Viewpoint

The Information Superhighway

Peter B. S. Ellis

Prognostications on the information superhighway range from the starry-eyed to the deeply pessimistic. In this article, we propose to present a realistic, balanced assessment of precisely what the information superhighway is, what it will do, and how it will develop – or, more accurately, how it will *continue* to develop. Those taking a cynical view of the information superhighway miss one critical fact: much of the highway is not a future development – it's here and now.

The Highway Today

For years now we've been living on the information superhighway, using it, and taking it for granted. Its key elements include the following:

• *Phone calls at the touch of a button.* Digital, touch-tone, global telephone service, one of the on-ramps to the information superhighway, is now serving more than 90 million households.

• *Live TV.* Instantaneous news from source, together with information and entertainment, are available almost whenever and wherever we want them. Television, an information platform in 98 percent of U.S. households, is a key terminal on the information superhighway. Some 60 million households have cable TV and 100 million VCRs have been sold. Still largely a „one-way street," it's evolving to allow interactivity.

• *Fax machines.* Now ubiquitous in offices, faxes are starting to appear in US homes as the „work-at-home" market (40 million people today) grows at a frenetic pace. The number of business establishments offering „fax your order" services grows daily.

• *Cellular phones.* There are 16 million users in the U.S. today, and the market is growing at 40 percent annually, providing communications anytime, anywhere.

• *Answering machines and voice mail services.* Now almost ubiquitous, these have become indispensable vehicles for transporting and delivering messages independent of people's schedules or locations.

• *PCs*. Over 70 million people use PCs or are „PC-literate," and they are ready for new interactive services.

The information superhighway is not so much a single entity, or a package of products and services, as a metaphor for an evolving vision of the future of communications, information, and entertainment. At Arthur D. Little, we have worked with several large players in this area, and together we are converging on a shared definition of the information superhighway:

The information superhighway is a seamless set of competing, interconnecting, high-speed networks, delivering omnipresent interactive data, text, sound, voice, video, and motion services, accessible to all providers and consumers.

Certain words in this definition represent hallmark attributes of the information superhighway:

• **Seamless.** Multiple broadband networks will be seamlessly interconnected. Thus, the highway is not just one highway or thoroughfare but a set of multiple highways joined together – eventually – so as to appear seamless to the user navigating its lanes.

• **Competing.** The highway will not have just one megaprovider. There are – and will be – multiple competing networks, large and small, local, regional, national, and global.

• **High-speed.** These will be high-capacity, reliable, intelligent networks that store, switch, address, and deliver services with minimal provider and user intervention.

• **Omnipresent.** The highway will be everywhere, with information in multiple media forms, accessible via multiple service access systems and delivery platforms, unrestricted by time and place.

• **Interactive.** Not everything needs to be interactive, and not everyone wants interactivity. But some applications, including real-time conversation, need to be interactive. For example, today's video game enthusiasts in the 8-16 age group won't sit still in front of a one-way, non-interactive media device. They want to control the entertainment and be part of its plot and ultimate outcome. Multiplayer, interactive, networked video games are a small, incremental step in the inevitable evolution of products for this generation. So the highway needs to be visually arresting and offer easy-to-use interactivity for new multimedia applications.

• **Data, text, sound, voice, video, and motion.**

The highway will accept and handle multimedia messages, offering intelligent and flexible any-to-any media

conversion and delivery to the final user's access platform in the user's preferred media.

• **Accessible to all.** Universal addressing, transparent to the sender, enabling the network to reach any and all final users anywhere at all times is another hallmark attribute.

To fulfill this definition, the information superhighway must offer at least three critical elements: *connectivity* (the pieces must fit together); *competitive services* (it must be an open architecture with open access for providers of services); and *accessibility* (it must have a variety of access paths for both sophisticated and unsophisticated users).

While we cannot say that all the elements of the information superhighway are in place, or that the vision articulated in the statement above is close to full realization, we can say that the information superhighway exists today. Just like the interstate highway system, it's in use, but it's also under construction – continually. In this sense, the information superhighway will never be completed, because it is and will be an evolving vision.

