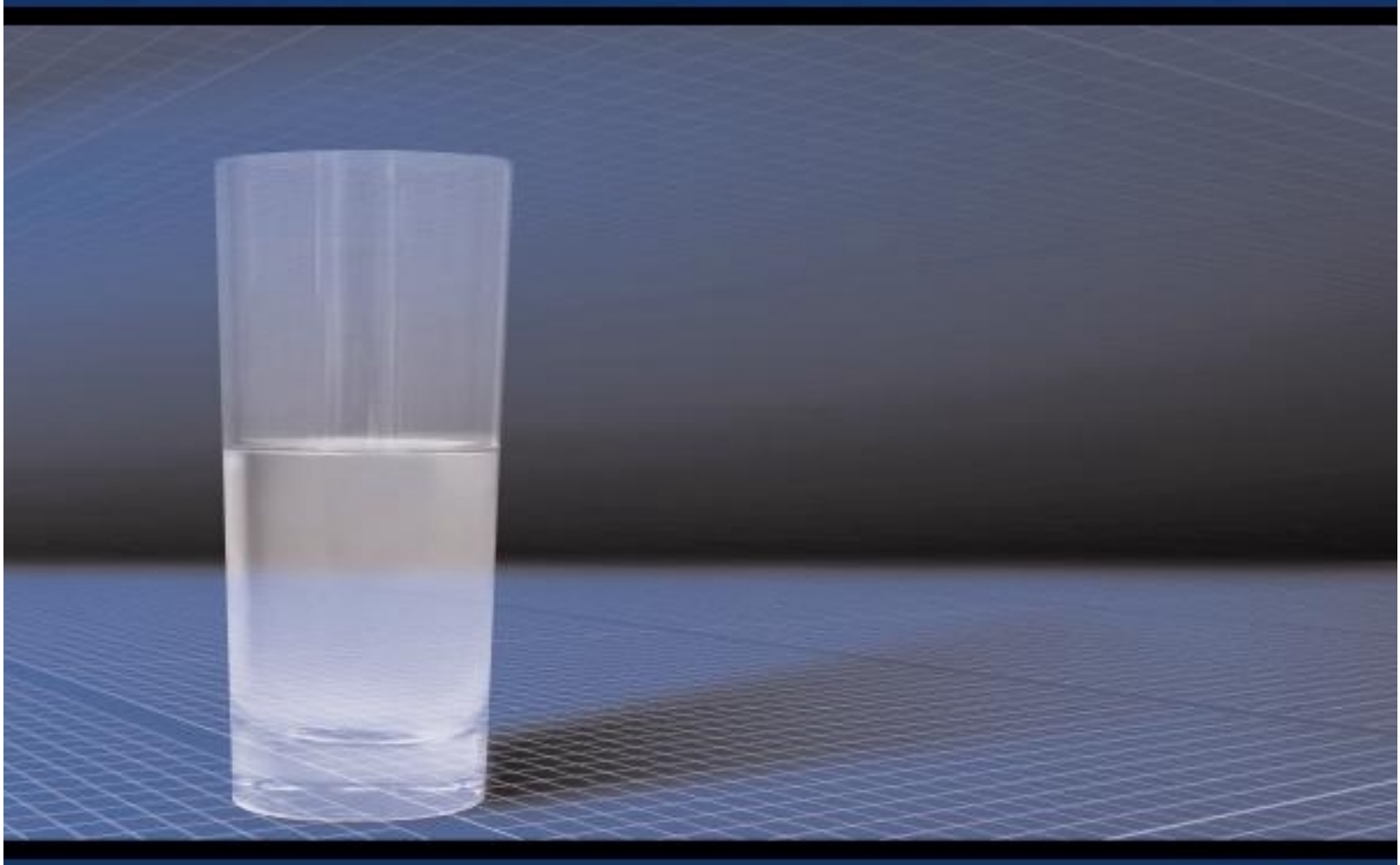
U.S. Communications Infrastructure at a Crossroads:
Opportunities Amid the Gloom



August 2001

Goldman Sachs

McKinsey&Company

CONTACTS

MCKINSEY & COMPANY

J.R. Lowry
james_lowry@mckinsey.com
McKinsey & Company, Boston: 1-617-753-2110

Jeff Kosowsky
jeff_kosowsky@mckinsey.com
McKinsey & Company, Boston: 1-617-753-2263

Kushe Bahl
kushe_bahl@mckinsey.com
McKinsey & Company, New Jersey: 1-973-549-6462

GOLDMAN, SACHS & CO.

Debra Katz, Communications Software
debra.katz@gs.com
Goldman Sachs, New York: 1-212-357-1377

Natarajan 'Subu' Subrahmanyan, US Communications Technology: Data Networking and Optical Components and Systems
natarajan.subrahmanyan@gs.com
Goldman Sachs, Menlo Park: 1-650-234-3313

Brantley W. Thompson, US Communications Technology: Wireline/Wireless Equipment
brantley.thompson@gs.com
Goldman Sachs, New York: 1-212-902-9823

Luanne Zurlo, US Telecommunications Services
luanne.zurlo@gs.com
Goldman Sachs, New York: 1-212-902-6702

CONTRIBUTORS/ACKNOWLEDGEMENTS

Many people at Goldman Sachs and McKinsey participated in the creation of this report. In particular, we acknowledge the following individuals:

MCKINSEY & COMPANY	GOLDMAN, SACHS & CO.
Core Team	**Core Team**
Kushe Bahl	Herb Beatson
Chris Gilbert	Sara Dawes
Jeff Kosowsky	Christopher Fine
Moshiko Levhar	Lisa Fontenelli
J.R. Lowry	James Simmons
Sarah Pohlen	
Dai Vu	Ernest Kwarteng (part time)
Bob Hu	**Research Analysts**
Manish Sinha	Debra Katz
Gilad Sokolov	Natarajan 'Subu' Subrahmanyan
Abhinav Taneja	Brantley W. Thompson
Shing Yin	Luanne Zurlo
Steering Committee	**Other Contributors / Reviewers**
Greg Besio	Jeff Adams
Peter Bisson	Lawrence Calcano
Brad Brown	Frank Connor
Tom French	Frank Governali
Vivek Mohindra	Chuck Harris
Mike Nevens	Mary Henry
Stagg Newman	Jim Himes
Jim Seaberg	Tim Ingrassia
	Brad Koenig
Other Advisors / Contributors	Gregory Lee
Simon Blackburn	Ryan Limaye
Curtis Copeland	
Perry Cui	
Feroze Dewan	
Chip Hardt	
James Kaplan	
Andrew Kincheloe	
Simon Landless	
Dana Maor	
Greg Moore	
Judith Stopard	

We would also like to thank all the individuals outside McKinsey and Goldman Sachs who spent time on this project. These include representatives from the companies we interviewed, including service providers, equipment and component manufacturers, operational support systems (OSS) providers, and systems integrators. We would like to thank the following individuals in particular: Bruno Codispoti, Jim Frey, Joe Gleeson, George Kawand, Vivek Khuller, Randy Korn, Tony Marson, Andrew Odlyzko, Debanjan Saha, and Ann Von Lehmen.

This summary is an abstract of a larger report published jointly by Goldman Sachs & Co. and McKinsey & Company in August 2001. For a copy of the full report, please contact your Goldman Sachs & Co. or McKinsey & Co. representative.

This report is the result of a joint research effort between McKinsey & Company and Goldman Sachs. This industry-level study owes its genesis to a series of ongoing conversations among the authors and the mutual decision that pooling resources would prove a productive means to gain insight into key market trends. McKinsey & Company was not retained by Goldman Sachs to work on this effort. Goldman Sachs may subsequently draw on information and conclusions contained in this report to develop investment recommendations. McKinsey & Company does not make investment recommendations, in this report or otherwise, and nothing in this report should be interpreted as an opinion by McKinsey & Company on the prospects of specific companies.

RESEARCH HIGHLIGHTS

OPPORTUNITIES AMID THE GLOOM

The *Wall Street Journal*, on July 25, 2001, stated that "The impact [of the Telecom bust] reverberates far beyond telecom carriers and their equipment suppliers, down through a food chain that reaches into almost every corner of the economy." Certainly, the last year has seen a serious contraction in stock valuations throughout the telecom universe, from service providers to equipment and component vendors. Each of the past three quarters has produced a flood of negative earnings announcements, write-offs, and layoffs. Like all rapid and wide-ranging industry and economic shifts, the "Telecom Crash" gives rise to more questions than answers. How did it happen? Where is the industry now? How wide are the effects? When will it be over? Which companies and technologies will emerge and who will come out ahead?

Over the past several months, a joint team of analysts from McKinsey and Goldman Sachs have examined these questions to gain context and perspective on the current communications infrastructure slowdown and life beyond for equipment, component, and Operational Support Systems (OSS) vendors. This team arrived at the following conclusions and strategies for success.

Key Conclusions

1. **The current equipment industry slowdown has not been caused by a falloff in actual bandwidth demand (versus ebullient demand forecasts) from enterprises and other end-users, but rather by supply-side factors such as over-building by carriers, over-manufacturing by vendors, and over-capitalization by financial markets, coupled with unrealistic market expectations.**

2. **We expect sales of equipment to be impacted for one to two years in long-haul and less than six months in metro transport markets, driven primarily by the time it will take to absorb installed overcapacity. In that time, excess inventories should be consumed and distressed assets redeployed. Component vendors should see a pickup approximately three months earlier because of the ordering lead times typically involved, partially offset by excess inventories at systems vendors.**

3. **The time necessary to absorb excess bandwidth capacity depends on actual demand growth and on the network overhead that is required to meet demand. According to our conversations with network engineers, the total overhead factor designed into networks could range from 32 to 50 times average bandwidth demand today, given existing network**

architectures, Internet protocol (IP) traffic characteristics, and carrier build strategies. As data traffic becomes a greater portion of the overall mix, overhead requirements should increase slightly, to 33-55 times average bandwidth demand.

4. **Beyond the current slowdown, equipment, component, and OSS vendors will need to help carriers satisfy demand growth while maintaining profitability by delivering solutions that reduce per-bit costs by 25%-30% per year. Capital expenditure (capex) reductions alone will not suffice, so new solutions must reduce operating expense (opex) and enable new revenue-generating IP services.**

5. **Successful equipment and component vendors can help carriers meet these profitability challenges by delivering transitional products that support legacy services and architectures, and deliver most of the reduced cost and complexity benefits of full next-generation products. According to our network model, these transitional network implementations should result in savings of 40%-45% in capex per bit and about 6% in opex per bit over current legacy network implementations.**

6. **OSS software providers will play a critical and complementary role by delivering products that reduce operating costs, support next-generation network architectures, and enable new value-added IP services. Based on our conversations with large carriers and systems integrators, near-term software fixes alone could reduce per-bit opex by up to 10% and increase revenues by up to 6%.**

7. **Given that many non-incumbent carriers have exited the business or are struggling, vendors will need to alter their product designs and sales approaches to accommodate the longer sales cycles and more rigorous certification processes of incumbents and their focus on total cost of ownership.**

8. **Technology vendors will need to work together and with standards bodies to promote interoperability, given the emerging need for end-to-end service provisioning, signaling, convergent billing, and integrated network management. This will prove to be a difficult challenge for the industry and may well not happen, given competitive forces as well as the overall difficulty and complexity of standards definition and compliance.**

9. **Industry consolidation appears inevitable. The demise of carriers that fail to reach profitability, and lack of funding for new service providers, will likely lead to fewer, larger leading equipment providers, supported by a handful of key component players. OSS vendor**

consolidation will likely be driven by service providers' desire to deal with fewer vendors that offer broader solutions, rather than many vendors with point solutions that address individual OSS areas.

10. **Additional downside risks—such as a prolonged economic downturn or destructive competitor behavior—pose the greatest risk to our perspectives. Missed upside opportunities are less likely.**

Strategies for Success

With the above conclusions in mind, we came up with the following strategies for success for equipment vendors, component vendors, and OSS companies. We believe these key success factors will form the basis of competition over the next three to five years and will require significant changes in mindset and competitive strategy.

System Vendors

1. Focus on providing hybrid systems that reduce total cost of ownership for carriers and enable new, value-added services, rather than purely innovative products that have a low up-front cost.
2. Push for early trial and successful deployment with leading service providers that will survive the current shakeout.
3. Support development of industry standards and ensure that products can be easily integrated.
4. Develop systems that further reduce the demand-to-capacity overhead factors.
5. Forge (multiple) partnerships with OSS vendors and systems integrators.
6. Facilitate value-added and integration services for customers (e.g., network design and planning).

Component Vendors

1. Focus R&D investment on specialty components and disruptive technologies that can improve price/performance by 5-10 times.
2. Improve manufacturing yields, throughput, and packaging to reduce costs 15%-20% per year.
3. Focus on product innovations that (directly or indirectly) help reduce total cost of ownership for service providers.
4. Develop more integrated modules and sub-systems.

OSS Vendors

1. Support the development and adoption of industry standards and truly open application programming interfaces (API).
2. Expand product portfolios horizontally across network management functions and selectively "northbound" into the service management layer.
3. Create integrated suites of IP OSS products.
4. Take advantage of selected legacy system opportunities.
5. Partner with multiple equipment vendors to create integrated and interoperable network management platforms.
6. Ally closely with multiple systems integrators (SIs).

