ABSTRACT

Mobile person-to-person speech communication has turned out to be extremely popular with more than one billion users today. Currently, mobile networks are evolving to support efficient and flexible data communications. This development will also enable an efficient use of multimedia elements in mobile communication. New content types, applications and services are emerging. Multimedia Messaging Service (MMS) is one key element in this development. From the user point of view, it is the continuation of a very popular mobile messaging paradigm and it offers a framework for mobile person-to-person multimedia communication. New mobile phones, with graphical color displays and integrated cameras, will provide a natural platform for a large set of multimedia applications. Including multimedia capabilities for small portable devices is driving the new development on display, imaging and processor technologies. Open software architectures in these terminals are giving new possibilities to the developer community. Evolution of the mobile multimedia will create new challenges and opportunities for related research and development activities.

Multimedia and Communication Networks

The integration of multiple media, e.g., voice, video, image, and data, provides an effective means of communication to the users of various services. Because of the advances in computer and communication technologies, creating sophisticated multimedia user interfaces is no longer limited to special-purpose applications. The popularity of the World Wide Web, where most applications currently utilize images and data, is adequate testimony to this fact. The increasing power of electronic circuitry in workstations, personal computers, and consumer electronics, in conjunction with the decreasing cost of high-bandwidth and low-latency communication, have created a large momentum to develop sophisticated multimedia applications as well as to provide new types of services to businesses and homes. These capabilities involve improving user interfaces to many traditional applications as well as creating futuristic applications such as virtual environments and augmented reality (Hodge, Mabon,Powers, 1993). The basic idea behind the latter types of applications is to immerse a user in an imaginary, computer-generated virtual world or to augment the real world (i.e., via augmentation of human perception by supplying information not ordinarily detectable by human senses) around a user with superimposed computer graphics projected onto the walls or onto a head-mounted display. In another example (referred to as telepresence), a multitude of stationary cameras mounted at a remote environment are used to acquire both photometric and depth information. A virtual environment is then constructed in real time and redisplayed in accordance with the local participant's head position and orientation. This allows local users to interact with other remote individuals (say, with a medical consultant) as if they were actually within the same space.

THE EVOLUTION OF MULTIMEDIA

The evolution of multimedia applications can be traced through three major stages. First, even prior to the deployment of delivery-network infrastructure, stand-alone applications (e.g., video arcade games) and CD-ROMbased applications had successfully integrated multiple media, mostly in the form of games, entertainment, and educational materials.

Next, high expectations of technological breakthroughs to make available lower-cost delivery bandwidth (as needed for sophisticated multimedia applications) created a tremendous excitement in the area of multimedia. The potential for the convergence of multiple services (e.g., TV, movie, and telephone) had stirred up the marketplace. Almost every day, newspaper headlines announced new field trials and potential mergers of corporations. The focus in multimedia shifted to the creation of large-scale video servers and delivery infrastructure that would be capable of delivering thousands of simultaneous high-quality video streams to homes and businesses. However, the economics of the marketplace has run counter to these high expectations. For example, in movie-on-demand applications, the cost of storage of a large video library and the cost of delivery bandwidth for a two-hour video per customer were found to be prohibitively expensive in comparison with traditional movie rentals. In addition, the infrastructure for delivering high-quality video was mostly unavailable, particularly to the home. This issue is referred to as the last-mile bandwidth problem. Compounding this problem, most available multimedia contents were created as movies. Video-on-demand applications lacked the depth of content (complexity of presentation) and provided only limited interactivity (e.g., VCR control operations) as compared to Web-based applications. New forms of content have to be created to provide marketable services to users (e.g., distance learning, travel, advertisement, electronic commerce). Furthermore, sophisticated tools must be available for easy creation of such multimedia contents.

The popularity of the Web, which can use very lowbandwidth networks in the last mile, and the lack of deployment of large-scale video servers have laid the groundwork for the current stage of multimedia. Applications using high-bandwidth multimedia streams will be deployed in enterprise (high-bandwidth-network) environments and more slowly (as higher-bandwidth infrastructure is deployed) for residential consumers. Such services will likely follow the near-video-on-demand (NVOD) model (Sincoskie, 1991) in which a large number of clients can share a set of broadcast channels, rather than the videoon-demand (VOD) model, which requires an individual stream per client. For example, the Digital Satellite System (DSS) broadcasts (via satellite) a large number of entertainment streams to its paid subscribers. In time, these services will evolve to include NVOD-like features; e.g., VCR control features will be provided by the mechanism of copying a broadcast stream to the local disk of a client or of switching to a different broadcast channel with later playback of the same material. (Of course, any local copying must take into account the protection of intellectual property rights.)