Where the Highway is Heading

The direction and scope of the information superhighway will be determined by two key dimensions:

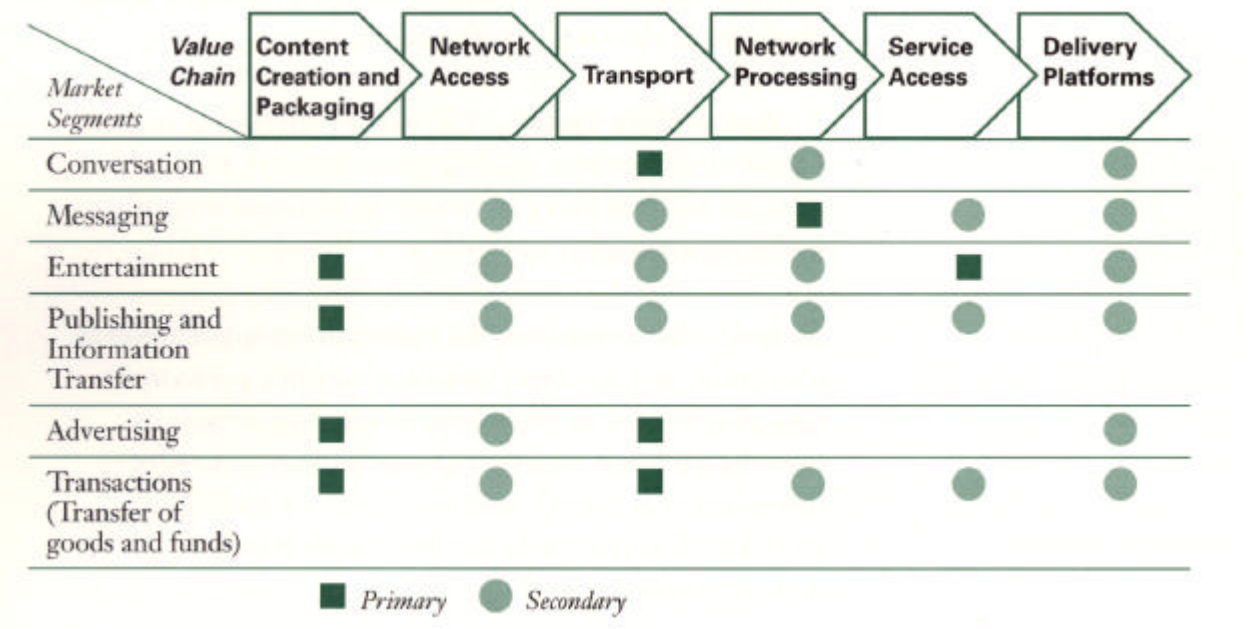
• Categories of products and services that will ride on it

• Elements of the „value chain" by which various players and competitors do and will provide products and services

These two dimensions are arrayed in Exhibit 1. Clearly, several key elements exist today. With the continued development of the information superhighway, as technology is developed and as various regulatory and other barriers fall, these elements will take place better, faster, and with more mobility, more choice, more variety, more players, and more interactivity.

Exhibit 1

The Information Superhighway Value Chain and Market Segments



So I believe that the information superhighway does not need to be built per se or even designed. Given the variety of players, the complexity of the value chain (which varies with different applications), and the diversity of service and product offerings, orchestrating such an activity would be akin to trying to herd cats. There are multiple competing visions for each of the components. And although (as in the animal kingdom) there is a generally understood evolutionary path, there are (as in the animal kingdom) a few „missing links." And there are likely to be more than a few surprises or „genetic mutations" that will confound even the best predictions.

That said, the information superhighway is not complete. Much remains to be done to provide the anticipated integration, connectivity, and access. The competitive services piece seems to be developing nicely on its own. Some services will make it, and others will fail, as dictated by the marketplace.