1. INTRODUCTION AND OVERVIEW

Even after the dotcom crash, telecom markets, companies, and commentators continued to ride a wave of mutually reinforcing euphoria. Valuations skyrocketed, participants across the value chain prospered, and commentators talked excitedly about the New Economy and the insatiable demand for bandwidth. The deep and sudden decline in the telecom markets after the summer of 2000 caught many industry participants by surprise. Both carriers and infrastructure companies have been hit hard by the slowdown. The commentators have rapidly adapted, now predicting gloom.

Capital markets fueled growth, then abruptly declined

In August 2000, telecom equipment and service provider stocks were near their all-time highs. JDS Uniphase's market cap was still greater than $100 billion. Nortel, fresh from several multibillion-dollar acquisitions, had a market cap of $280 billion and a full order book. New entrants like Corvis and Sycamore were valued in the tens of billions of dollars, despite having only a handful of customers. Acquisitions were occurring at a feverish pace and at high valuations, such as Lucent's $5-billion acquisition of Chromatis in 2000 and Cisco's $7-billion acquisition of Cerent in 1999. Start-ups were valued at high multiples of future revenues, even in the absence of customers or completed products. An unprecedented flow of venture capital poured into start-up companies in all areas of communications technology, particularly optical networking, packet voice, and wireless. Metro technology became the new hot growth area, introducing companies such as Yipes, Looking Glass, and Telseon. Even the incumbent local exchange carriers (ILECs) were valued at all-time highs, on the promise of broadband access and potential deregulated entry into long distance service. Investors—new and experienced alike—followed the momentum, pouring money into telecom stocks and funds, for fear of being left behind in the eager stampede to each new technology or business idea. The euphoria was pervasive, even after the dotcom crash began to affect the broader technology markets.

Since the summer of 2000, optimism has turned to gloom. Service provider and communications technology company valuations are uniformly and significantly below their 2000 highs, with the top ten showing a loss of about $2 trillion of equity value. Cisco alone has seen its market capitalization decline by more than $300 billion. The stocks of large systems vendors, like Lucent and Nortel, and major component companies, like Corning and JDS Uniphase, are down 90%. IPO successes like Corvis and Avanex have seen their market capitalizations decline more than 95%. Several former telecom service provider highfliers such as Northpoint, PSINet, 360networks, Winstar, and Aerie have

recently declared bankruptcy, with others potentially following the same course. Debt and equity markets have effectively shut down, with the number of offerings in the first quarter of 2001 down 80% and 90%, respectively, from last year. The face amount of outstanding telecom debt exceeds $500 billion, with much of it valued at pennies on the dollar. In less than a year, the telecom bubble has burst in an unprecedented fashion.

Telecom Companies Followed a Land Rush Mentality

Last year's activity by service providers, systems houses, and component manufacturers was driven by a "land rush" mentality. Carriers were laying conduit and fiber to meet what seemed like unlimited demand. Each new build attempted to leapfrog the competition by laying more miles, installing fatter conduits and more fibers, and rushing to adapt the fastest, densest, and most innovative optical transport and switching technology available.

Service providers worried about bottlenecks everywhere—in the backbone, in the metro, and in last-mile access. Carrier capex (for our index of 13 service providers) grew at a 34% compounded annual growth rate (CAGR) between 1998 and 2000. Every carrier appeared to be simultaneously evaluating dozens of new competing technologies from large and small vendors. Systems vendors announced innovations at breakneck speed, moving for example from 8-channel dense wave division multiplexing (DWDM) at 2.5 gigabits per second (Gbps) in the latter half of the 1990s to newly announced systems with 320 channels at 10 Gbps—an improvement of almost a thousand-fold in half a dozen years. Component companies could not manufacture their goods fast enough to satisfy systems vendor demand, placing even major customers on "allocation," a form of rationing. Innovation poured out of both corporate and university R&D organizations, with many of the industry's best engineers abandoning secure careers to found new technology-based telecom start-ups. Engineering talent became the scarce resource of the day, and for a short period of time, labor markets were almost 100% employed. The pervasive attitude was "build it and they will come" for service providers, "announce it and they will buy" for equipment companies, and "write the business plan and they will fund" for start-ups.

Today, shaken by the downturn, telecom companies are much more sober. Capital spending by carriers dropped 16% between the fourth quarter of 2000 and the first quarter of 2001. Carriers have moved from announcing ambitious new builds to improving the utilization of existing assets. New equipment companies are having trouble obtaining carrier evaluations, let alone sales. Carriers are already talking about delaying the deployment of next-generation technologies such as OC-768 (40 Gbps). The slowdown in spending has rippled through the supply chain, resulting in bloated equipment and component

inventories. For example, days of inventory on hand for systems vendors has increased almost 50%. Cisco recently wrote off $2.5 billion in inventory. Nortel announced a staggering $19-billion markdown of overvalued acquisitions and excess inventory. JDS Uniphase wrote-off a record $45 billion in goodwill. Start-ups rewrote business plans to conserve cash for two years or more in attempts to outlast the downturn. Scarcity of talent has turned to layoffs, with Cisco, Nortel, Lucent, JDS Uniphase, and many others announcing substantial downsizing. Now, cost cutting and cash preservation are predominate themes as companies reposition themselves.

Telecom Market Sentiment Turns Bearish

The world of market commentators has similarly done a rapid about-face. Last year, it was accepted wisdom that Internet traffic was doubling every four to six months. UUNet indicated that traffic on its network doubled every 90 to 120 days. New laws of the photon were declared, putting Moore to shame. Optical technology, the New Economy paradigm, the dotcom boom, new bandwidth-hungry applications like multimedia and peer-to-peer, and highly elastic bandwidth demand were all conspiring to drive a spiral of growth, leading to near-infinite bandwidth at near-zero price. New paradigms were declared, and novel valuation models were proposed. The rare telecom bear was unwelcome. Analogies to other great boom periods were widely cited to reassure the markets and size the opportunity. Experts claimed that this was just the dawning of a new telecom and bandwidth revolution—the photonic analog of the vacuum tube. The land grab of the great backbone fiber builds was compared to the expansion of the railroads a century and a half earlier that opened up the West to development and commerce. Claims were reminiscent of the early days of nuclear energy, when advocates predicted electrical power too cheap to meter.

Today, the bulls have retreated, while the bears have come to the forefront. Slowing bandwidth demand growth is the new mantra. The fear of bandwidth bottlenecks has changed to talk of a fiber (and capacity) glut. Recent market commentary asserted that as much as 97.5% of backbone fiber might be dark. Some fret that companies across the telecom value chain may still be significantly overvalued. The metaphors in turn have come full circle.

OUR OBJECTIVES AND APPROACH

Our Fundamental Questions

With this industry context in mind, our objective was to address the following fundamental questions:

1. What is driving the current slowdown for equipment players, how long will these factors last, and how will they resolve themselves?—**Chapter 2**
2. Beyond the current slowdown, what issues will equipment and OSS providers need to address to help their service provider customers support and increase traffic and revenue growth?—**Chapter 3**
3. What are the key emerging trends and technologies in network evolution, and how will carriers' renewed emphasis on profitability affect their deployment?—**Chapter 4**
4. What are the major (and often unappreciated) OSS challenges impeding network evolution, and conversely, how can carriers' OSS investments best be targeted to push down costs and drive new revenues today?—**Chapter 5**
5. How will the telecom equipment and software industry landscape change? Will the industry continue to grow? What are the resulting implications for equipment, component, and OSS players, and how should they position themselves to adapt to the new telecom market environment?—**Chapter 6**
6. What critical risks and uncertainties could alter our outlook on the future of networking?—**Chapter 7**

Area of Focus

We restricted the scope of this report to preserve focus: Our objective was to understand the key business and technology drivers shaping the future for high-capacity traffic transport and management.

- **Network perspective.** We concentrated primarily on the long-haul and metro core and did not address wireless or last-mile access, except as sources of demand. Similarly, we researched high-bandwidth channels and technologies, which primarily meant optical technologies and systems. We focused on "pure bandwidth," (i.e., the flow of bits through the core.) We did not go inside the enterprise wall to look at either the local area network (LAN) or the broader corporate information technology (IT) market.
- **Market perspective.** We confined ourselves to the US market, given that it is the largest and most acutely affected by the slowdown. Our interviews of service providers, systems houses, and component players were primarily limited to North America.
- **Emerging technologies.** Finally, when addressing emerging technologies, we concentrated on those that are likely to have discontinuous impact on industry economics or structure, rather than on incremental innovation.

Partly for this reason, we focused more on new systems and architectures than on components.

Methodology

Beyond our core team, we tapped the extensive expertise of senior McKinsey industry experts and Goldman Sachs research analysts across a wide range of sectors. We interviewed dozens of service providers, equipment and component manufacturers, OSS vendors, and systems integrators. Our quantitative data sources included public filings, internal McKinsey and Goldman Sachs industry data, market research data from companies like RHK and Probe, consensus industry estimates, and extensive, specific proprietary data supplied to our core team by some of the leading telecom carriers and suppliers. We believe that the combination of public and proprietary data enabled us to attain some insights that would have not been easily attainable with either source alone.

We also developed a number of detailed economic models, most significantly one that projects network opex and capex over time for a variety of network architectures. We had these models vetted by both internal and external network experts, and the inputs were based on multiple sources wherever possible.

We believe that the prognosis for industry status and growth lies somewhere between the extremes of last year and today, though probably somewhat closer to today's more sobering picture than to yesterday's euphoria. We believe that the telecommunications world is at a crossroads—emerging from an unsustainable boom, moving through a "frozen" period, and then progressing to a long-term era of steady, though not-frenzied, growth.

KEY RESEARCH CONCLUSIONS

From our interviews and analyses, we came up with ten research conclusions:

1. The current equipment industry slowdown has not been caused by a falloff in actual bandwidth demand (versus ebullient demand forecasts) from enterprises and other end-users, but rather by supply-side factors such as over-building by carriers, over-manufacturing by vendors, and over-capitalization by financial markets, coupled with unrealistic market expectations.

Although data demand has grown much faster than voice, aggregate bandwidth demand (voice and data) has grown approximately 50% annually over the past several years. We assume a similar growth rate, at least through 2005, in line with prominent industry forecasts such as RHK. Additionally, virtually all the carriers and industry experts to whom we have spoken in the past four to six weeks have confirmed that traffic growth on their networks remains robust.

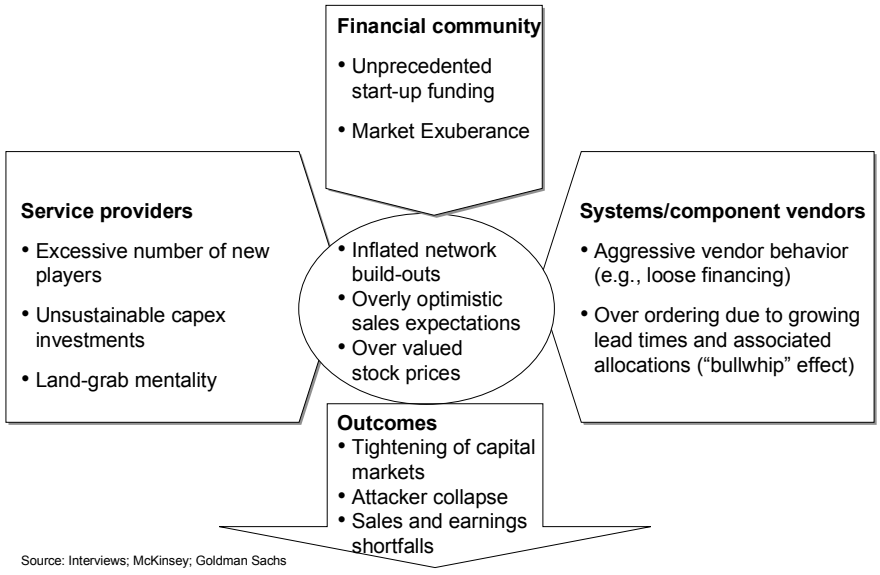
During 1999-2000 there was a period when bandwidth demand growth expectations were overly optimistic, well in excess of 50% per year, especially for Internet traffic growth. While much has been written about demand-side factors such as the failure of dotcoms and the cutbacks in corporate bandwidth demand, we believe that supply-side factors have driven the current slowdown in the communications technology industry (see Exhibit 1-1).

We believe that overselling, overbuilding, and overspending produced enough "slack" in the market to remove or impede technology vendors' visibility into true demand. Specific factors include general market exuberance, unsustainable capital expenditure levels, an overabundance of service providers, over-ordering by carriers and systems providers, and aggressive vendor financing, even for customers with questionable business plans. The prevailing view among investors and service providers was that overbuilding and even waste were justified in order to "play the game," and that demand would rapidly absorb any excess in the system anyway.

In the United States, part of this frenzy was driven by the Telecommunications Act of 1996, which was intended to deregulate the telecom industry and give rise to competition in the local access markets. Deregulation supposedly would allow new participants to tap into the profitable terrain long monopolized by the so-called "Baby Bells." This was thought to be the basis of widespread traffic growth, which would feed directly into the core of the network. Overspending and overbuilding turned into a self-sustaining cyclone of hyper growth, which could not and did not last.

