How Telecommunications Have Evolved Over Time

5.1 The Emergence of Wearables

How we engage in computing and communications will change dramatically in the next decade. Portable computing devices have changed our notion of what and where a workplace is and emphasized our desire for mobility and wireless communication; they are beginning to redefine the phrase dressed for success. But the portable devices we know today are just a stepping stone on the way to wearables. Context-aware wearable computing will be the ultimate in light, ergonomic, reliable, flexible, and scalable platforms. Products that are available for use in industrial environments today will soon lead to inexpensive, easy-to-use wearables appearing at your neighborhood electronics store:

Xybernaut's Mobile Assistant IV (MA-IV), a wearable computer, provides its wearer with a full-fledged PC that has a 233MHz Pentium chip, 32MB memory, and upward of 3GB storage. A wrist keyboard sports 60 keys. Headgear suspended in front of the eye provides a full-color VGA screen, the size of a postage stamp but so close to the eye that images appear as on a 15-inch monitor. A miniature video camera fits snugly in a shirt pocket. Bell Canada workers use MA-IVs in the field; they replace the need to carry manuals and provide the ability to send images and video back to confer with supervisors. The MA-IV is rather bulky, weighing in at 4.4 pounds (2 kilograms), but the soon-to-be-released MA-V will be the first mass-market version, and it promises to be lightweight.

MIThril is the next-generation wearables research platform currently in development at MIT's Media Lab. It is a functional, operational body-worn computing architecture for context-aware human-computer interaction research and general-purpose wearable computing applications. The MIThril architecture combines a multiprotocol body bus and body network, integrating a range of sensors, interfaces, and computing cores. It is designed to be integrated into everyday clothing, and it is both ergonomic and flexible. It combines small, light-weight RISC processors (including the StrongARM), a single-cable power/data "body bus," and high-bandwidth wireless networking in a package that is nearly as light, comfortable, and unobtrusive as ordinary street clothing.

To be truly useful, wearables will need to be aware of where you are and what you're doing. Armed with this info, they will be able to give you information accordingly.

Bandwidth

A term that you hear often when discussing telecommunications is bandwidth. Bandwidth is a critical commodity. Historically, bandwidth has been very expensive, as it was based on the sharing of limited physical resources, such as twisted-pair copper cables and coax. Bandwidth is largely used today to refer to the capacity of a network or a telecom link, and it is generally measured in bits per second (bps). Bandwidth actually refers to the range of frequencies involved—that is, the difference between the lowest and highest frequencies supported—and the greater the range of frequencies, the greater the bandwidth, and hence the greater the number of bits per second, or information carried.

Moving Toward Pervasive Computing

As we distribute intelligence across a wider range of devices, we are experiencing pervasive computing, also called ubiquitous computing. We are taking computers out of stand-alone boxes to which we are tied and putting them into ordinary things, in everyday objects around us. These new things, because they are smart, have a sense of self-awareness and are able to take care of themselves. When we embed intelligence into a device, we create an interesting new opportunity for business. That device has to have a reason for being, and it has to have a reason to continue evolving so that you will spend more money and time on it. To address this challenge, device manufacturers are beginning to bundle content and applications with their products. The result is smart refrigerators, smart washing machines, smart ovens, smart cabinets, smart furniture, smart beds, smart televisions, smart toothbrushes, and an endless list of other smart devices. (These smart devices are discussed in detail in Chapter 15, "The Broadband Home and HANs.")

Devices are becoming smaller and more powerful all the time, and they're getting physically closer to our bodies, as well. The growing amount of intelligence distributed throughout the network is causing changes in user profiles.

Moving Toward Machine-to-Machine Communications

We are moving away from human-to-human communications to an era of machine-to-machine communications. Today, there are just over 6 billion human beings on the planet, yet the number of microprocessors is reported to be more than 15 billion. Devices have become increasingly intelligent, and one characteristic of an intelligent system is that it can communicate. As the universe of communications-enabled devices grows, so does the traffic volume between them.