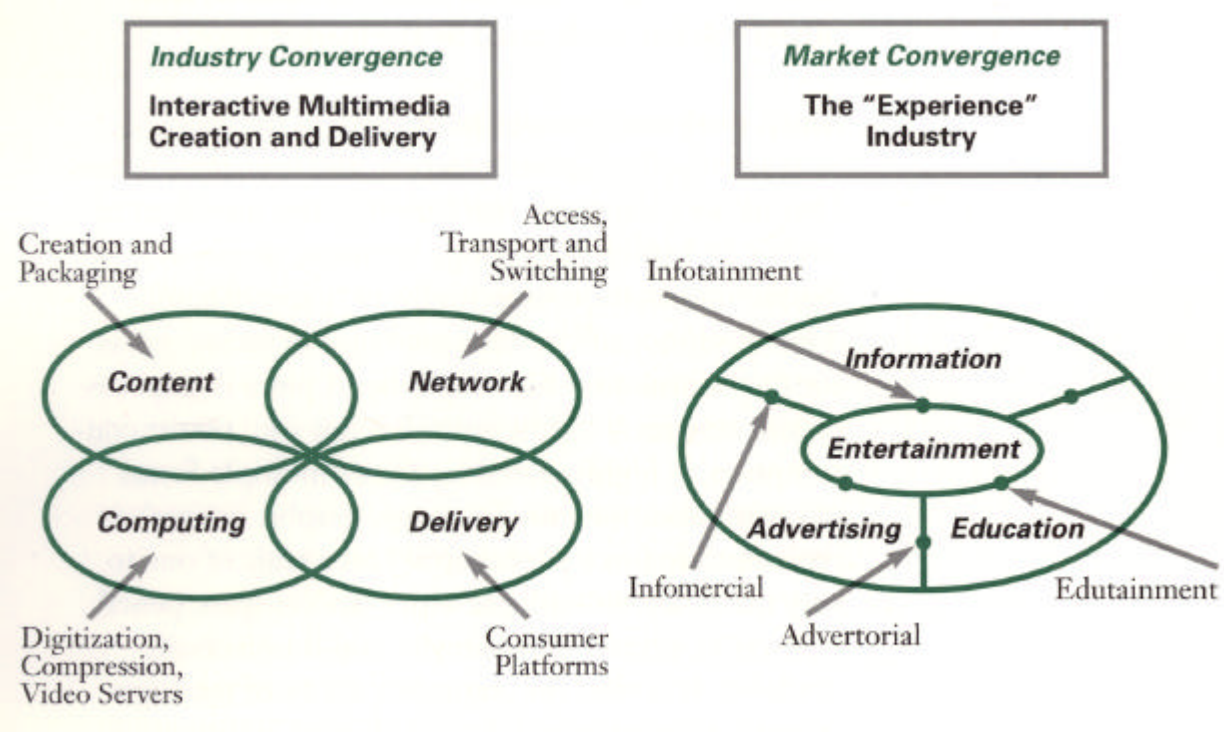
Much work also remains to be done in the areas of interactivity, the human interface, and user-friendliness. One of my colleagues, Stu Lipoff, a vice president in Arthur D. Little's technology business, speaks of making the information superhighway „paper-friendly." This metaphor offers some guidance in setting goals for the information superhighway. A piece of paper is cheap, extremely lightweight, has low (no) power consumption, is highly portable, allows multiple forms of communication (any language, graphic images), is reproducible (on a photocopier) on a scale of one to very many, allows multiple input devices (pen, pencil, typewriter, printer, paintbrush), and is universally available. It is used for communications of messages (letters), transactions (bills and checks), information (books, magazines, reports), advertising, and other purposes. Messages on the information superhighway should offer similar convenience.

In the area of convergence, much of the literature describes a convergence of *providers in* four key areas: content creation and packaging, communications networks, computing and software, and delivery platforms. These are certainly critically important. But equally important is the convergence of *information, advertising, entertainment,* and *education* – what users see and use. These two forms of convergence are highlighted in Exhibit 2.

Furthermore, products riding the information superhighway, as defined earlier, will be delivered on multiple delivery platforms. Those who focus narrowly on one delivery platform – the TV set – risk missing the boat. The information superhighway is truly multimedia – all media, anytime, anywhere, in any form, on any platform. AT&T, for example, has one working definition of its role in broadband network services as the leader and major provider of services in the future „multimedia hosting industry."

Exhibit 2

Two Forms of Convergence



Will Access Equipment Costs Be a Constraint?

I consider it shortsighted to predict that major elements of the information superhighway will fail to materialize because of certain cost elements. For example, if we were to limit ourselves to today's definition of what makes up the various information superhighway networks, we might assume that today's high prices for components in an intelligent two-way set-top converter (those clunky-looking black boxes that sit on TV sets to descramble incoming cable TV signals) will prevent the development of intelligent, interactive video services.

However, the „intelligent" converters that will replace these boxes are likely to have at their core the equivalent of an Intel 80386 chip as the „brains" of the device. In fact, the needed intelligence could all be built into a single chip-set. In that case, the box would be necessary only for the installed base and irrelevant for future intelligent

TV sets.