Exhibit 1-1

Market Exuberance And Several Supply-side Factors Contributed To The Recent Slowdown



Source: Interviews; McKinsey; Goldman Sachs

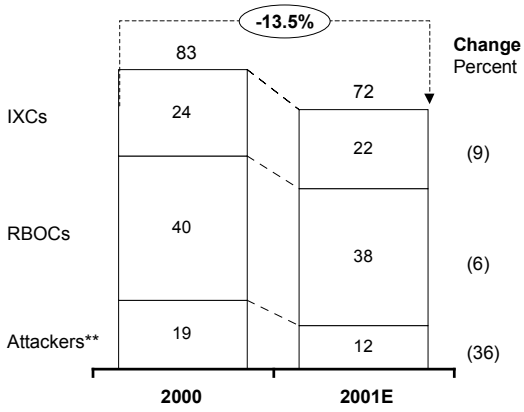
2. We expect sales of equipment to be impacted for one to two years in long-haul and less than six months in metro transport markets, driven primarily by the time it will take to absorb installed overcapacity. In that time, excess inventories should also be consumed and distressed assets redeployed. Component vendors should see a pickup approximately three months earlier because of the ordering lead times typically involved, partially offset by excess inventories at systems vendors.

We looked at several factors to develop this estimate, including carrier capital spending plans, carrier and supplier inventories, the impact of distressed assets reentering the market, current and projected utilization rates for both lit and dark fiber, and the overall supply/demand balance in the backbone and metro. According to spending guidance from a sample group of carriers, capex will be 10%-15% lower in 2001 than in 2000 (see Exhibit 1-2). Although the initial shock—a 16% drop between the fourth quarter of 2000 and the first quarter of 2001—is over, more shocks may follow. Carriers have revised their capex spending plans further downward after the second quarter of 2001, suggesting that spending could be down more than 15% for the year.

Exhibit 1-2

Current Carrier Capex Plans Suggest 2001 Spending Will Decline 10%-15%

Service provider capex budgets*
$ Billions



*Excludes capex on wireless equipment
** Excludes 360networks for the year 2001
Source: Goldman Sachs estimates

Much has been made about what portion of carrier capex spending will be "stolen" from the equipment industry by the resale of assets from bankrupt carriers. A number of factors will limit the impact of such distressed assets, including the fact that some equipment is custom-built, that removing and reinstalling equipment is costly (and often not worthwhile), and that the

equipment manufacturers themselves are repossessing some of the assets to cover failed vendor financing agreements. We looked at the asset bases of 22 companies that had either already exited or declared bankruptcy, or whose cash positions threaten their futures. As indicated in Exhibit 1-3, we believe a realistic resale scenario would have such companies selling assets to other carriers equivalent to less than 30 days of equipment industry sales. Moreover, these asset sales will likely occur over an 18-month period, suggesting that they will reduce annual equipment industry sales by 6%-8% at most through late 2002. Note that while this percentage may appear small, the actual sales revenue, given the size of the equipment industry, is significant.

Exhibit 1-3

Troubled Carriers' Resale of Equipment Is Unlikely To Significantly Reduce Equipment Provider Sales

Resale scenarios

Attacker capacity resold Percent	**Resulting system sales decline** Percent	**Equivalent days of equipment sales lost**
100	28	101
75	21	76
50	14	51
25	7	25
10	3	10

Likely scenarios

Source: SEC filings, McKinsey team analysis

Another significant factor affecting the duration of the slowdown is inventory of equipment and components. Consistently our interviews yielded anecdotes about the negative consequences of the "allocation" system in place during late 1999 through the third quarter of 2000—carriers ordered more equipment than they needed, equipment vendors ordered more components than needed, and component makers produced more than necessary. There were many comments about a "perceived component shortage" that turned out to be artificial. In addition, aggressive vendor financing had the effect of encouraging all parties to over-order even more. Several carriers told us about "equipment in the warehouse," which although short term in nature, prior to 1998, was an almost unheard-of phenomenon for carriers, which normally plan purchases very carefully in advance. In some cases, upstart carriers, flush with proceeds from large financings, deliberately chose not to adopt the normal purchasing

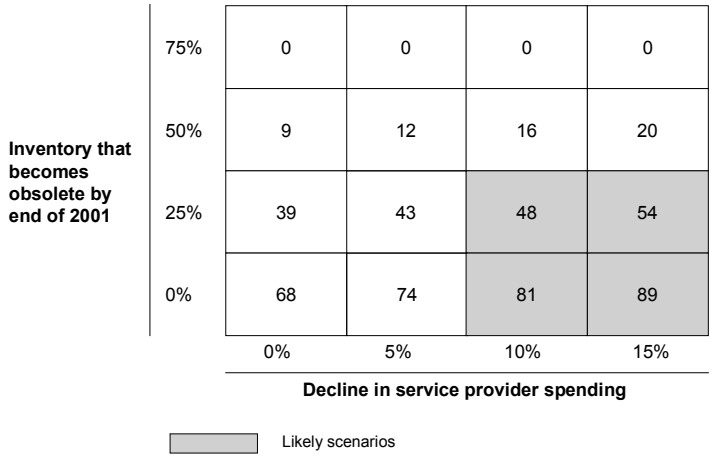
discipline of the traditional carriers. After all, it appeared that predictions of growth were so robust, build-out schedules so ambitious, and equipment in such short supply, that some excess inventory was deemed favorable as a hedge against shortages.

To examine these issues, we analyzed equipment and component vendor inventories. We concluded that these would be worked off over the next few months (see Exhibit 1-4) even though they were about two to three months in excess of the norm. This work-off is already being seen in second-quarter results, as inventory levels largely have been absorbed or written off. Interviews with equipment and component manufacturers supported this analytical conclusion—interviewees consistently stated that inventory build-up was a short-term problem, likely to be resolved over the next few months.

Exhibit 1-4

Excess Equipment Inventory Is Unlikely To Last More Than Another Quarter Under Expected Scenarios

Excess inventory days above norm*



* Excess over 50 inventory days, which is assumed to be the appropriate inventory level for equipment providers; analysis considers inventory written-off as still available for sale

Source: Wall Street estimates; McKinsey

Service provider inventory of uninstalled equipment is harder to estimate, because carriers do not reveal how much of the purchased equipment they have actually installed. Thus, we assumed that any carrier inventory was installed, and we used equipment sales of DWDM equipment and line cards, in particular, to estimate installed capacity. This excess carrier capacity, particularly in the backbone, is the most significant factor affecting the length of the slowdown. In fact, this analysis revealed that about 22% of installed long-haul fibers are currently lit, and between 20% and 30% of available lit capacity is being used. We also compared projected demand through 2005 with the current lit capacity (see Exhibit 1-5). The analysis suggests that, in

aggregate, there is sufficient installed lit capacity in long-haul networks to meet demand for the next one to two years. This is likely to result in a downward pull on equipment sales for the same period. We do not believe that the overcapacity will bring sales to a standstill, however, because in reality, individual carriers along individual routes will still need to add capacity. In fact, our service provider interviewees consistently commented that the overcapacity picture varied substantially across different routes.

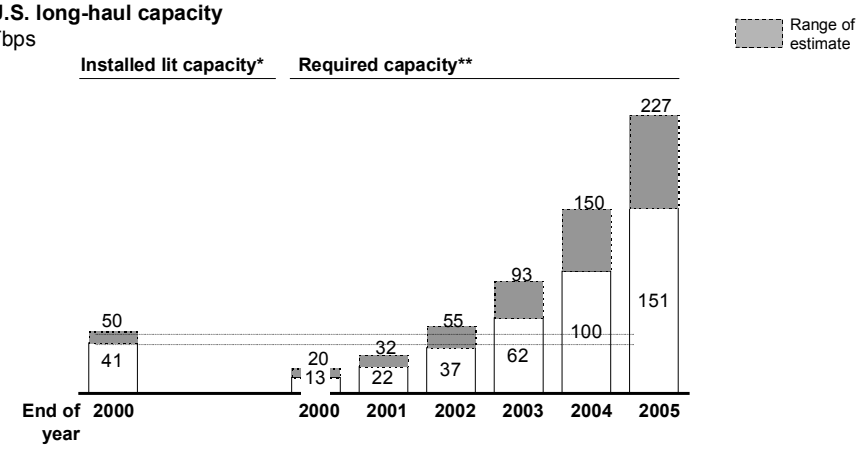
Our analysis also shows that, beyond this time frame, carriers can continue to satisfy demand for more than five years by adding new wavelengths to existing fibers and lighting additional fibers. Note that these estimates are subject to (1) variances in estimation of percentage of fiber lit, due to lack of complete information considered sensitive and proprietary by carriers; (2) variance between our average calculation and the actual route-by-route utilization and supply/demand balance; (3) shifts in carriers' build strategies that could change the overhead bandwidth required; and (4) unforeseen advances in technology that could further increase the capacity carried by a single fiber.

Exhibit 1-5

A 1 To 2 Year Supply Overhang In Long-haul Networks Will Play A Key Role In Extending The Slowdown

U.S. long-haul capacity

Tbps



* Estimate based on fiber deployed (24,000 miles), percent lit (21.5%), average wavelengths lit (3.4) and average speed deployed (3.2 Gbps); the range for installed lit capacity is assumed to be ±10% of the median estimate because of variability in percentage of fiber lit

** Derived using bandwidth demand projections and estimates of required overhead capacity; range assumed to be ±20% of our median estimates due to uncertainty in demand, advance lighting factor (due to carriers 'sweating' their networks), and other overhead factors (protocol, protection/restoration, equipment granularity, network inefficiencies, forecasting limitations)

Note: Although the excess capacity illustrated might imply that no lighting is required for the next 1-2 years, we do not expect equipment sales to stop completely because there are routes where excess capacity may not exist and there are players who may not have excess capacity

Source: RHK; FCC; KMI; Broadband Week; interviews; McKinsey estimate

Supply/demand analysis in the metro is more difficult to perform, since capacity is distributed, fibers are difficult to count, and every city looks different from a supply/demand perspective. On average, though, our analysis suggests less than six months of excess lit capacity but as much as two to three years of dark fiber capacity in metro transport markets. Thus, we expect equipment sales to continue in the metro without any significant slowdown

beyond six months. Of course, as this is an aggregate view across metro markets, the supply/demand balance in any particular metro or set of metro markets may differ. Therefore, fiber or equipment sales could pick up sooner in some metro areas and later in others. In general, it is important to remember that our slowdown analysis does not suggest that total metro fiber and equipment sales will come to a standstill during the predicted period, but that they will experience downward pressure.

A summary of our slowdown expectations is shown in Exhibit 1-6. Overall, we expect the combination of factors just described to lead to weakness in metro transport fiber sales for two to three years and in long-haul fiber sales for more than five years, barring any significant changes in network or fiber technology. Long-haul equipment sales will likely remain weak for one to two years.

Exhibit 1-6

In Aggregate, The Slowdown Should Last Less Than 6 Months In The Metro, But 1-2 Years In The Backbone

	Equipment categories	Estimated length of slowdown	
		Long-haul	Metro transport
Place new fiber	Fiber	More than 5 years	2-3 years
Light new fiber	EDFAs, WDM equipment, DCM	2-3 years	Less than 6 months
Light new channels	SONET ADM; regenerators; transponders/line cards	1-2 years	Less than 6 months

Source: McKinsey estimates

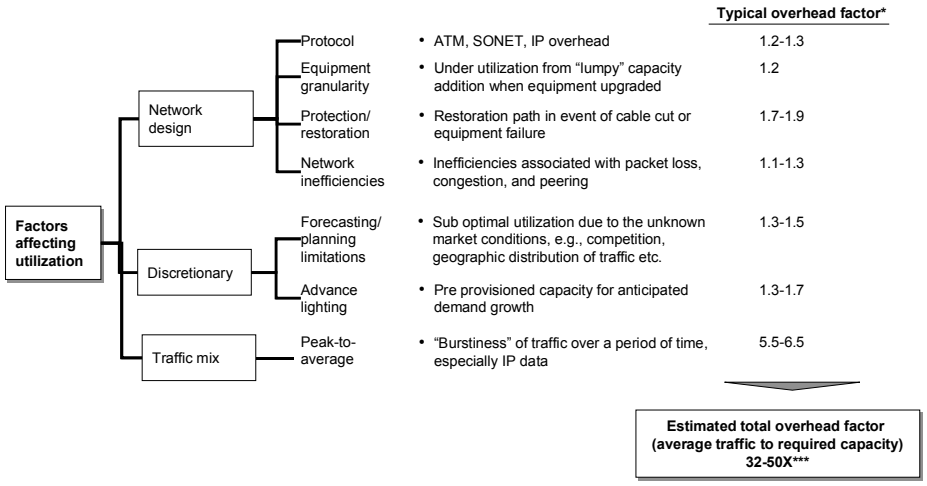
3. The time necessary to absorb excess bandwidth capacity depends on actual demand growth and on the network overhead that is required to meet demand. According to our conversations with network engineers, the total overhead factor designed into networks could range from 32 to 50 times average bandwidth demand today, given existing network architectures, IP traffic characteristics, and carrier build strategies. As data traffic becomes a greater portion of the overall mix, overhead requirements will likely increase slightly, to 33-55 times average bandwidth demand.

A variety of specific factors drive these overhead requirements in a multiplicative fashion, i.e., they do not simply add up (see Exhibit 1-7). Overhead factors will likely increase slightly as the share of data traffic increases, even though the overhead on the data traffic itself will likely drop due to more efficient next-generation network topologies and protocols and more conservative carrier build-out strategies. This increase is driven by the higher peak-to-average ratio of data compared to voice.

It is interesting to note that the presence of overhead multiples in network design can cause a significant capacity miscalculation if there is a slight variance in demand growth, equipment capabilities, or traffic patterns. The natural tendency (particularly in an environment where there is unlimited funding) is to design for the engineer's "worst case" (i.e., sustained traffic loads). If the worst case never materializes, the network is overbuilt and has capacity to spare. This phenomenon may well have contributed to the overcapacity built in the past few years.