The primary focus of current research activities, however, is on the creation of multimedia content that can be delivered inexpensively by means of the existing lowbandwidth networking infrastructure as well as on the development of platform-independent applications that can adapt to heterogeneity in environments arising from the differences in capabilities of system components and end-user devices. The new forms of content fall into two categories: low-bandwidth, real-time conferencing, and delivery of composite multimedia documents consisting of images, text, and possibly short audio and video clips. The quality of the presentation will change (i.e., dynamically adapt) with the availability of delivery bandwidth.

The business and research focus has shifted from just video or audio quality to information delivery. Video-conferencing applications, for example, are replacing special videoconferencing rooms (which have high operational cost) used in many business environments, and bringing the desired functionality to the desks.

USES AND APPLICATIONS OF MULTIMEDIA

Video on demand

Video on demand (VOD), also called movies on demand, is a service that provides movies on an individual basis to television sets in people's homes. The movies are stored in a central server and transmitted through a communication network. A set-top box (STB) connected to the communication network converts the digital information to analog and inputs it to the TV set. The viewer uses a remote control device to select a movie and manipulate play through start, stop, rewind, and visual fast forward buttons. The capabilities are very similar to renting a video at a store and playing it on a VCR. The service can provide indices to the movies by title, genre, actors, and director. VOD differs from pay per view by providing any of the service's movies at any time, instead of requiring that all purchasers of a movie watch its broadcast at the same time. Enhanced pay per view, also a broadcast system, shows the same movie at a number of staggered starting times.

Home shopping and information systems

Services to the home that provide video on demand will also provide other, more interactive, home services. Many kinds of goods and services can be sold this way. The services will help the user navigate through the available material to plan vacations, renew driver's licenses, purchase goods, etc.

Networked games

The same infrastructure that supports home shopping could be used to temporarily download video games with graphic-intensive functionality to the STB, and the games could then be played for a given period of time. Groups of people could play a game together, competing as individuals or working together in teams. Action games would require a very fast, or low-latency, network.

Video conferencing

Currently, most video conferencing is done between two specially set-up rooms. In each room, one or more cameras are used, and the images are displayed on one or more monitors. Text, images, and motion video are compressed and sent through telephone lines. Recently, the technology has been expanded to allow more than two sites to participate. Video conferences can also be connected through LANs or the Internet (Bisdikian, Brady, Doganata, Foulger, . Marconcini, Mourad, Operowsky, Pacifici, and Tantawi, 1998). In time, video conferences will be possible from the home.

Education

A wide range of individual educational software employing multimedia is available on CD-ROM. One of the chief advantages of such multimedia applications is that the sequence of material presented is dependent upon the student's responses and requests. Multimedia is also used in the classroom to enhance the educational experience and augment the teacher's work. Multimedia for education has begun to employ servers and networks to provide for larger quantities of information and the ability to change it frequently.

Distance learning

Distance learning is a variation on education in which not all of the students are in the same place during a class. Education takes place through a combination of stored multimedia presentations, live teaching, and participation by the students. Distance learning involves aspects of both teaching with multimedia and video conferencing.

Just-in-time training

Another variation on education, called just-in-time training, is much more effective because it is done right when it is needed. In an industry context, this means that workers can receive training on PCs at their own workplaces at the time of need or of their choosing. This generally implies storing the material on a server and playing it through a wide-area network or LAN.

Digital libraries

Digital libraries are a logical extension of conventional libraries, which house books, pictures, tapes, etc. Material in digital form can be less expensive to store, easier to distribute, and quicker to find. Thus digital technology can save money and provide better capabilities. The Vatican Library (F. C. Mintzer, L. E. Boyle, A. N. Cazes, B. S. Christian, S. C. Cox, F. P. Giordano, H. M. Gladney, J. C. Lee, M. L. Kelmanson, A. C. Lirani, K. A. Magerlein, A. M. B. Pavani, and F. Schiattarella, 1996) has an extraordinary collection of 150 000 manuscripts, including early copies of works by Aristotle, Dante, Euclid, Homer, and Virgil. However, only about 2000 scholars a year are able to physically visit the library in Rome. Thus, the IBM Vatican Library Project, which makes digitized copies of some of the collection available to scholars around the world, is a very valuable service, especially if the copies distributed are of high quality.