So, we might ask, what do these 80386 chips cost? When Intel introduced this chip around 1986, it cost more than $1,000. Today, an 80386 can be bought for about $25. Given Intel's strategy of systematically reducing prices on its older chips at the rate of 30 percent annually, the very intelligent box on top of (or within) the TV set will be anything but expensive, and similar trends can be shown for memory storage which will be required for the massive video servers needed for video on demand. Equally important is the cost of the network infrastructure. As will be shown later, network infrastructure costs will only slightly exceed major players' current and planned levels of spending.

What Do Users Want?

One way to determine what the information superhighway is likely to do is by asking what consumers want it to do. Arthur D. Little recently completed a study of multimedia and the information superhighway, from which we gained some significant insights into the market.

We asked adult consumers from more than 1,000 randomly selected U.S. households various questions about the information superhighway. We first described to them in simple terms some information superhighway concepts, such as electronic video libraries (to deliver video on demand) with movies available at certain price points and on certain movie release schedules; electronic catalog shopping; interactive video games; electronic news, information, and educational services; and video telephony. We then asked them for their thoughts about these services, the kinds of devices through which they would like to access these services, and the providers from which they might buy these services. While some of the results may have been predictable, others were surprising. Exhibit 3 summarizes a portion of the survey.

While one should never bet on what consumers say they will do – they are terribly fickle – the survey does give us some directional indicators that allow us to draw some tentative conclusions:

• Large numbers of consumers will buy the emerging applications that are finding their way onto the information superhighway.

• Consumers (as always) want choice – particularly in the source of their purchases. Even if companies provide high-quality services at a reasonable price, consumers basically don't trust monopolies. (Ellis' law says that given a choice, at least 10 percent of any market will go to a competitor no matter what.)

• Consumers want to be entertained more than they want to learn. This is not surprising. People have always been willing to pay more for their wants than for their needs. Perhaps this explains why 98 percent of U.S. households have television sets, but only 93 percent have telephones.

• Consumers place significant value on convenience and simplicity. This explains the relative attractiveness of a TV and remote control as the access platform for the information superhighway, versus a PC.

• Consumers are attracted to powerful brand images linked to high-quality products.

Who Will Pay for the Information Superhighway?

Much has been written about the enormous costs (in the billions of dollars) of building the information superhighway. However, most estimates fail to take into account the hundreds of billions of dollars that have already been spent or the ongoing spending plans of the major players. The latter are a key indicator of how the information superhighway will be paid for. We can look at what the key players have been doing for years and ask, „Are they likely to continue?" There is no evidence that capital spending rates will decline. In fact, there is every evidence that they will increase, while the cost of equipment and infrastructure will continue to decline significantly.

Furthermore, the failure of deals such as the TCI/Bell Atlantic merger and the Southwestern Bell/Cox deal has little to do with who will pay for the information superhighway network, for several reasons. First, the highway is already under construction. Much of the information superhighway has already been built, and the pieces that haven't are well under development. The combined fiber optic networks of AT&T, MCI, Sprint, and other long distance carriers have created a 2.5 million fiber-mile network covering the entire country. This network is linked to trans-Atlantic and trans Pacific fiber optic cables and satellite networks to cover the whole world. At the local end, local telephone companies have also been laying copious quantities of fiber. Today, they have about 120 yards of fiber deployed for every subscriber, and cable TV companies have about 25 fiber yards deployed per subscriber.

Exhibit 3

Consumer Information Superhighway Survey

Questions	Response rate	Measurement
Likelihood of subscribing to an electronic home movie library (same price as video store rental)	47%	of respondents*
Average number of movies likely to select for viewing	4.1	movies per month
Effect on rental of movies from video stores	55%	of the 47% would significantly replace
Likelihood of buying products through electronic catalog service (same prices as in printed catalogs)	26%	of respondents*
Effects on purchases from printed catalogs	28%	of the 2 6% would significantly replace
Likelihood of subscribing to multiplayer video games at $10 per month	19%**	of respondents*
Likelihood of subscribing to an electronic information service at $10 per month	31%	of respondents*
Way consumers would prefer to access the information service	69%	Through TV and a remote control
	21%	Using a PC
	8%	Either
Who consumers would choose as providers of Information Superhighway services	47%	AT&T
	15%	Local telephone company
	14%	Local cable TV company
	7%	Another long distance carrier
	3%	Local electric power company
	1%	Information services company
	1%	Other
	7%	No preference

* Those responding „Definitely“ or „Probably“
** Since the survey was only of adults in households in the US, the 19% „attractiveness“ rate is quite high. Had the survey included the kids who really play these games, the rate would likely be much higher.
Source: Arthur- D. Little

Moreover, about 77 percent of cable TV companies' networks are capable of two-way communications. These networks have required about $150 billion in spending over the past five years.