Exhibit 1-7

Overhead Factors Require Carriers To Install Capacity At A Significant Multiple Of Demand



* Based on current long-haul network architectures; factors for voice and data weighted by current traffic mix

** 95% confidence interval for the combined overhead, based on Monte-Carlo simulation, assuming each of the overhead factors follows a uniform distribution within the range shown

Note: Based on 2000 network architectures and traffic patterns. In practice, factors will change over time (e.g., change in protocols, competitive environment) and with position in network (e.g., long haul vs. metro)

Source: Interviews; McKinsey

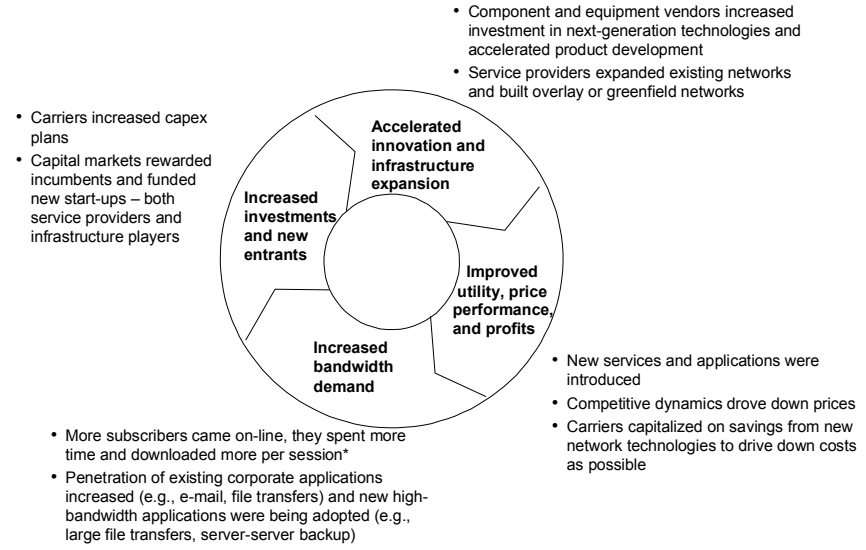
4. Beyond the current slowdown, equipment, component, and OSS vendors will need to help carriers satisfy demand growth while maintaining profitability by delivering solutions that reduce per-bit costs 25%-30% per year. Capex reductions alone will not suffice, so new solutions must reduce opex and enable new revenue-generating IP services.

An accelerating cycle of growth has existed over the past few years (see Exhibit 1-8). Attractive financial markets, the rise of the Internet, and changes

in the regulatory environment (e.g., the Telecom Act of 1996) led to increased investment in both infrastructure providers and new carriers, resulting in accelerated innovation and infrastructure expansion. The rapid increase in low-cost transport capacity, improvements in technology, and associated competitive dynamics, caused significant decreases in bandwidth prices, which in turn drove the explosion in demand and propagated the favorable growth-cycle economics.

Exhibit 1-8

Over the Past Few Years, an Accelerating Cycle Fueled Unprecedented Growth in Bandwidth Supply



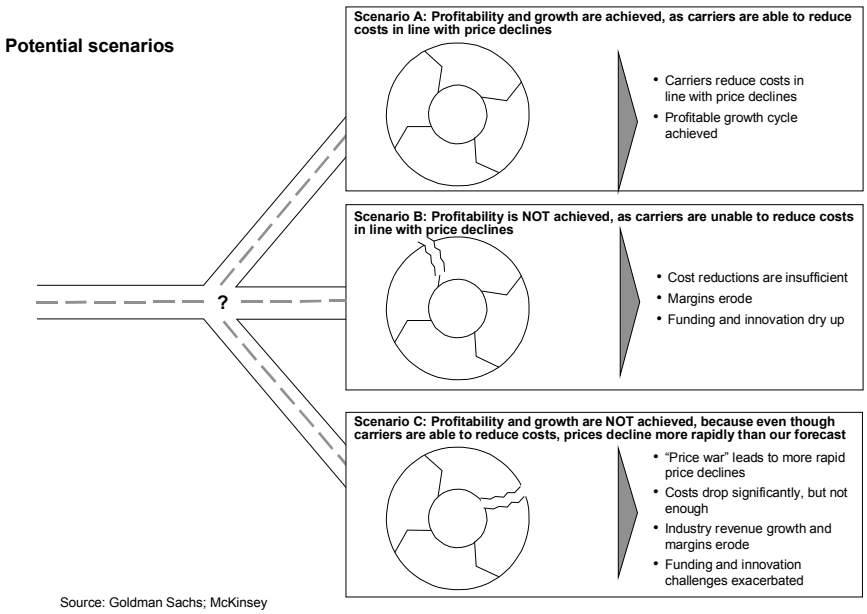
* For example, AOL indicates that while their number of hits increases 2X, total traffic increases 3X per year

Source: Goldman Sachs; McKinsey

Over the last year, the accelerating cycle of growth has dramatically slowed. Beyond the near-term slowdown, we believe carriers, in particular, will encounter the long-term challenge of achieving profitability and growth in the face of an extended downward-sloping and volatile price curve. It is important to note that prices and costs need to drop proportionately. In other words, carriers will need to shift their mindsets from "building for demand" to "building for profitability," and they will need hardware and software from the vendor community to help them make this shift. If carriers are unable to reduce their costs in line with price declines, or fail to judiciously control supply, industry profitability will suffer. If price declines are too aggressive, industry margins and growth will be destroyed. (see Exhibit 1-9).

Exhibit 1-9

From This Crossroads, We See Three Potential Scenarios for the Industry



Source: Goldman Sachs; McKinsey

Assuming a reasonable level of growth in telecom revenues and the bandwidth demand growth levels discussed in Conclusion 1, revenues per bit should drop much more rapidly than in the past, on the order of 25%-30% per year[1]. Consequently, according to our analysis, carriers will have to reduce total costs 25%-30% per year to achieve a targeted 12% return on invested capital (ROIC) by 2005 (see Exhibit 1-10).

In essence, our conclusion is that bandwidth demand—i.e., bit traffic—will continue to grow at a significantly faster rate than carrier revenues; thus, carriers will need to find a way to move more bits through the network at a significantly lower cost per bit transported. One significant assumption in our analysis is that telecom spending is unlikely to grow at a rapid rate as a percentage of GDP, based on current economic conditions as well as historical comparisons with other technology industries, and the fact that telecom spending does not "substitute" for other spending. For example, there is little evidence that spending on telecom as a percentage of GDP will grow at the expense of spending on transportation or other basic GDP categories.

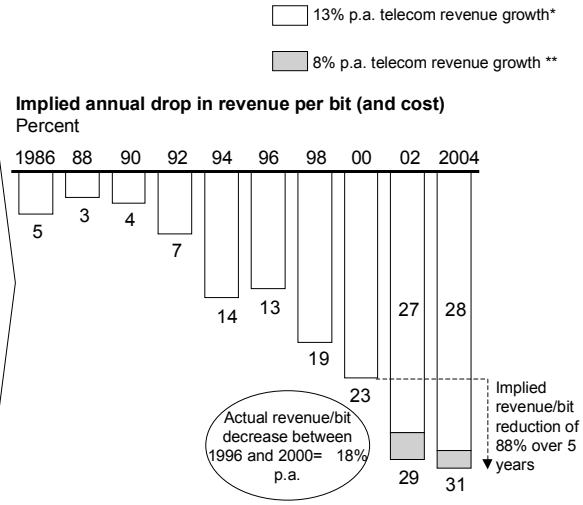
[1] A revenue-per-bit decline does not translate directly to an equivalent price decline for raw bandwidth because it is also a function of service mix and utilization of available bandwidth by customers.

Exhibit 1-10

Maintaining a Profitable Growth Cycle Will Be More Challenging Than In The Past

Influential factors:

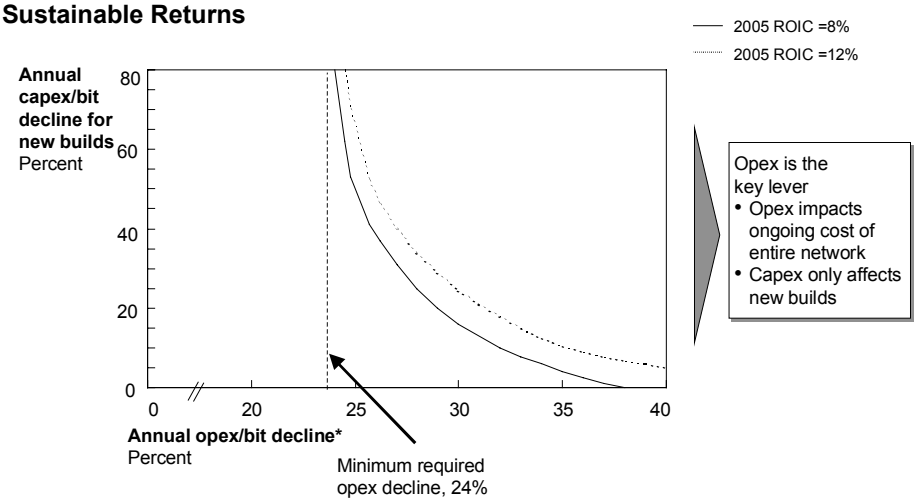
- Acceleration of aggregate demand driven by IP traffic growth and its domination in the traffic mix
- Low likelihood that total telecom expenditures will increase dramatically as a fraction of GDP over the next 3-4 years, given that:
  - Bandwidth consumption does not appear to significantly substitute revenues from other industries (e.g., transportation)
  - Telecom spending will likely follow patterns of past technology-driven revolutions such as IT



* Consistent with 1990-00 IT revenue trend
** Consistent with 1995-00 telecom trend
Source: McKinsey estimates

Exhibit 1-11

Opex Reduction Will Be The Key Lever For Service Providers To Achieve Sustainable Returns



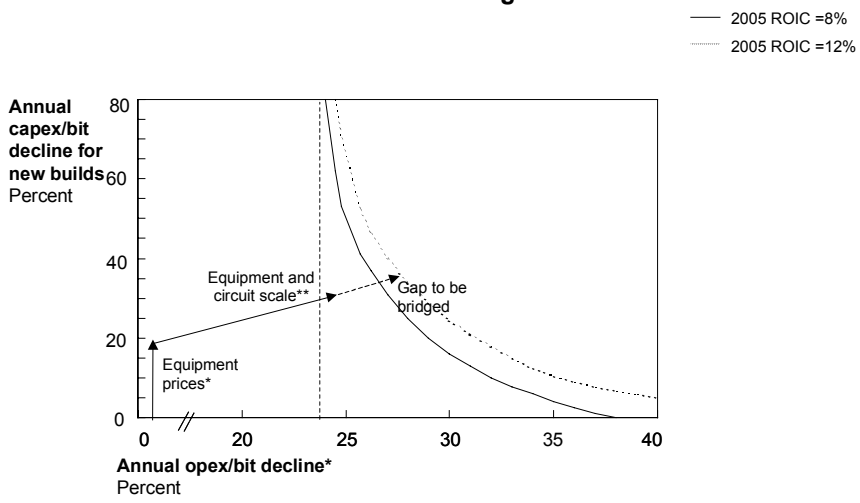
* Applies to all opex excluding depreciation
Note: Carriers are hindered by the low returns today (ROIC~9%) and the continued drag that past capital spending (through depreciation) will have on their earnings
Source: Compustat; McKinsey

Opex will be key for carriers to achieve these cost reductions, because opex reductions impact the ongoing cost of the entire network. Capex reductions, by contrast, affect only new builds because carriers are strongly resistant to swapping out and reprovisioning existing facilities (see Exhibit 1-11). In fact, according to our model, unless per-bit opex is reduced 25%-30% per year through 2005, no reasonable amount of per-bit capex reduction will allow carriers to achieve a targeted ROIC of 12% in 2005.

Obviously, carriers will employ multiple techniques for driving down costs (see Exhibit 1-12). The per-bit savings offered by equipment price declines and generational technology advances will play a major role on the capex axis, as will improving utilization (through less advance building) to a degree. Scale and utilization play an even more significant role in reducing per-bit opex costs. These three levers are likely to leave a gap for many carriers, which suggests significant opportunities for hardware and software vendors to develop products that will help carriers further reduce their opex costs on a per-bit basis. What carriers can do to reduce expenses with today's equipment and architectures is unlikely to be sufficient to develop a strongly profitable operating model.