Virtual reality

Virtual reality (. Singh, S. Feiner, and D. Thalmann, 1996) provides a very realistic effect through sight and sound, while allowing the user to interact with the virtual world. Because of the ability of the user to interact with the process, realistic visual effects must be created "on the fly."

Telemedicine

Multimedia and telemedicine (V. Pebsworth Debold, E. Johnson, A. Cameron, and D. Chuang, 1991) can improve the delivery of health care in a number of ways. Digital information can be centrally stored, yet simultaneously available at many locations. Physicians can consult with one another using video conference capabilities, where all can see the data and images, thus bringing together experts from a number of places in order to provide better care. Multimedia can also provide targeted education and support for the patient and family.

MULTIMEDIA OVER WIRELESS INTERNET

Mobile Internet and Third Generation (3G) wireless multimedia applications and services promise a future world of universal wireless phones, global roaming and wireless Internet access. However, the widely used transport protocols in today's Internet do not fit well in wireless networks. This is mainly due to the special characteristics of wireless networks. Wireless networks usually have a bit error rate (BER) much higher than that of wired networks. The bit error rate in a wired link is normally less than 10^{-12}, while in wireless link it often varies from 10^{-5} to 10^{-3}. (Fan Yang[1], Qian Zhang, Wenwu Zhu, and Ya-Qin Zhang) Moreover, wireless communication may confront with "fading". Packets transmitted to a mobile that is in a fading period will be lost.

The unreliability in wireless links results in low performances of traditional transport-layer protocols such as UDP and TCP. TCP protocol assumes congestion in the network to be the primary cause for packet losses and unusual delay. It will halve the transmitting rate while meet the packet lost. Unfortunately, packets are lost in wireless channel for error rather than congestion; thereby resulting in an unnecessary reduction in end-to-end throughput; Both the high BER and frequently occurred fading make packet loss ratio very high during a UDP connection. Many works have been made to overcome the drawbacks of transport protocols over wireless networks. Some split schemes use local retransmissions at the base station that shield the random errors over wireless link during a TCP connection. Some statistical methods (Vaidya, Samaraweera, 1999) are deployed to discriminate packet losses due to congestion from random errors thus makes current TCP congestion control mechanisms still perform well over wireless Internet. As for UDP, UDP-Lite (Larzon, Degermark, Pink, 1999) tries to bypass the checksum policy for some parts of a packet (e.g., payload of a packet) in order to decrease the packet lost ratio. This technique is called partial checksum. It leaves the task of correctness checking for the upper level applications. To deal with the fading problem, M-UDP (Brown and Singh, 1996) develops a mechanism for re-transmitting the lost packets after the fading ends. All these works had seldom addressed the following aspects: How to make a congestion control for an unreliable transport protocol over wireless Internet; Reporting the information of random errors to upper level applications so that they could adjust their error control mechanism.

MULTIMEDIA OVER WIRELESS CONNECTION

The potential of mobile and wireless communications to stimulate growth and re-vitalise economic sectors is far from being exhausted. We are now entering into a second phase of growth in the mobile and wireless communications sector as applications and services are incorporated into business processes and all aspects of daily life. The importance of the sector to economic development is also appreciated in Asia and in the US, where large scale investments in mobile and wireless technologies are part of their strategic priorities.

Further investment in advanced applications based on new technologies is now required in order to ensure that the European economy reaps the maximum benefit from the productivity increase and improvement in the quality of life that mobile and wireless communications technologies offer.

The following sentence articulates the essence of the future aims and vision: "The improvement of the individual's quality of life, achieved through the availability of an environment for instant provision and access to meaningful, multi-sensory information and content". Realisation of this vision demands a major shift from the current concept of "anywhere, anytime" to a new paradigm of "any network, any device, with relevant content and context in a secure and trustworthy manner".

The future system will be complex, consisting of a multitude of service and network types ranging across Wireless Sensor Networks (WSN), Personal Area, Local Area, Home Networks, Moving Networks to Wide Area Networks. The increasing dependency of society on such communication infrastructure requires new approaches.

