demand. With bandwidth prices falling at an astounding 50 to 60 percent per year on competitive routes, the exact degree of elasticity can have considerable consequences for future traffic volumes. Yet demand is not linked solely to price. A whole host of other factors—new Internet applications, dissemination of high-speed local access, and geographic sources of web content to name a few—determine take-up of international capacity. Unfortunately, buyers can quantify these variables even less exactly than they can guess future price levels. In the old era of predictable growth, network planning horizons over three years were feasible. In today's world of logarithmic increases in both the supply of and demand for capacity, formal planning over one year (or even less) is increasingly unreliable. With linear network growth, forecasting mistakes were usually manageable; when working with exponential increases, forecast errors can prove disastrous.

## What's Ahead

This book identifies potential problems for both sellers and buyers of international bandwidth in an age of logarithmic network growth—and provides some suggestions on how to deal with them. The book is divided into three main chapters: an analysis of supply, a review of demand trends, and a profile of major international bandwidth systems.

### Supply

1. Fiber Optic Cable Systems. This section begins with an examination of terrestrial and undersea fiber optics. It reviews the technology underpinning the breakthroughs in

capacity growth and network availability, profiles the different types of system suppliers, and details the various purchase and lease options open to buyers. Sample contracts are provided in an appendix.

2. Satellite Systems. This section surveys the roles played by satellites, including broadcasting, multicasting, and point-to-point service among regions underserved by fiber optic systems. It also reviews the technology behind those services, the evolution of system suppliers, and the financial arrangements available for satellite capacity lease.

3. Telehouses. This chapter examines the issue of colocation—why telehouses have evolved, what a carrier should expect in a typical lease, and tips for negotiating equipment housing agreements.

### Demand

1. Quantifying Demand. In the era of logarithmic network growth, many predictions of future traffic volumes appear to be based as much on divination as on reliable, empirical modeling. This section surveys what we *do* know about bandwidth demand by breaking down its individual components—voice and fax public switched network calls, private corporate networks, and Internet traffic. The piece concludes with a look at what the telecommunications industry *doesn't* know—the variables that drive much of the growth in bandwidth demand but whose unpredictability can destroy even the most carefully constructed models.

2. Bandwidth Buyers: Who They Are and What They Need. The final section addresses how buyers can make intelligent choices in today's market of proliferating purchase options and uncertain future network requirements. This segment includes a review of bandwidth needs of the different buyer types and offers suggestions universal to all buyers for avoiding the pitfalls inherent in purchasing capacity.

### Profiles

The International System Profiles include contact information, network details, service offerings, and geographic illustrations of major international systems. Profiles are presented by system type:

1. Submarine cable systems—international cables ready for service by January 2002 with a capacity of at least ten Gbps.

2. Terrestrial systems—pan-European networks specializing in major bandwidth (STM-1 and above) sales to carriers and ISPs.

3. Satellite systems—constellations with at least 15 transponders in use for international voice and data communications.

4. Telehouses—non-carrier aligned sites in 17 cities that provide space for equipment housing and interconnection.

The system profiles are cross-referenced in a number of indices, including a matrix of submarine cables and their landing points, a list of city connectivity by terrestrial systems, and a directory of major system owners—important contact information for buyers seeking capacity on consortium systems.