Exhibit 1-12

To Achieve Cost Reductions Beyond Benefits of Scale, Carriers Need To Pursue New Hardware And OSS Technologies



* Inherent equipment price decline, excluding any generational improvements

** Opex reduction driven by increase in average circuit size; capex reduction driven by generational improvements in price/performance at higher speeds; illustrated savings are for a player with minimum economic scale (15% market share) that grows at same rate as the market

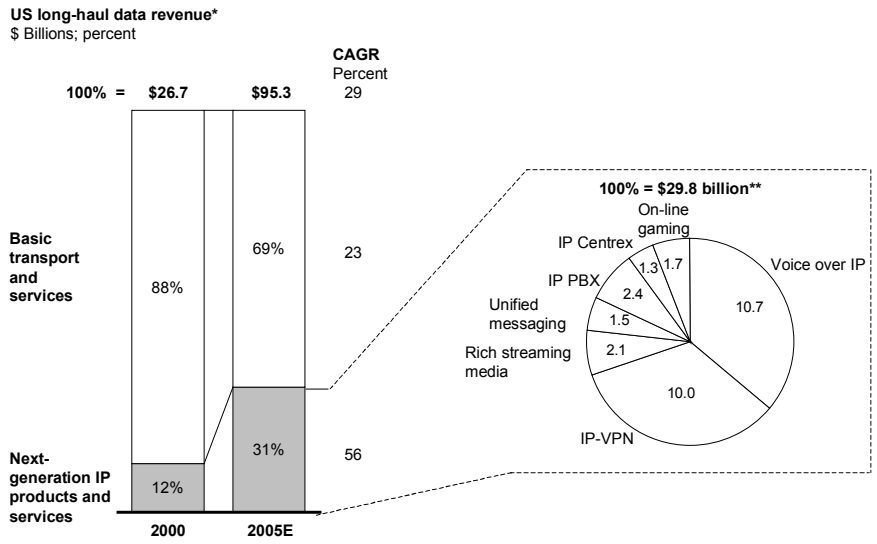
Source: Compustat; McKinsey estimates

In addition to reducing costs, equipment and OSS providers can enhance carrier profitability by helping them to deploy new, value-added IP services to expand the top line. These services will likely account for more than 30% of long-haul data revenues by 2005 (see Exhibit 1-13). Very little of the infrastructure exists today to enable these services, again suggesting an opportunity for hardware

and software providers, though not one as large in the short term or as pressing as that associated with cost reduction.

Exhibit 1-13

Vendors Will Need To Help Service Providers Differentiate By Supporting A Range Of New Services



* Includes long-haul carrier revenues from IP and non-IP (private line, ATM/Frame) data services

** Not all content-based revenues (e.g., rich streaming media, on-line gaming) will be captured by service providers

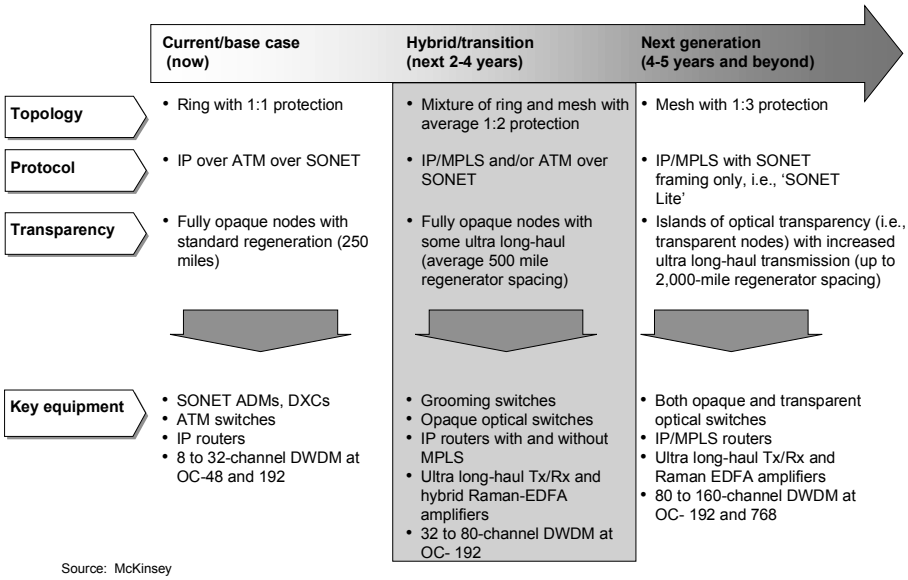
Source: IDC; Yankee; Gartner Dataquest; AT&T; RHK; ACM; McKinsey estimates

5. Successful equipment and component vendors can help carriers meet these profitability challenges by delivering transitional products that support legacy services and architectures, and deliver most of the reduced cost and complexity benefits of full next-generation products. According to our network model, these transitional network implementations should result in savings of 40%-45% in capex per bit and about 6% in opex per bit over current legacy network implementations.

Among the myriad debates on how carriers' networks will evolve over the next few years, we believe three changes will be the most critical: a *topology* shift in the long-haul from SONET-based ring and point-to-point networks to meshed architectures, a collapsing of network *protocols* to eliminate redundant intermediate protocols and boxes, and a gradual shift toward more *transparent* networks, i.e., areas of wholly optical transmission without any electro-optical conversions (see Exhibits 1-14A and 1-14B).

Exhibit 1-14A

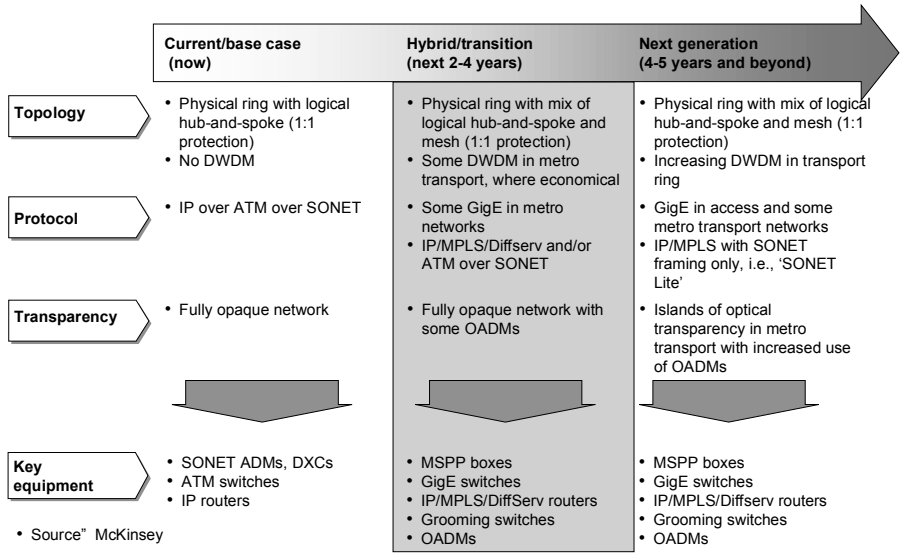
Carrier Goals to Reduce Costs, Minimize Disruption, and Preserve Legacy Service Support Favor Hybrid Equipment in the Backbone



Source: McKinsey

Exhibit 1-14B

Carrier Goals to Reduce Costs, Minimize Disruption, and Preserve Legacy Service Support Favor Hybrid Equipment in the Metro



• Source" McKinsey

In aggregate, we expect hybrid equipment in all these areas—topology, protocols, and transparency—to dominate most carriers' network builds over the next few years. This hybrid equipment should offer most of the capex and opex savings of full next-generation equipment. According to our network model, capex savings on a per-bit basis should approach 45% and opex savings should approach 6% over current legacy network implementations (see Exhibits 1-15 and 1-16). Hybrid gear should also be better able to support legacy products and services, which carriers expect to continue selling for the foreseeable future, while easing the transition to true next-generation architectures. For equipment makers, we believe this focus on hybrid gear, particularly that which will help reduce carrier opex, will be a key opportunity over the next few years. It is worth noting, however, that once next-generation networks are in place, the cost savings will be even greater. At some point, carriers will decide to "bite the bullet" and make the architecture upgrade, at which point the hybrid products may decline. Given current economic conditions and expectations, however, it is unlikely that such wholesale architecture upgrades will take place anytime soon, for most of the remaining traditional carriers.

Exhibit 1-15

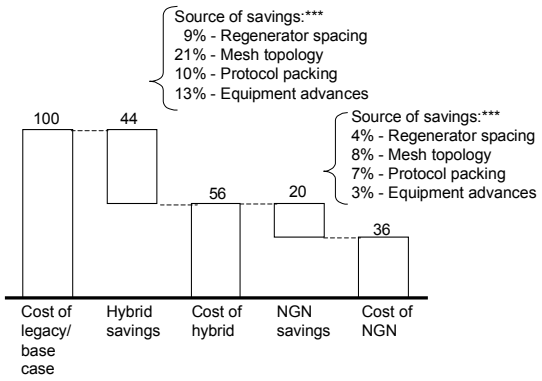
Hybrid Networks Offer Most Of The Savings Of A Full Next-Gen Network

Capital expenditure spend*

Percent

Key assumptions

- 16,000 route-miles
- 24-node backbone network
- 5-year capital spend
- 20% average annual equipment pricing decline**
- Cost savings in each case evaluated for new build portion of the network



* 5-year spend, normalized to base case

** Including the effects of inherent price decline (~11%) and generational shifts, e.g., going from OC-12 ports to OC-48 (~9%)

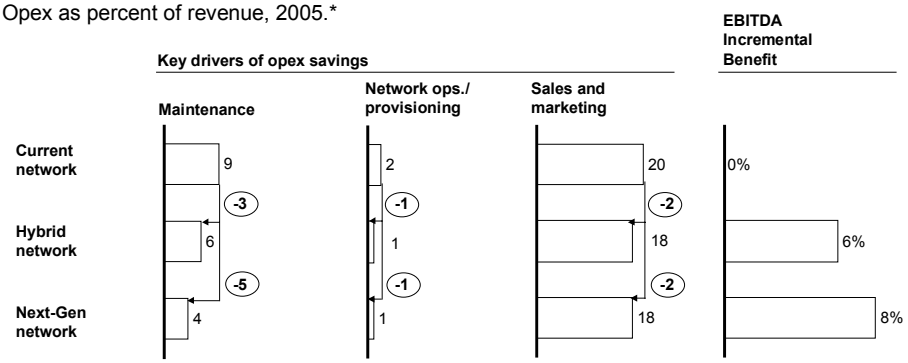
*** Components do not add to total, since savings calculations are multiplicative i.e., (1-0.44)= (1-0.09)(1-0.21)(1-0.1)(1-0.13); equipment advances include using intelligent optical switches in place of SONET ADM's and DXC's in the core, using MSPP boxes in place of ATM switches, edge routers, and SONET ADMs at the edge; and NGN= next generation network using more transparent equipment

Source: McKinsey estimates

Exhibit 1-16

A Hybrid Network Architecture Delivers 75% Of Potential Operating Cost Savings Relative To Full Next-Gen Networks

Opex as percent of revenue, 2005.*



Assumptions

- Legacy network requires 12 hours' preventive maintenance per circuit per year vs. 9 hours for hybrid network and 6 hours for next-gen
- 75% of trouble reports in legacy network require technician dispatch vs. only 50% in hybrid and 25% in next-gen, due to increased use of remote monitoring and configuration

- Legacy network requires provisioning time of 20 hours per new circuit; hybrid requires 15 hours; and next-gen requires 10 hours, due to fewer truck-rolls and greater automation

- Improved customer support and response time increases sales force effectiveness by 10%

* Total opex savings as a percentage of revenue are limited because over 50% of the backbone provider's cost comes as access charges and depreciation, which are not directly influencable by operations

Source: McKinsey estimates

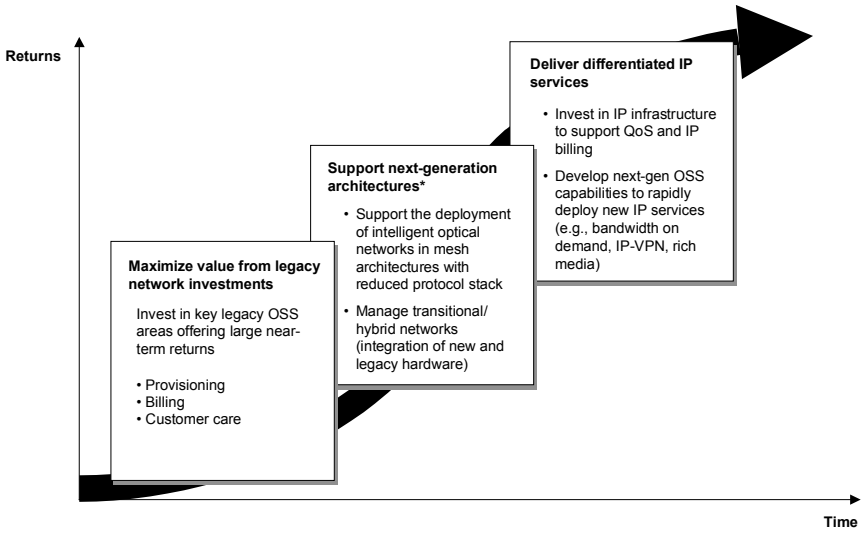
6. OSS software providers will likely play a critical and complementary role by delivering products that reduce operating costs, support next-generation network architectures, and enable new value-added IP services. Based on our conversations with large carriers and systems integrators, near-term software fixes alone could reduce per-bit opex up to 10% and increase revenues up to 6%.

The carriers and equipment vendors we interviewed were nearly unanimous in their belief that OSS is currently one of the worst pain points in network design and operation, and thus must be improved in the future. OSS improvement has been an intractable problem, given the presence of legacy systems, the innate complexity of the processes that OSS endeavors to support, the difficulty of systems integration, and the fragmentation of the OSS vendor market around numerous point solutions, with few overall sector leaders.

We see OSS investments by carriers evolving in three overlapping stages (see Exhibit 1-17). In the first stage, the focus will likely be on tactical investments, with short-term returns, to extract additional value from existing networks by improving provisioning, billing, and customer care. Targeted investments in these areas could allow carriers to reduce opex associated with legacy networks and OSS as much as 10% and boost revenues up to 6% (Exhibit 1-18).