Key outstanding issues

- **Technical:**

  Mobile and wireless communications requires end-to-end compatible solutions encompassing not only a range of constituent technical solutions, but also a consistent context for their use as part of the communication grid, the services and the applications. This implies a systematic collaboration of all sector actors within a consistent framework and a shared vision.

- **Economic:**

  Economics will play a key role in this collaboration. A return on the massive investments and long lead-times depend on economy of scale and on a large home market. The need for inter-working implies concentration on the most attractive options, and the need to master technology requires an optimal use of human resources and research facilities, finance and time.

- **Political**

  Mobile and wireless communications have created unprecedented possibilities for people to communicate and the sector has been a key driver of economic growth.

Here is a study made by *Fan Yang[1], Qian Zhang, Wenwu Zhu, and Ya-Qin Zhang* with regards to scheme for multimedia delivery over wireless Internet:

An End-to-End Architecture for Multimedia Delivery over Wireless Internet

To transmit multimedia over wireless Internet, high bit error rate and fading problem will confront over wireless links. In addition, packets loss may occur in the wired network. To efficiently deliver multimedia, the upper applications should be aware of the network conditions. In the meanwhile, appropriate error/fading control and congestion control should be taken.

A scheme for multimedia delivery over wireless Internet is proposed in this paper. Packet losses caused by congestion or by random errors can be discriminated, thus the congestion control and error control can be performed respectively. Network conditions include packet loss ratio and bit error rate (BER) / block error rate (BLER) are reported to multimedia application so that they can adjust their behavior. Retransmission mechanism is incorporated in our scheme to reduce the errors in a packet and the packet losses due to fading.

To distinguish the packet losses caused by different reasons, an intermediate node (gateway) at the edge between wired network and wireless link is introduced in our scheme. Application-level error control and congestion control are performed on the sender side based on the feedbacks from the gateway and the mobile host. Wired network and wireless link are treated differently in this scheme, thus requiring an agent running at the intermediate node interacts with the two ends respectively. Considering the delay constraint, packet retransmissions are only performed between the gateway and mobile host. During a connection, the fixed host (server) sends data to the mobile host via a gateway. The gateway buffers the data first, and then relays them to the mobile host (client). The mobile host calculates the BER/BLER and informs the server periodically. While a corrupted packet is received, the mobile host would send a negative acknowledgement (NACK) to the gateway if its delay constraint can be satisfied. On receiving this negative acknowledgement, the gateway retransmits the corresponding packet if it is still in the buffer. The gateway also monitors the wired network conditions, and sends the congestion information back to the sender at a regular interval. The TCP-friendly transport protocol we proposed [8] is adopted in the wired network part for the purpose of congestion control. Three agents are running at the server (fixed host), the client (mobile host), and the gateway, respectively.

MULTIMEDIA TECHNOLOGY (Dan, A, Feldman, S I, Serpanos, D N, 1998***)***

A wide variety of technologies contribute to multimedia. Some of the technologies are going through rapid improvement and deployment because of demand for PCs and workstations. As a result, multimedia benefits from lower-cost, better-performance microprocessors, memory chips, and disk storage. Other technologies are being developed specifically for multimedia systems. We present here the major technologies relevant to multimedia.

MPEG

The Moving Picture Expert Group has sponsored the creation of video compression standards ISO/IEC 11171, called MPEG-1, and ISO/IEC 13818, called MPEG-2. MPEG [13, 14] is now the predominant high-quality video standard. MPEG "tiles" each video frame into a matrix of separate macro blocks, each of which is treated in the same way. MPEG defines three kinds of frames. "Iframes," or intrapicture frames, contain base data and are independent of all other frames. The periodic occurrence of I-frames allows initialization after a loss of data. "Pframes," or predicted frames, are constructed as differences in the data values from those represented by the prior Pframe or I-frame. "B-frames," or bidirectional prediction frames, are constructed from macro blocks from either the prior P- or I-frame or the next P- or I-frame. This allows for good compression of B-frames despite great changes in the visual content. In order for the data to be decompressed, the frames must be presented to the decoder somewhat out of time order. P-frames are advanced in the stream so that B-frames always follow the P- and I-frames that they depend upon. MPEG also has the ability to consider either motion in the visual field or the panning of the camera. Motion vectors allow the specification of the displacement of macro blocks from one frame to the next. VCR-quality MPEG video can be achieved with a data or transmission rate of 1.5 million bits per second (Mb/s). Higher quality, more comparable to broadcast or cable TV, is in the range of 3 to 6 Mb/s.