As these smart things begin to take on many of the tasks and communications that humans traditionally exchanged, they will change the very fabric of our society. For example, your smart washing machine will initiate a call to the service center to report a problem and schedule resolution with the help of an intelligent Web agent long before you even realize that something is wrong! These developments are predicted to result in the majority of traffic—up to 95% of it—being exchanged between machines, with traditional human-to-human communications representing only 5% of the network traffic by 2010.

Adapting to New Traffic Patterns

Sharing of information can occur in a number of ways—via smoke signals, by letters sent through the postal service, or as transmissions through electrical or optical media, for example. Before we get into the technical details of the technologies in the industry, it's important to understand the driving forces behind computing and communications. You need to understand the impact these forces have on network traffic and therefore on network infrastructure. In today's environment, telecommunications embodies four main traffic types, each of which has different requirements in terms of network capacity, tolerance for delays—and particularly variations in the delay—in the network, and tolerance for potential congestion and therefore losses in the network:

Voice—Voice traffic has been strong in the developed world for years, and more subscriber lines are being deployed all the time. However, some three billion people in the world haven't even used a basic telephone yet, so there is yet a huge market to be served. Voice communications are typically referred to as being narrowband, meaning that they don't require a large amount of network capacity. For voice services to be intelligible and easy to use, delays must be kept to a minimum, however, so the delay factors in moving information from Point A to Point B have to be tightly controlled in order to support real-time voice streams. (Concepts such as delay, latency, and error control are discussed in Chapter 6, "Data Communications Basics.")

Data—Data communications refers to the exchange of digitized information between two machines. Depending on the application supported, the bandwidth or capacity requirements can range from medium to high. As more objects that are visual in nature (such as images and video) are included with the data, that capacity demand increases. Depending again on the type of application, data may be more or less tolerant of delays. Text-based exchanges are generally quite tolerant of delays. But again, the more real-time nature there is to the information type, as in video, the tighter the control you need over the latencies. Data traffic is growing much faster than voice traffic; it has grown at an average rate of about 30% to 40% per year for the past decade. To accommodate data communication, network services have been developed to address the need for greater capacity, cleaner transmission facilities, and smarter network management tools. Data encompasses many different information types. In the past, we saw these different types as being separate entities (for example, video and voice in a videoconference), but in the future, we must be careful not to separate things this way because, after all, in the digital age, all data is represented as ones and zeros.

Image—Image communications requires medium to high bandwidth—the greater the resolution required, the greater the bandwidth required. For example, many of the images taken in medical diagnostics require very high resolution. Image traffic tolerates some delay because it includes no motion artifacts that would be affected by any distortions in the network.

Video—Video communications, which are becoming increasingly popular and are requiring ever-greater bandwidth, are extremely sensitive to delay. The future is about visual communications. We need to figure out how to make video available over a network infrastructure that can support it and at a price point that consumers are willing to pay. When our infrastructures are capable of supporting the capacities and the delay limitations required by real-time applications, video will grow by leaps and bounds.

All this new voice, data, and video traffic means that there is growth in backbone traffic levels as well. This is discussed further later in the chapter, in the section "Increasing Backbone Bandwidth."

The telecommunications revolution has spawned great growth in the amount and types of traffic, and we'll see even more types of traffic as we begin to incorporate human senses as part of the network. The coming chapters talk in detail about what a network needs in order to handle the various traffic types.

Handling New Types of Applications

The new traffic patterns imply that the network will also be host to a new set of applications—not just simple voice or text-based data, but to new genres of applications that combine the various media types.

The ability to handle digital entertainment applications in a network is crucial. In some parts of the world, such as Asia, education may have primary focus, and that should tell us where we can expect greater success going forward. But throughout much of the world, entertainment is where people are willing to spend the limited numbers of dollars that they have to spend on electronic goods and services. The digital entertainment realm will include video editing, digital content creation, digital imaging, 3D gaming, and virtual reality applications, and all these will drive the evolution of the network. It's the chicken and the egg story: What comes first, the network or the applications? Why would you want a fiber-optic broadband connection if there's nothing good to draw over that connection? Why would you want to create a 3D virtual reality application when there's no way to distribute it? The bottom line is that the applications and the infrastructures have to evolve hand-in-hand to manifest the benefits and the dollars we associate with their future.