Exhibit 1-17

OSS Investments Will Play A Critical Role In Cost Reduction And Revenue Enhancement In 3 Overlapping Stages



* Mesh topologies, IP/SONET Lite/fiber protocol stack, fewer/no OEO conversions
Source: Goldman Sachs; McKinsey

Exhibit 1-18

Provisioning, Billing, And Customer Care Are Likely To Have The Greatest Near-term Financial Impact

ILLUSTRATIVE

Potential opex* reduction

8-10%**

Potential benefits will be highly dependent on the carrier and their product set

Potential incremental revenue

4-6%**

OSS area	Description	Potential benefit
Provisioning	• Reduced manual processing of service orders • Fewer truck rolls	3-4%
Billing	• Lower accounts receivable balances • Reduced manual processing of bills	2-3%
Customer Care	• Customer self-service • Improved CSR utilization	1-2%
Other	• Reduction in NOC and sales head count	2-3%

OSS Area	Description	Potential benefit
Provisioning	• Accelerated/incremental days of billing	1-2%
Billing	• Reduction in revenue leakage	1-3%
Customer Care	• Cross-selling, up-selling	2-3%
Other	• Improved SLA management	1-2%

* Pertains to opex excluding access charges
** A single service provider is unlikely to achieve the upper ranges for every OSS area addressed
Note: CSR-Customer Service Representative; NOC-Network Operations Center; SLA-Service-level Agreement
Source: Systems integrator interviews; McKinsey estimates

The second stage of OSS investments will include those upgrades necessary to support hybrid and next-generation network architectures (see Exhibit 1-19). Upgraded network management systems (NMS) will be necessary to support new topologies, protocols, and transparent network elements. Carriers are likely to choose between two imperfect solutions: either augmenting their existing legacy NMS to support new hardware at the element level, or adopting vendor-proprietary NMS along with the network elements. Note that some software vendors can provide NMSs that operate with a wide range of equipment, with the vendor supplying periodic updates for new types of equipment. This may be a successful approach for some carriers, but NMS software today is only beginning to operate at the scale required by a large carrier. The trend, however, is positive. Note also that the savings associated with this phase of investment are included in the savings estimates detailed in Exhibit 1-15.

Exhibit 1-19

New Hardware Will Require Fundamentally Different Network Management Functionality

Next-generation hardware feature	Fulfillment		Assurance
	Network provisioning	*Network planning and development*	*Network maintenance and restoration*
Mesh architecture/ topology 	• Legacy: requests for bandwidth are for specific point-to-point routes • NGN: contention of multiple requests must be managed	• Legacy: point-to-point planning is straightforward and depends only on the demand growth of that route • NGN: new routes affect overall network characteristics in terms of provisioning and restoration	• Legacy: 1:1 restoration provides a physically pre-provisioned backup connection • NGN: 1:N restoration provides multiple backup routes comprised of multiple shared links in the mesh network
Protocol compression 	• Legacy: different layers of the network stack operate as separate domains • NGN: IP and optical layers share topology and resource information to configure integrated paths	• Legacy: capacity planning and development are independent for each layer • NGN: integrated capacity planning and development between IP and optical layers; may require sophisticated new simulation tools	• Legacy: restoration is independent at each layer • NGN: restoration requires updating topology and resource information between IP and optical layers
Optical layer transparency 	• Legacy: bandwidth requests can be processed relatively simply – provision specific routes • NGN: total network topology and signal degeneration need to be taken into account while provisioning	• Legacy: relatively straightforward planning – signal quality is maintained by adding regenerators as required • NGN: each optical path must be analyzed to determine whether intermediate electrical regeneration is needed	• Legacy: electronically monitor bit errors, packet loss, and throughput • NGN: fault detection is complex because overhead bits cannot be read optically; must also monitor optical characteristics (e.g., power levels, signal-noise ratio)

Source: Optical Networks, Ramaswami and Sivarajan; McKinsey

A final stage of investment likely will be required to deploy new value-added services that some industry analysts predict will make up more than 30% of total long-haul revenues by 2005 (Exhibit 1-13). Key new OSS functionality will be required in the areas of IP Quality of Service (QoS,) IP mediation, and billing. Several barriers will need to be addressed before these services become feasible (see Exhibit 1-20). To implement this new OSS functionality, carriers will again need to choose between trying to extend their current OSS or look to a third-party solution, presumably of newer vintage. There are significant challenges in either approach. Legacy OSS systems tend to be huge mainframe application programs that are tied to hundreds of other systems and thus are

extremely difficult to replace. On the other hand, the existence of multiple, immature point solutions, and the associated integration challenge, limit the attractiveness of this option as well. Ideally, the phased purchase and deployment of one or more selected modules from a multi-component integrated product suite may be the best option to effect change with a manageable level of integration risk.

Exhibit 1-20

Service Providers Will Experience Three Sets Of Challenges In Deploying Value-added IP Service Capabilities

	Specific issues
Off-net vs. on-net traffic	• Providing end-to-end QoS and other advanced IP services requires all participating service providers to provide the same capabilities, adapt standard interfaces, and agree to honor end-to-end service level agreements • Without such standardization, services like QoS can only be provided (and charged) for traffic that remains on on-net end-to-end, which typically represents less than 10% of most carrier traffic
Legacy integration	• Carriers, especially older incumbents, need to deal with a large existing legacy OSS infrastructure • Deployment of new applications requires integration with legacy OSS components to ensure consistent customer experience
Modules do not work well together	• Currently available packages are new and immature (some functionality gaps also exist but these will probably be filled over the next 1-2 years) • Most are point solutions that need to be integrated with other components • Ongoing costs associated with maintaining/updating and integration can be quite significant

Source: Interviews; Goldman Sachs; McKinsey

A number of issues will affect how these OSS changes are adopted and integrated into existing systems, including carrier choices on how to add new capabilities, the extent to which new standards are established as an alternative to the current proprietary systems (e.g., Telcordia's OSMINE process), and the paths that equipment makers, software providers, and systems integrators choose in staking a claim to what we believe will be a substantial OSS opportunity. How these factors unfold will have a dramatic impact on the OSS industry.

7. Given that many non-incumbent carriers have exited the business or are struggling, vendors will need to alter their product designs and sales approaches to accommodate the longer sales cycles and more rigorous certification processes of incumbents and their focus on total cost of ownership.

Service providers are becoming increasingly focused on technology that reduces total cost of ownership over time. They are looking for solutions that "work now and enable what comes later." "Works now" describes equipment

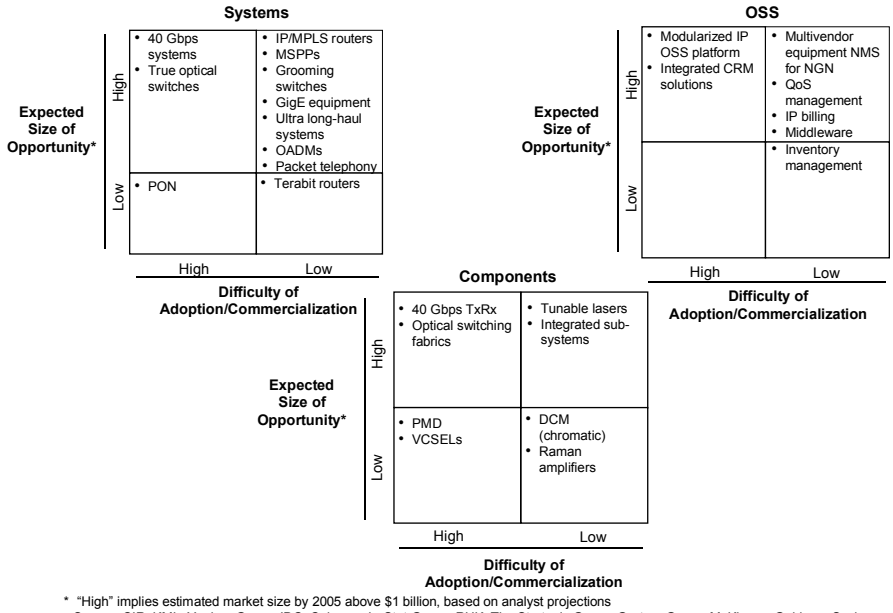
that installs seamlessly in the current network environment and shortens the path to lower costs and new service revenues. They want technology that does not require them to operate multiple overlay networks with different generations of hardware or to replace a large portion of their infrastructure before becoming effective.

Key opportunity areas for hardware and software providers will be those that will (1) enable the network and OSS changes summarized previously; (2) meet carrier needs to accelerate cost reductions, particularly in opex; and (3) deliver new services. These areas include multi-service provisioning platforms (MSPPs), IP/multi protocol label switching (MPLS) routers, grooming switches, optical add/drop multiplexers (OADMs,) ultra long-haul systems, and GigE equipment for equipment providers; tunable lasers and integrated modules/sub-systems for component providers; and multi-vendor NMS for next-generation networks, QoS management, and IP billing solutions for OSS providers.

Equipment providers must also come to terms with the new reality of purchasing patterns. CLECs and other aggressive attackers that were more willing to take on new technology without extended trials are becoming a lesser percentage of total spending (see Exhibit 1-21). Thus, infrastructure providers will need to work closely with the strongest carriers, especially RBOCs, patiently waiting as their equipment is put through rigorous testing and, in the case of OSS, often requiring certification by Telcordia's OSMINE process.

Exhibit 1-21

Perspectives on Growth Opportunities



* "High" implies estimated market size by 2005 above $1 billion, based on analyst projections

Source: CIR; KMI; Yankee Group; IDC; Cahners -In-Stat-Group; RHK; The Strategic Group; Gartner Group; McKinsey; Goldman Sachs

8. Technology vendors will need to work together and with standards bodies to promote interoperability, given the emerging need for end-to-end service provisioning, signaling, convergent billing, and integrated network management. This will prove to be a difficult challenge for the industry and may well not happen, given competitive forces as well as the overall difficulty and complexity of standards definition and compliance.

The issue of open standards for equipment and OSS is an old one for the industry. The conventional wisdom in the industry is that equipment vendors and OSS vendors will never be able to work with each other to develop such standards and comply with them.

However, we expect a new impetus for such standards to be developed, driven by the needs of carriers as they deploy hybrid and next-generation network technologies and optimize their network design and management. The need for end-to-end service provisioning, both to reduce operational costs and improve customer service, is well recognized, as is the need for integrated network management as networks move from local ring and point-to-point connections to a single "mesh." For these shifts to be possible, however, hardware in different parts of the network will need to work seamlessly with the rest of the network. Additionally, in the transition phase, the next-generation or hybrid hardware might need to work with the legacy equipment present in the network.

Carriers are typically unwilling to restrict themselves to one vendor's hardware or software, so vendor interoperability will be critical. In fact, we expect to see an increasing level of mandated interoperability by carriers, based on a set of defined industry standards. We would not be surprised to see incumbents rely more heavily on open-standards compliance as a critical part of their vendor evaluation process.

Today, in the absence of network management-element management interface standards and network-network interface standards, carriers need to fund a large systems integration effort to make all the different element and network management systems work together. Going forward, carriers will not be willing (or, in some cases, able) to bear this cost. If standards do not take root, adoption of the new network hardware and management systems will slow. This will harm both the carriers (which will not get the cost reduction they need to survive and grow) and the vendors (which will find it increasingly difficult to sell their products).

Clearly, the solution to this problem is for equipment and OSS vendors to cooperate on standards development. Industry forums such as the TeleManagement Forum (TMF), the Optical Inter-networking Forum (OIF), and the Internet Engineering Task Force (IETF), have already begun work on a number of crucial standards, with the participation of a number of equipment vendors. We believe that sustained pressure from service provider customers

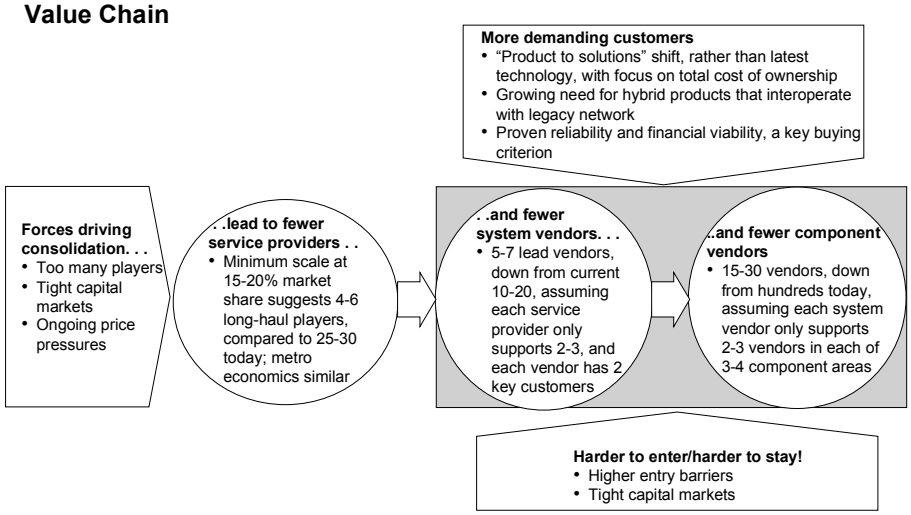
will increase the likelihood that vendors cooperate with these forums and comply with the standards developed. However, the industry's record of cooperation is not good, so there will be substantial forces that resist "commoditization" of standards and interfaces, despite lip service given to the idea.

9. Industry consolidation appears inevitable. The demise of carriers that fail to reach profitability, and lack of funding for new service providers, will likely lead to fewer, larger leading equipment providers, supported by a handful of key component players. OSS vendor consolidation will likely be driven by service providers' desire to deal with fewer vendors that offer broader solutions, rather than many vendors with point solutions that address individual OSS areas.