Along with the fiber optic cable, the needed switching electronics are also deployed throughout the networks. Fiber optics and digital switching offer such significant productivity gains, cost reductions, and low maintenance

requirements, that companies can meet information superhighway expenditure requirements simply by pursuing or expanding only slightly their ongoing capital spending. The telephone industry has already reached the stage where, for new construction, it's already more economical to deploy fiber optic cable than copper. According to their existing construction plans, the local telephone companies will continue deploying fiber and will reach about 250 fiber yards per subscriber over the next 3 years.

The cost of more-expensive switching equipment is no more an obstacle for the industry players in the information superhighway than it has ever been. The telephone companies have ongoing plans to enhance the network by introducing high-capacity voice, data, and video (ATM or asynchronous transfer mode) switching and then lightwave switching. Their actual spending on the network has historically exceeded the plans they file with the FCC. For years, the local telephone companies have been spending $18-$20 billion annually on their network construction. ATM switching is already being deployed both in the long distance networks and by local telephone companies. Furthermore, while initial costs of new products are always high, telecom switching equipment costs today are actually 7 percent less than they were in 1987, and digital central office switch costs have risen only 3 percent over the same period.

All this means that the players in the information industry don't need home shopping, major sports events, or any other single category of information or entertainment services to pay for the network. The network is being built and upgraded for existing services anyway. So any incremental revenue that comes along is simply icing on the cake. The incremental investments for the additional services will be relatively modest.

The same applies to high-cost, high-capacity video servers. These are still under development. Like any new technology, they will be expensive at first, but costs will come down dramatically over time. A video server is little more than a mass memory storage device, a high-speed processor, compression algorithms, a database engine, and some smart software. The costs of all these elements, especially memory storage, have declined dramatically over time. Costs of magnetic media storage devices have declined 35 percent annually, and optical storage costs have declined even more rapidly from about $15 per megabyte in 1985 to about 10 cents per megabyte today – an annual cost reduction of about 40 percent. Mass storage costs are on a track similar to that of integrated circuits; therefore, the cost of video servers should not be a long-term issue.

Furthermore, we have some leading indications that server and switching technology is quite far advanced. In California, Pacific Bell is conducting a test this year of an electronic „cinema of the future" using existing Alcatel video compression technology to digitally compress movies and then transport the video over a network of SONET (synchronous optical network) rings and ATM switches to 10 theaters in Los Angeles and others in Northern California. It is estimated that 60 terabytes of video storage are needed for the 200 movies that will be in distribution at any point. Redundant Arrays of Inexpensive Drives, or RAIDs, would be used for distributed storage. Instead of setting up point-to-point links from studios to movie theaters, using ATM the system will allow movies to be „multicast" on virtual paths to multiple theaters, a process that is expected to greatly simplify network design and dramatically reduce costs. One farther step will integrate such a network with residential video-on-demand (see *Telephony*, March 28, 1994).

Technology is dramatically reducing costs. For both systems and networks, new technologies, such as advanced lightwave switching, can potentially eliminate the need for expensive repeaters and amplifiers, dramatically reducing the cost of equipment and maintenance, which are the most expensive and labor-intensive components of a telephone company's cost structure. So even where capital costs are high, the offsetting major reductions in operating costs will more than pay for the highway. The players in the information superhighway game are not building these networks out of some altruistic desire to benefit mankind, but to create economic value added (EVA). The issue is not capital spending requirements. There is plenty of available capital and no limit to capital spending levels, as long as returns are commensurate.