Another form of application that will be increasingly important is in the realm of streaming media. A great focus is put on the real-time delivery of information, as in entertainment, education, training, customer presentations, IPO trade shows, and telemedicine consultations.

E-commerce (electronic commerce) and m-commerce (mobile commerce) introduce several new requirements for content management, transaction platforms, and privacy and security tools, so they affect the types of information that have to be encoded into the basic data stream and how the network deals with knowledge of what's contained within those packets.

Many of the changes discussed so far, but primarily the changes in traffic patterns and applications, will require immense amounts of backbone bandwidth.

In addition, advances in broadband access technologies will drive a demand for additional capacity in network backbones. Once 100Gbps broadband residential access becomes available—and there are developments on the horizon—the core networks will require capacities measured in exabits per second (that is, 1 billion Gbps). These backbone bandwidth demands make the revolutionary forces of optical networking critical to our future.

Responding to Political and Regulatory Forces

New developments always bring with them politics. Different groups vie for money, power, the ability to bring new products to market first and alone, and the right to squash others' new ideas. A prominent characteristic of the telecommunications sector is the extent to which it is influenced by government policy and regulation. The forces these exert on the sector are inextricably tied to technological and market forces.

Because of the pervasive nature of information and communication technologies and the services that derive from them, coupled with the large prizes to be won, the telecommunications sector is subjected to a lot of attention from policymakers. Particularly over the past 20 years or so, telecommunications policy and regulation have been prominent on the agendas of governments around the world. This reflects the global trend toward liberalization, including, in many countries, privatization of the former monopoly telcos. However, interest from policymakers in telecommunications goes much deeper than this. A great deal of this interest stems from the extended reach and wide impact that information and communication technologies have. Here are some examples:

Telephony, e-mail, and information services permit contact between friends and families and offer convenience to people in running their day-to-day lives. Thus, they have major economic and social implications.

In the business arena, information and communication technologies offer business efficiency and enable the creation of new business activities. Thus, they have major employment and economic implications.

Multimedia and the Internet offer new audio, video, and data services that affect entertainment and education, among other areas. These new services are overlapping with traditional radio and television broadcasting, and major cultural implications are appearing.

News delivery influences peoples' perceptions of governments and their own well-being, thereby influencing voter attitudes. Telecommunications brings attention to cultural trends. Therefore, telecommunications has major political as well as cultural implications.

Government applications of information and communication technologies affect the efficiency of government. Defense, national security, and crime-fighting applications are bringing with them major political implications.

Given this background of the pervasive impact that information and communication technologies have, it is hardly surprising they get heavy policy attention.

Regulatory Background

Although many national regulatory authorities today are separate from central government, they are, nevertheless, built on foundations of government policy. Indeed, the very act of creating an independent regulatory body is a key policy decision. Historically, before telecommunications privatization and liberalization came to the fore, regulation was often carried out within central government, which also controlled the state-run telcos. That has changed in recent years in many, but not all, countries.

Given their policy foundation, and the fact that government policies vary from country to country and from time to time, it is not surprising that regulatory environments evolve and differ from country to country. These evolutions and international variations sometimes pose planning problems for the industry, and these problems can lead to frustrations and tensions between companies and regulatory agencies. They can also lead to disagreements between countries (for example, over trade issues). Although moves to encourage international harmonization of regulatory regimes (for example, by the International Telecommunications Union [ITU] and by the European Commission) have been partially successful, differences remain in the ways in which countries interpret laws and recommendations. Moreover, given that regulations need to reflect changing market conditions and changing technological capabilities, it is inevitable that over time regulatory environments will change, too. So regulation is best viewed as another of the variables, such as technological change, that the telecommunications industry needs to take into account.