An initial stage of rationalization will occur as the industry shakes out non-viable business plans of start-up service providers and equipment vendors that can no longer obtain funding. Before further strategic consolidation can occur, however, participants in the value chain (service providers, equipment vendors, component vendors, and OSS vendors) will need to gain better visibility into their businesses as conditions stabilize and the effects of restructuring efforts begin to be felt. Then, strategic consolidation of infrastructure vendors will likely be driven by three primary reasons: (1) service providers' need for integrated network solutions, rather than individual, innovative hardware products and point-solutions in the software space; (2) technology vendors' need for "critical mass" and efficiency in R&D, sales, product breadth, and other areas of operation; and (3) tighter capital markets. These factors will likely result in a much more concentrated industry structure (see Exhibit 1-22). In OSS, the pressure to move from multiple point solutions to more integrated OSS platforms and suites will likely drive a similar consolidation of OSS software vendors, both vertically and horizontally across the OSS management layers.

Exhibit 1-22

At An Industry Level, Consolidation Will Ripple Through Layers Of The Value Chain



Source: Goldman Sachs; McKinsey

10. Additional downside risks—such as a prolonged economic downturn or destructive competitor behavior—pose the greatest risk to our perspectives. Missed upside opportunities are less likely.

Factors that could impede growth include:

- a fundamentally sharper falloff in bandwidth demand growth;
- a deep and prolonged economic slowdown leading to reduced service provider capital spending and end-user bandwidth purchases;
- prolonged shutdown of capital markets and private equity funding;
- unsuccessful regulatory efforts that slow service providers' ability to offer new services;
- changes in service provider ownership (which could also be a positive factor); and
- predatory price wars among service providers attempting to escape other problems.

Unexpected developments that would accelerate growth include:

- the sudden, viral growth of a "killer app" that drives accelerated bandwidth demand and mandates infrastructure upgrades;

- disruptive technology developments in core areas such as optics, particularly if they help to drive down carrier opex;
- faster-than-anticipated rollout of high bandwidth access to residences and small businesses;
- more rapid consolidation and rationalization of the service provider industry;
- successful entry into the OSS market by new, powerful companies such as large enterprise resource planning (ERP) vendors and computing hardware companies; and
- recovery of the capital markets.

STRATEGIES FOR SUCCESS

The above conclusions suggest some strategies for success for equipment vendors, component vendors, and OSS companies. We believe these key success factors will form the basis of competition over the next three to five years, both within and across key segments of the network infrastructure value chain. We expect these factors to require significant changes in mindset and competitive strategy.

System Vendors

1. **Focus on providing hybrid systems that reduce total cost of ownership for carriers and enable new, value-added services, rather than purely innovative products or products that have a low up-front cost.** Innovative hardware alone cannot deliver the required opex savings. System vendors must bundle in sophisticated software and network management tools that enable advanced functionality and reduce provisioning, monitoring, and repair costs. System vendors should also change their marketing strategy to emphasize total cost of ownership.
2. **Push for early trial and successful deployment with leading service providers that will survive the current shakeout.** Vendors can no longer rely on attacker service providers to readily test their products because incumbents are likely to dominate spending over the next three to five years. Therefore, they must prepare for long qualification processes and must tailor their products to work with incumbents' existing network management systems. New equipment must preserve investments in legacy infrastructure and support a variety of protocols.

3. **Support development of industry standards, and ensure that products can be easily integrated.** Going forward, vendors should move away from proprietary interfaces and management systems and instead develop products that are easily integrated into carriers' legacy network management systems or into standard, third-party OSS platforms. The best way to do this would be to work with carriers, standards bodies, and leading OSS vendors to support industry standards for NMS-element management system (EMS) and network-network interfaces and platforms, including standards for legacy protocols such as SONET and asynchronous transfer mode (ATM), and emerging protocols such as generalized MPLS (GMPLS), and metro ethernet.

4. **Develop systems that further reduce the demand-to-capacity overhead factors.** System vendors can directly influence several of the key overhead factors including protocol overhead and protection/restoration requirements. Less directly, they can influence other network inefficiencies, equipment granularity issues, and the ability to shape peak-to-average traffic patterns. Every reduction of overhead has a multiplicative effect that powerfully impacts costs.

5. **Forge (multiple) partnerships with OSS vendors and systems integrators.** As carriers deploy next-generation networks, they will be looking for complete hardware and software solutions that minimize their integration costs, while preserving multi-vendor interoperability. System vendors should therefore partner closely with leading OSS vendors and systems integrators in developing end-to-end network management solutions and platforms that support their specific hardware functionality, while preserving interoperability and minimizing integration costs.

6. **Facilitate value-added and integration services for customers.** Vendors should actively seek to leverage their unique hardware knowledge to provide new value-added services such as network design and planning, testing and monitoring, and performance tuning. System vendors should also consider branching into broader systems integration services.

Component Vendors

1. **Focus R&D investment on specialty components and disruptive technologies that can improve price/performance by 5-10 times.** Any component business without continuous technological innovation will be challenged to maintain a record of success. This cannot be truer than in the optoelectronics industry, where innovation has driven dramatic improvements in price/performance over the last few years. Service providers' shift in focus, from increasing capacity to increasing flexibility and reducing total ownership costs, will be pushed down to equipment and

component vendors. Vendors must therefore strive to deliver new technologies capable of improving price/performance 5-10 times.

2. **Improve manufacturing yields, throughput, and packaging to reduce costs 15%-20% per year.** In an intensely competitive space, where the market expects hardware price declines every year, component vendors will be forced to reduce costs correspondingly. Manufacturing technology for optical components is still immature, with many components assembled and calibrated by hand and with unstable processes that often have yields lower than 10%. Significant room for improvement exists.

3. **Focus on product innovations that (directly or indirectly) help reduce total cost of ownership for service providers.** In addition to reducing up-front component cost, component vendors should look for opportunities to reduce installation, operating, and repair costs.

4. **Develop more integrated modules and sub-systems.** Monolithic integration as well as hybrid integration (integrating components into modules and sub-systems) will both allow component manufacturers to capture additional value by increasing reliability and reducing system vendor assembly cost and complexity. Moving upstream into modules also allows component vendors to tune and optimize the performance of their components. While the incremental value they capture by doing so may be limited in the short term, they could gain significant upside in the longer term.

OSS Vendors

1. **Support the development and adoption of industry standard middleware and truly open APIs.** Standards such as those being developed by the TMF increase the attractiveness of next-generation OSS software by reducing integration costs and improving overall software and hardware interoperability. The advantages of standards are thus likely to outweigh any short-term rewards from more proprietary solutions.

2. **Expand portfolios horizontally across network management functions and selectively "northbound" into the service management layer.** Developing broader software suites by expanding solutions horizontally and vertically will allow OSS vendors to capture additional value while improving performance and reducing carrier integration costs. For example, billing vendors should expand across into the other customer care processes within the fulfillment and assurance areas and incorporate telecom-specific CRM offerings into their product portfolios.

3. **Create integrated suites of IP OSS products**. Currently, most IP services (e.g., IP-virtual private network [VPN]) are offered as point solutions. As

service providers begin to roll out new IP services in earnest, they will likely favor integrated IP OSS platforms that allow them to provide multiple IP services without incurring significant integration costs.

4. **Take advantage of selected legacy system opportunities.** Opportunities exist for ISVs who make enhanced software packages that can integrate with legacy systems to address specific functionality requirements, for example, mediation. Additionally, there are opportunities for ISVs to create software that can exist "side-by-side" with legacy systems, exchanging data on a periodic basis, but not fully integrated on a real-time basis.

5. **Partner with multiple equipment vendors to create integrated and interoperable network management platforms.** To maximize the performance of next-generation network architectures, OSS vendors will need to work closely with equipment vendors to support new element functionality and to develop the required network management platforms.

6. **Ally closely with multiple SIs.** In the near term, systems integrators will play a pivotal role in enabling and integrating new OSS, including making recommendations about software choices. OSS vendors can substantially benefit by developing preferential relationships with system integrators and building simple interfaces to their reference platforms.

We derived the success factors from our analyses of opportunities in the hardware and software market, the likely industry structure, and the likely drivers of value creation/capture. The strategies also reflect extensive commentary voiced by industry participants during our interviews. The actions prescribed should help equipment, component, and OSS vendors take advantage of opportunities arising from the evolving industry structure and provide a hedge against the changes to come.

APPENDIX: WILL THE MARKET EVER BOOM AGAIN?

Outside of our joint work, McKinsey on its own developed a separate perspective on the future growth of the transport equipment market. This forecast is based on work performed by McKinsey alone and should not be attributed to Goldman Sachs. It is based on the estimates of bandwidth demand growth, current overcapacity, and likely evolution of network technology discussed earlier in this report. It therefore represents an "ideal" scenario where carriers spend exactly what they need to meet demand. While it does account for the current capital market situation, in that it assumes carriers will maximize utilization of existing assets in response to capital market tightness, it does not account for a prolonged economic slowdown or a reemergence of irrational exuberance that might drive bandwidth demand itself lower or higher or lead carriers to spend less or more than the "ideal" amount predicted by the model.

We believe that while the shock of the recent slowdown is drastic in the short term, its real impact will be felt in the longer term as carriers recalibrate their capital spending and begin building for profitability rather than growth alone. Although the market will recover from the downward pull of excess capacity and inventory over the next one to two years, we believe that it is unlikely to revert to the levels of growth witnessed over the last three years.

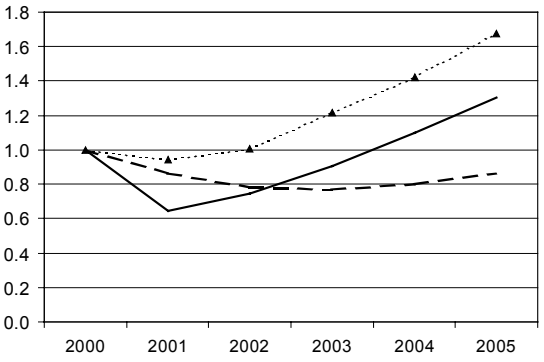
Already, system and component vendors have drastically revised their sales outlooks for the next five years, while carriers have done the same with their capex outlooks. However, as Exhibit A-1 shows, there is still a wide gap in expectations, both in the short and the long term. In the short term, system vendors project a steep 35% drop-off, while component players and carriers foresee a much milder 5%-6% correction. In the longer term, both system and component manufacturers predict a return to still relatively robust 15%-19% annual growth, while carriers see capex remaining flat.

Some, but not all, of the difference is explained by the fact that the spends are not fully comparable. For example, carrier capex includes software, fiber, capitalized labor (e.g., installation and systems integration), and systems that are not network-related. Also, the target markets are not strictly comparable in terms of customer segments or geography (e.g., carriers are largely US-only, while vendors sell on a global basis).

In any case, the true growth probably lies somewhere in between the various players' views. We have used carrier and equipment vendor forecasts, along with our network model and understanding of the drivers of the current slowdown, to forecast growth for major categories of capex spend over the next five years. We have then applied our network model and associated assumptions

Exhibit A-1

A Clear Gap Exists Between Carriers' Capital Spending Projections And Equipment And Component Vendors' Sales Expectations



	Drop in 2001	CAGR, 2001-2005
Component vendor sales projections*	5%	15%
Equipment vendor sales expectations**	35%	19%
Carrier projections***	13.5%	0%

* Based on analyst reports from May and June 2001 for the following companies: Agere, Corning, JDSU, Nortel ME

** Based on analyst reports from May and June 2001 for the following companies: Nortel, Lucent, Cisco, Ciena, Sycamore, ONI, and Corvis; includes optical-related sales only

*** Based on analyst reports from May and June 2001 for the following companies: AT&T, Sprint, Worldcom, BellSouth, SBC, Verizon, Qwest, 360networks, Broadwing, Genuity, Level 3, Global Crossing, and Williams; excludes wireless expenditures

Source:Epoch Partners/Goldman Sachs; Wall Street estimates; McKinsey

about network evolution to determine how much it will cost to deliver capacity. The resulting capex spend projections were then checked and normalized against our understanding of current and historical capex spending. We have also checked to make sure that our model includes all the major drivers of network infrastructure spend, including hardware, OSS, and systems integration costs (see Exhibit A-2). Specifically, we have used our demand projections netted against the current supply and utilization picture to predict how much new capacity will be needed over the next five years. We have then applied our network model and associated assumptions about network evolution to determine how much it will cost to deliver the capacity. The resulting capex spend projections were checked and normalized against our understanding of current and historical capex spending. We have also checked to make sure that our model includes all the major drivers of network infrastructure spend, including hardware, OSS, and systems integration costs.