Customers and carriers can and will spend the billions of dollars required. Customers have spent over $150 billion on communications equipment over the past five years. On the carrier side, in 1993 alone, local telephone companies spent $5 billion on fiber optic equipment and a similar amount on central office switching equipment. Over the past five years, they've spent more than $30 billion. Cellular companies are also spending huge amounts relative to the development of their industry – $2 billion a year on cellular switching equipment alone. Furthermore, many of the major players have huge free cash flows and have also announced large future capital commitments. As long as companies believe there is money to be made out there, they will spend what is needed to enter the market.

Megamergers are unnecessary. Some observers have pointed to the breakdowns in negotiations between would-be behemoth partners in this industry as reflecting badly on the highway's potential. In my view, the development of the information superhighway does not depend on massive mergers such as the one proposed between Bell Atlantic and TCI. That deal is likely to have broken up for a number of reasons that have nothing to do with the information superhighway and everything to do with who would head up the merged entity, how well the two cultures would blend, and the relative stock prices and valuation of the corporate entities. Clearly,

the corporate value of TCI was higher when they were counting on subscribers spending $25-$30 per month for cable TV service than it was after the FCC's mandate of a 17 percent reduction in cable TV rates. And in fact, long before the FCC took action, Bell Atlantic and TCI had been announcing delays in coming to a definitive agreement. The FCC announcement merely allowed the parties to back out of a deal that was falling apart anyway. Because the information superhighway is so much more than just the combining of cable TV service and telephony, merger deals will neither make nor break it.

Some players have additional incentives to participate in the highway. Today, the long distance companies pay about 40 percent of their revenues to the local telephone companies in the form of access charges. If they had an alternative way of connecting their long distance services to the end customer (either directly or through an alternative access provider, such as a cable TV company), they could negotiate lower access rates. With more than $24 billion of annual access charges at stake, there is a lot of incentive for the long distance companies to build new on-ramps and off-ramps to the information superhighway.

Local telephone companies that are already deploying fiber optic networks anticipate incremental revenue streams from carrying entertainment video services at much lower incremental costs than someone who was building a single-purpose network from scratch could offer. Similarly, the cable TV companies see telephony as incremental revenues. However, it's primarily access charges and possible wireless personal communications services (PCS) that the cable TV companies have their eyes on as alternative access providers – not local residential service revenues of local telephone companies, which in most areas of the country are provided either at or below cost.

The Role of the Federal Government

The private sector is not asking for and does not expect the government to fund the information superhighway. The industry is already pouring billions of dollars into the information superhighway – for both plain, old-fashioned services and new, advanced services. The top 50 telecommunications equipment vendors in the world sold $110 billion worth of equipment in 1992 alone (source: Decision Resources, December 1993). So when the U.S. government talks about providing $5 billion over four years as seed money, it's a drop in the ocean. That level of spending gets „lost in the rounding" on the income statements of the large players in the industry. These companies are also spending 11 – 14 percent of their revenues annually on R&D to develop next-generation products and networks. In the United States, at least, the required developments will come about and the capital will be available with or without government funding. (This might not be the case in other countries where penetration of telecommunications – and service levels – are much lower than in the United States). Also, U.S. telephone companies are willing to spend money to provide advanced services to schools, traditionally a government responsibility, so they can raise a generation of network-literate, information superhighway addicts who will use and pay for highway services when they grow up. As a result, in the United States there is no legitimate case to be made for public sector financing of the information superhighway.

On the other hand, the government can play an important role in removing barriers to competition and in enabling U.S. companies to sustain global leadership in these areas. Barriers need to be removed to let telephone companies and cable TV companies compete directly in each others' territories; to expedite the transfer of scarce radio spectrum to the private sector; to remove export constraints; to open local long distance service to full competition; to eliminate the artificial distinction between local calling areas and long distance calling areas; and to allow all players to compete in all areas. The government can also ensure that there is open access to the information superhighway for both service providers and users.

Conclusions

Development of the information superhighway, while occasionally revolutionary (when enabled by new technology, regulation, or competitive realignment), is essentially evolutionary. We notice it only when we look back and compare it with the past. In short, the information superhighway is alive and well. Most people are commuting on it right now. They might not be traveling in the fast lane – which is still under construction – or driving a turbo-charged Lamborghini with climate control, a CD-ROM player, and an automatic navigation system, but they're definitely on the highway and ready to step on the gas.

Peter Ellis leads Arthur D. Little's telecommunications industry consulting practice in North America. He has extensive experience in all areas of business strategy and corporate development. When he's not at work, be spends his time cruising the information superhighway.