Video servers

The role of a multimedia server is to store and deliver multimedia objects, which implies having a mapping from the name of an object to the locations where it is stored. Rotating magnetic disk storage is the preferred medium for storing multimedia objects, with solid-state memory used for buffering.

Multimedia servers are based on computer file servers and will benefit from the research being done to improve the performance and reduce the cost of storage, memory, and microprocessors. Research to specifically reduce the cost of storing and playing back video files is important. Research is also appropriate to achieve the unique requirement of isochronous delivery of audio and video files because it is a requirement not found in other computer servers.

Video file systems

Video file systems, which incorporate disk layout, disk scheduling, and service guarantees, are either modified traditional file systems or file systems specially designed for video. Some of the functions, like disk scheduling, are traditionally done by the operating system and not the file system. One of the tensions in video file system design is the desire to be independent of device characteristics, for the sake of serviceability and extendibility, yet to create algorithms that take advantage of device characteristics for the sake of throughput and service.

Storage hierarchy

In classical computer architecture, a small amount of high-speed, high-cost storage is used to store the most frequently referenced data. This provides average dataaccess time only slightly greater than that of the highspeed storage at an average cost just above the cost of the low-speed storage. In large video servers, it may be economical to store some material in high-cost solid-state storage, other material on disk, and low-frequency material on an archival device

Networks

Telephone networks dedicate a set of resources that forms a complete path from end to end for the duration of the telephone connection. The dedicated path guarantees that the voice data can be delivered from one end to the other end in a smooth and timely way, but the resources remain dedicated even when there is no talking. In contrast, digital packet networks, for communication between computers, use time-shared resources (links, switches, and routers) to send packets through the network. The use of shared resources allows computer networks to be used at high utilization, because even small periods of inactivity can be filled with data from a different user. The high utilization and shared resources create a problem with respect to the timely delivery of video and audio over data networks. Current research centers around reserving resources for time-sensitive data, which will make digital data networks more like telephone voice networks.

Internet

The Internet and intranets, which use the TCP protocol suite, are the most important delivery vehicles for multimedia objects. TCP provides communication sessions between applications on hosts, sending streams of bytes for which delivery is always guaranteed by means of acknowledgments and retransmission. User Datagram Protocol (UDP) (Dan, Sitaram, Song, 1996) is a "best-effort" delivery protocol (some messages may be lost) that sends individual messages between hosts. Internet technology is used on single LANs and on connected LANs within an organization, which are sometimes called intranets, and on "backbones" that link different organizations into one single global network. Internet technology allows LANs and backbones of totally different technologies to be joined together into a single, seamless network.

Part of this is achieved through communications processors called routers. Routers can be accessed from two or more networks, passing data back and forth as needed. The routers communicate information on the current network topology among themselves in order to build routing tables within each router. These tables are consulted each time a message arrives, in order to send it to the next appropriate router, eventually resulting in delivery.

ATM

Asynchronous Transfer Mode (ATM) is a new packet-network protocol designed for mixing voice, video, and data within the same network. Voice is digitized in telephone networks at 64 Kb/s (kilobits per second), which must be delivered with minimal delay, so very small packet sizes are used. On the other hand, video data and other business data usually benefit from quite large block sizes. An ATM packet consists of 48 octets (the term used in communications for eight bits, called a byte in data processing) of data preceded by five octets of control information. An ATM network consists of a set of communication links interconnected by switches. Communication is preceded by a setup stage in which a path through the network is determined to establish a circuit. Once a circuit is established, 53-octet packets may be streamed from point to point.

ATM networks can be used to implement parts of the Internet by simulating links between routers in separate intranets This means that the "direct" intranet connections are actually implemented by means of shared ATM links and switches.

ATM, both between LANs and between servers and workstations on a LAN, will support data rates that will allow many users to make use of motion video on a LAN.