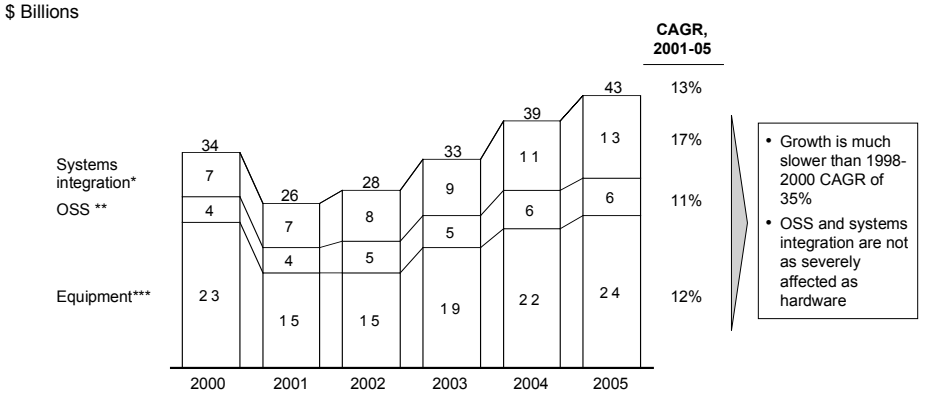
These projections represent the portion of capex spend that we have focused on in this report—high bandwidth transport and switching equipment, OSS, and systems integration. The projections exclude spending on fiber, wireless, and access equipment (such as DSL, coaxial cable, and fiber laterals to buildings). The total spend in the year 2000 is based on RHK and Gartner Group estimates for the year. We expect the total resulting capex spend to fall by 24%-25% this year and then to increase by 13% annually between 2001 and 2005 (see Exhibit A-2). The growth estimates for hardware are based on our network model, and

the estimates for OSS software and systems integration are based on Gartner Group projections, adjusted for the portion of spend that is hardware dependent. Thus, the growth projections for hardware take into account the impact of the current slowdown, the expected long-term demand growth, the likely network evolution, and the expected price drops for various categories of equipment.

Even as the equipment market slows, we expect software and systems integration spends to remain strong as carriers attempt to leverage their existing network assets more efficiently, integrate new hardware, and push for operating savings. In fact, in terms of total spend over the next five years, OSS software and systems integration will rival hardware spend (see Exhibit A-3).

Exhibit A-2

Aggregate Carrier Spend On Core Network Hardware And Software Is Expected To Drop 25% In 2001 And Grow At A 13% CAGR Through 2005



* Includes all U.S. telecom systems integration spending, since optical networking-related spend cannot be easily separated; Gartner Group estimate, adjusted for spend related to hardware

** Includes all OSS software and related hardware, since optical networking-related spend cannot be easily separated; Gartner Group estimate, adjusted for spend related to hardware

*** Excludes wireless and wireline access equipment, fiber, and capitalized labor; includes optical networking gear – SONET, DWDM, regeneration, ATM switches, IP routers, and core switches/cross connects; derived using 2000 market size from RHK and growth estimates from network model, including the impact of demand growth rate, network architecture evolution, and equipment price decline

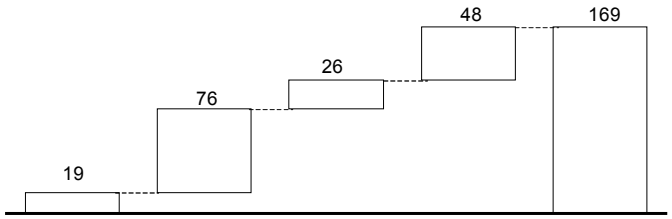
Source:RHK; Gartner Group; McKinsey estimate

Exhibit A-3

Over The Next 5 Years, OSS And Systems Integration Spend Will Rival Hardware Spend

Total core network capex - 2001-05*

$ Billions



	Transport equipment**	Node equipment***	OSS****	Systems integration	Total carrier capex
Long-haul Percent	84	27	n/a	n/a	
Metro Percent	16	73	n/a	n/a	

* Excludes wireless and wireline access equipment, fiber, and capitalized labor
** Includes DWDM, regeneration, and amplification equipment
*** Includes SONET ADMs, DXCs, ATM switches, IP routers, optical switches
**** Includes software and related hardware
Source: RHK; Gartner Group; McKinsey estimate

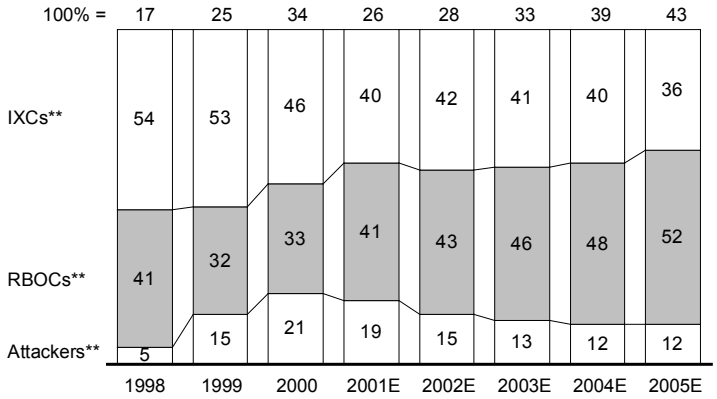
To understand which companies will be spending the money, we have looked at total capex projections by the top 13 carriers, which account for over 90% of the market and include attackers (360networks, Broadwing, Genuity, Global Crossing, Level3, and Williams), ILECs (SBC, BellSouth, Verizon, and Qwest), and incumbent IXCs (Sprint, Worldcom, and AT&T). We then used our projections of total equipment, software and systems integration spend, together with an estimate of the portion of total capex that this comprises for each type of carrier, to split our market forecasts by type of carrier. Not surprisingly, the major spenders over the next five years are likely to be carriers that have been least affected by the slowdown—the ILECs (see Exhibit A-4). Their share of total industry capex, which has declined over the last two years from 41% to 33%, will rebound to more than 50%, as the IXCs cut spending on new fiber builds and burn off overcapacity, while the attackers are forced to cut back by market pressures.

Exhibit A-4

Spending Will Be Increasingly Dominated by the RBOCs, Largely at the Expense of Attackers

Core network capex (U.S.)*

$ Billions; percent



* Excludes wireless and wireline access equipment, fiber, and capitalized labor; includes optical networking gear (SONET, DWDM, regenerators), ATM switches, IP routers, and core switches/cross connects; also includes systems integration, OSS software and related hardware

** IXCs include AT&T, Worldcom, and Sprint; RBOCs include SBC, BellSouth, Verizon, and Qwest; attackers include 360networks (up to 2000), Broadwing, Genuity, Global Crossing, Level3, and Williams

Source:Epoch Partners; Goldman Sachs; RHK; Gartner Group; McKinsey estimates

Again, it is important to note that this forecast accounts for the current capital market situation, given its assumptions that carriers will maximize utilization of existing assets in response to capital market tightness, but it does not account for a prolonged economic slowdown or a reemergence of irrational exuberance that might drive bandwidth demand itself lower or higher or lead carriers to spend less or more than the "ideal" amount predicted by the model. Additionally, our network evolution model and supply/demand balance methodology is best suited for predicting the longer-term post-bubble capex growth trajectories, which we have pegged at a 13% annual growth rate. The exact point where growth resumes (e.g., 2002 versus 2003) and the specific year-to-year variations will depend more on individual carrier dynamics and specific short-term market characteristics. Additionally, our network evolution model and supply/demand balance methodology is best suited for predicting the longer-term, post-bubble capex growth trajectory, which we have pegged at a 13% annual growth rate. The exact point where growth resumes (e.g., 2002 vs. 2003) and the specific year-to-year variations will depend more on individual carrier dynamics and specific short-term market characteristics. It is, though, a "stake in the ground" based on currently available market data and one that we believe is based on a solid fact base and understanding of current market dynamics.

ABOUT GOLDMAN, SACHS & CO.

Goldman Sachs is a leading global investment banking and securities firm, providing a full range of investing, advisory, and financing services worldwide to a substantial and diversified client base, which includes corporations, financial institutions, governments, and high net worth individuals. Founded in 1869, we are one of the oldest and largest investment banking firms. After more than a century as a private partnership, our firm became a public company in 1999. The Goldman Sachs Group, Inc. is headquartered in New York and has 44 offices in more than 20 countries.

The firm's Investment Research Division provides far-reaching and comprehensive analysis and commentary on portfolio strategy, economics, industries, and companies. For over two decades, Goldman Sachs has committed the resources on a global scale to develop an industry-leading position for the firm's investment research products. Major investors worldwide recognize Goldman Sachs for its value-added research products, which are highly rated in client polls across the Americas, Europe, and Asia. The Global Investment Research Division has a well-regarded staff of approximately 900 professionals, including more than 300 equity analysts, 25 global research teams, and 12 portfolio strategists, covering approximately 2,400 companies, more than 50 economies, and more than 25 stock markets.

We are committed to a distinctive culture and set of core values. These values are reflected in our Business Principles, which emphasize placing our clients' interests first, integrity, commitment to excellence and innovation, and teamwork.

ABOUT MCKINSEY & COMPANY AND ITS TELECOMMUNICATIONS AND HIGH-TECH PRACTICES

McKinsey & Company, Inc. is the leading international consulting firm serving top management. We work with our clients, a broad range of corporate and government institutions, to significantly improve their performance in seizing new opportunities and resolving critical problems.

McKinsey's mission is to help clients make lasting and substantial improvements in their performance. Our problem-solving approach is based on a combination of our integrated total business perspective, fact-based analytics, and objective analyses designed to help bring both new and impactful approaches to addressing business problems. McKinsey's commitment to results is paramount, and the firm has a demonstrated track record of assisting companies in solving problems and identifying opportunities throughout their internal operations.

McKinsey offers a unique combination of top-level management perspective and deep industry and functional expertise. Our size—over 6,000 professionals—gives us a wealth of experience and know-how, while our global network—80 offices in 43 countries—ensures both international perspective and local knowledge of the changes that are sweeping many industries and regions. Our worldwide presence makes it possible for us to serve clients on global issues. Today, much of our work crosses national borders and is performed by teams representing three or four of the more than 78 citizenships of our consultants.

McKinsey's telecommunications and high-tech industry experience is broad. We have conducted well over 1,000 engagements within each industry over the past five years, serving communications companies, value-added service companies, and software and equipment suppliers across the world. We serve a wide range of industry participants: established players, challengers, early stage companies, and venture capital and private equity firms seeking to invest.

We regularly deal with all the major forces reshaping the industry: the Internet, deregulation, globalization, technological advances, and changing customer needs. The interplay between these forces and the special situations McKinsey has encountered within geographic regions have given us insights into how these industries are evolving throughout the world.

Goldman, Sachs & Co. or an affiliate may deal as principal in any of the securities mentioned.

This report is not to be construed as an offer to sell or the solicitation of an offer to buy any security in any jurisdiction where such an offer or solicitation would be illegal. We are not soliciting any action based upon this material. This material is for the general information of clients of Goldman Sachs. It does not take into account the particular investment objectives, financial situation or needs of individual clients. Before acting on any advice or recommendation in this material, a client should consider whether it is suitable for their particular circumstances and, if necessary, seek professional advice. Certain transactions, including those involving futures, options, and high yield securities, give rise to substantial risk and are not suitable for all investors. The material is based upon information that we consider reliable, but we do not represent that it is accurate or complete, and it should not be relied upon as such. Opinions expressed are our current opinions as of the date appearing on this material only. While we endeavor to update on a reasonable basis the information discussed in this material, there may be regulatory, compliance, or other reasons that prevent us from doing so. We and our affiliates, officers, directors, and employees, including persons involved in the preparation or issuance of this material may, from time to time, have long or short positions in, and buy or sell, the securities, or derivatives (including options) thereof, of companies mentioned herein. No part of this material may be (i) copied, photocopied or duplicated in any form by any means or (ii) redistributed without Goldman, Sachs & Co.'s prior written consent.

This material has been issued by Goldman, Sachs & Co. and/or one of its affiliates and has been approved by Goldman Sachs International, which is regulated by The Securities and Futures Authority, in connection with its distribution in the United Kingdom and by Goldman Sachs Canada in connection with its distribution in Canada. This material is distributed in Hong Kong by Goldman Sachs (Asia) L.L.C., in Korea by Goldman Sachs (Asia) L.L.C., Seoul Branch, in Japan by Goldman Sachs (Japan) Ltd., in Australia by Goldman Sachs Australia Pty Limited (ACN 092 589 770), and in Singapore through Goldman Sachs (Singapore) Pte. This material is not for distribution in the United Kingdom to private customers, as that term is defined under the rules of The Securities and Futures Authority; and any investments, including any convertible bonds or derivatives, mentioned in this material will not be made available by us to any such private customer. Goldman Sachs International and its non-U.S. affiliates may, to the extent permitted under applicable law, have acted upon or used this research, to the extent it relates to non-U.S. issuers, prior to or immediately following its publication. Foreign-currency-denominated securities are subject to fluctuations in exchange rates that could have an adverse effect on the value or price of, or income derived from, the investment. In addition, investors in securities such as ADRs, the values of which are influenced by foreign currencies, effectively assume currency risk. .

Further information on any of the securities mentioned in this material may be obtained upon request, and for this purpose persons in Italy should contact Goldman Sachs S.I.M. S.p.A. in Milan, or at its London branch office at 133 Fleet Street, persons in Hong Kong should contact Goldman Sachs (Asia) L.L.C. at 2 Queen's Road Central, and persons in Australia should contact Goldman Sachs Australia Pty Limited. Unless governing law permits otherwise, you must contact a Goldman Sachs entity in your home jurisdiction if you want to use our services in effecting a transaction in the securities mentioned in this material.

Frank Governali, and/or a member of his household, owns a position in the securities of AT&T Corp., AT&T Wireless, and Worldcom. Natarajan (Subu) Subrahmanyan, and/or a member of his household, owns a position in the securities of Juniper Networks, Lucent Technologies, and Sycamore Networks. Brantley Thompson, and/or a member of his household, owns a position in the securities of Cisco Systems and JDS Uniphase.

Goldman Sachs

McKinsey&Company