Modems

Modulator/demodulators, or modems, are used to send digital data over analog channels by means of a carrier signal (sine wave) modulated by changing the frequency, phase, amplitude, or some combination of them in order to represent digital data. (The result is still an analog signal.) Modulation is performed at the transmitting end and demodulation at the receiving end. The most common use for modems in a computer environment is to connect two computers over an analog telephone line. Because of the quality of telephone lines, the data rate is commonly limited to 28.8 Kb/s. For transmission of customer analog signals between telephone company central offices, the signals are sampled and converted to "digital form" (actually, still an analog signal) for transmission between offices. Since the customer voice signal is represented by a stream of digital samples at a fixed rate (64 Kb/s), the data rate that can be achieved over analog telephone lines is limited.

ISDN

Integrated Service Digital Network (ISDN) extends the telephone company digital network by sending the digital form of the signal all the way to the customer. ISDN is organized around 64Kb/s transmission speeds, the speed used for digitized voice. An ISDN line was originally intended to simultaneously transmit a digitized voice signal and a 64Kb/s data stream on a single wire. In practice, two channels are used to produce a 128Kb/s line, which is faster than the 28.8Kb/s speed of typical computer modems but not adequate to handle MPEG video.

ADSL

Asymmetric Digital Subscriber Lines (ADSL) extend telephone company twisted-pair wiring to yet greater speeds. The lines are asymmetric, with an outbound data rate of 1.5 Mb/s and an inbound rate of 64 Kb/s. This is suitable for video on demand, home shopping, games, and interactive information systems (collectively known as interactive television), because 1.5

Mb/s is fast enough for compressed digital video, while a much slower "back channel" is needed for control. ADSL uses very high-speed modems at each end to achieve these speeds over twisted-pair wire.

ADSL is a critical technology for the Regional Bell Operating Companies (RBOCs), because it allows them to use the existing twisted-pair infrastructure to deliver high data rates to the home.

Cable systems

Cable television systems provide analog broadcast signals on a coaxial cable, instead of through the air, with the attendant freedom to use additional frequencies and thus provide a greater number of channels than over-the-air broadcast. The systems are arranged like a branching tree, with "splitters" at the branch points. They also require amplifiers for the outbound signals, to make up for signal loss in the cable. Most modern cable systems use fiber optic cables for the trunk and major branches and use coaxial cable for only the final loop, which services one or two thousand homes. The root of the tree, where the signals originate, is called the head end.

Cable modems

Because it is so easy to transmit perfect copies of digital objects, many owners of digital content wish to control unauthorized copying. This is often to ensure that proper royalties have been paid. Digital watermarking consists of making small changes in the digital data that can later be used to determine the origin of an unauthorized copy. Such small changes in the digital data are intended to be invisible when the content is viewed. This is very similar to the "errors" that mapmakers introduce in order to prove that suspect maps are copies of their maps. In other circumstances, a visible watermark is applied in order to make commercial use of the image impractical.

Authoring systems

Multimedia authoring systems are used to edit and arrange multimedia objects and to describe their presentation. The authoring package allows the author to specify which objects may be played next. The viewer dynamically chooses among the alternatives. Metadata created during the authoring process is normally saved as a file. At play time, an "execution package" reads the metadata and uses it as a script for the playout.

Authoring systems, as well as systems for gathering information for multimedia presentations (scanning, classifying, indexing and processing images, audio, and video) are very active research areas. Particularly challenging, and also very useful, are techniques that can be applied to compressed data. Entirely new techniques are required, and the human factors involved in the processing of this new data must be understood.

Multimedia architecture In this section we show how the multimedia technologies are organized in order to create multimedia systems, which in general consist of suitable organizations of clients, application servers, and storage servers that communicate through a network. Some multimedia systems are confined to a stand-alone computer system with content stored on hard disks or CD-ROMs. Distributed multimedia systems communicate through a network and use many shared resources, making quality of service very difficult to achieve and resource management very complex.

Internet over cable systems

World Wide Web browsing allows users to see a rich text, video, sound, and graphics interface and allows them to access other information by clicking on text or graphics. Web pages are written in HyperText Markup Language (HTML) and use an application communications protocol called HTTP. The user responses, which select the next page or provide a small amount of text information, are normally quite short. On the other hand, the graphics and pictures require many times the number of bytes to be transmitted to the client. This means that distribution systems that offer asymmetric data rates are appropriate.

Cable TV systems can be used to provide asymmetric Internet access for home computers in ways that are very similar to interactive TV over cable. The data being sent to the client is digitized and broadcast over a prearranged channel over all or part of the cable system. A cable modem at the client end tunes to the right channel and demodulates the information being broadcast. It must also filter the information destined for the particular station from the information being sent to other clients. The lowbandwidth reverse channel is the same low-frequency band that is used in interactive TV. As with interactive TV, a telephone modem might be used for the reverse channel. The cable head end is then attached to the Internet using a router. The head end is also likely to offer other services that Internet Service Providers sell, such as permanent mailboxes. This asymmetric connection would not be appropriate for a Web server or some other type of commerce server on the Internet, because servers transmit too much data for the low-speed return path. The cable modem provides the physical link for the TCP/IP stack in the client computer. The client software treats this environment just like a LAN connected to the Internet.

Video conferencing

Video conferencing, which will be used on both intranets and the Internet, uses multiple data types, and serves multiple clients in the same conference. Video cameras can be mounted near a PC display to capture the user's picture. In addition to the live video, these systems include shared white boards and show previously prepared visuals. Some form of mediation is needed to determine which participant is in control. Since the type of multimedia data needed for conferencing requires much lower data rates than most other types of video, low-bit-rate video, using approximately eight frames per second and requiring tens of kilobits per second, will be used with small window sizes for the "talking heads" and most of the other visuals. Scalability of a video conferencing system is important, because if all participants send to all other participants, the traffic goes up as the square of the number of participants. This can be made linear by having all transmissions go through a common server. If the network has a multicast facility, the server can use that to sidtribute to the participants.

Issue on Wireless Connection (“CCS News”, 2006):

17 July 2006 – International Herald Tribune: CCS quoted in an article headed "Wireless: Luring the Mobile into the Web”

CCS was quoted in an article entitled “Wireless: Luring the Mobile into the Web”. The article described the way companies like Yahoo, Google, Microsoft and Skype are starting to make their marks in the wireless world. Yahoo has signed an accord with 3Group covering search functions and instant messaging, Google search will be available on the Vodafone Live portal, Skype’s internet-based calling can use 3Group’s network and Microsoft’s Windows operating system is available on a growing number of advanced handsets.

Ben Wood, CCS Director of Clients, said “Without a doubt, the internet giants are going to irrevocably change the mobile space. The rules they play by are totally alien to the mobile operators, by virtue of the fact that they seldom worry about a business case, move at ten times the speed of the phone companies, and work on a ‘throw enough mud and something will stick’ approach to launching products.” The internet giants seem content for now to get their services available on as many phones as possible. Yahoo and Google describe mobile as a critical part of their strategy and Microsoft says that mobile products are the fastest growing part of its business.

Summary

Multimedia is obviously a fertile ground for both research and the development of new products, because of the breadth of possible usage, the dependency on a wide range of technologies, and the value of reducing cost by improving the technology. Now that the technology has been developed, however, the marketplace will determine future direction. The technology will be used when clear value is found. For example, multimedia is widely used on PCs using CDs to store the content. The CDs are inexpensive to reproduce, and the players are standard equipment on most PCs purchased today. The acceptance caused a greater demand for players, which, in turn, caused greater production and further reduced prices.

The computer industry is providing demand, and an expanding market, for the key hardware technologies that underlie multimedia. These include solid-state memory, logic, microprocessors, modems, switches, and disk storage. The price declines of 30-60% per year that we have seen for several decades will continue into the foreseeable future. As a result, the application of multimedia, which appears expensive now, will become less expensive and more attractive. An exception to this fast rate of improvement is the cost of data communications. Communications depend both on technology with rapidly decreasing cost and on mundane and basically unchanging tasks such as laying cable with the help of a backhoe or stringing cables from poles. The cost of communication is not likely to decline significantly for quite a while.

The initial uses will be information dissemination, education, and training on campus LANs. Multimedia will be used in education, government, and business over campus LANs, with low-bit-rate video that will not place excessive stress on the infrastructure. The availability of switched LAN technology and faster LANs will allow increases in both the bit rate per user and the number of users. As the cost of communications decreases, the cost for Internet attachment for servers will decline, and higher-quality video will be used on the Internet.

Multimedia will be a compelling interface for commerce and advertising on the Internet. Eventually, cable modems and/or ADSL will provide bandwidth for movies to the home, and the declining computer and switching costs will allow a cost-effective service. The winner between ADSL and cable modems will have as much to do with the ability of cable companies and RBOCs to raise capital as with the inherent cost and value of the two technologies.