Broadband demand, videoconferencing, and some policy and regulatory environments

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Abstract: The demand for high bandwidth networks and the satellite technology will play a greater role in the delivery of telecommunications, high bandwidth and multimedia. Satellite constellations will become the delivery mechanism for global mobile personal communications via satellite (GMPCS) systems. An VTC (Video TeleConference) overview, the ten golden rules for videoconferencing, the benefits of videoconferencing and some policy and regulatory environments are presented.

Key words: High bandwidth networks, policy and regulatory environments, satellite communication, videoconferencing.

1 Introduction

Burgeoning demand for broadband capacity is now one of the most fundamental tenets of the global telecommunications industry. Demand for high bandwidth networks is being driven by the development of new communications technologies and applications, the rise of Internet, the future potential of electronic commerce and an ongoing obsession with bringing the information superhighway to one and all. Moreover, the spread of applications such as videoconferencing, home-working, telemedicine, distance learning, remote access and interactive entertainment are also fuelling demand for broadband multimedia services. As a result, a situation is emerging whereby the current installed infrastructure around the world is unable to keep up with demand - despite the multitude of "global infrastructure projects" that are constantly being announced. Plans to meet current and future demand for high-capacity broadband networks continue to surface in many forms. At a local and national network level, telecommunications operators are pushing forward with network upgrades. Progress is also being made on a global level and here the infrastructure market can really be separated into three camps:

- The carrier's carrier market: here, bandwidth is leased to new entrants and incumbent operators by companies using utility-based network (Hermes Europe Railtel for instance), or by those that have built new infrastructure;
- The terrestrial global infrastructure market: in this case, companies like Fibre-optic Link Around the Globe (FLAG), Project Oxygen and Global Crossing are ramping up capacity over a world-wide network of terrestrial high-speed backbones and fibre-optic submarine cables;
- The satellite global infrastructure market: yet to launch and hence unproven, this market consists of players such as Teledesic and Skybridge, which plan to provide high capacity communications over sky-based constellations of low earth orbit (LEO) satellites.

Satellites emerged as a transmission vehicle long before the implementation of fibre cables on a widespread basis. Thanks to the ongoing globalisation of telecommunications and technology developments, however, the satellite market is now undergoing fundamental change and the role that satellite technology will play in the delivery of telecommunications, high bandwidth and multimedia services is poised to take on greater significance. Satellite constellations will become the delivery mechanism for global mobile personal communications via satellite (GMPCS) systems. They will support direct-to-home video services, digital television, interactive programming and digital data broadcasting. In the fixed market they will deliver services to underserved markets - especially those not covered by fibre.
It is the world's data market - especially the market for Internet - that is perhaps the most significant for this emerging satellite sector. A report published by "Satellite Data Networks: The Internet's Next Frontier" forecasts the number of Internet users rising "from around 51m at year-end 1996 to approximately 1000m global users by year-end 2004. This growth will occur most rapidly in areas outside the US, though the US will remain a leader in the deployment of Internet technology and applications."

It is figures like these that back up the plans of Skybridge and Teledesic to launch high-capacity satellite-based networks. Here, the use of satellites as a transmission medium has numerous advantages over fibre-optic cable installations. Broadband LEO satellite systems offer low delays and are able to support Internet protocols. Major technological advances now mean that satellites themselves operate as virtual switches instead of mere relay stations, while the development of high-powered satellites allows the use of smaller receiving terminals, thus opening the market for personal satellite services. Satellites can also provide immediate and cost-effective coverage of previously unserved or underserved regions of the world. In addition, the development of Ka-band satellite technology and future broadband technologies will mean that these satellite networks will be able to compete with advanced terrestrial network technologies such as frame relay and ATM.

The major satellite players in the race to provide global broadband connectivity are Skybridge and Teledesic. Similar systems are also being developed by the likes of Cyberstar, while lower-end data services are provided by satellite operators such as Orbcomm.

Skybridge LP was set up as a limited partnership in the US in 1997. Its major partner and prime contractor is Alcatel and other partners include: LOEAL Space and Communications of the US; SPAR Aerospace and Com Dev of Canada; Mitsubishi Electric, Sharp and Toshiba from Japan; SRIW of Belgium and CNES and Aerospatiale of France. In its second phase of establishing partnerships, Skybridge states that its priority will be given to operators and service providers which will support distribution of the Skybridge service to end-users. British Telecom (UK) is expected to be one of the first operators to sign up, perhaps contracting for a franchise covering the whole of Europe Skybridge's approach to signing up telecommunication partners.

The Skybridge system is to be based on a constellation of 80 Ku-band LEO satellites and will deliver global connectivity to business and residential users world-wide. Traffic will run from user terminals through the Skybridge satellites which then interface with one of approximately 200 gateway stations. The gateway stations will link into the existing terrestrial network through an ATM switch. The system will offer downstream speeds up to 20 Mbit/s and up to 2 Mbit/s on the return link for residential users. Three to five times higher bit rates will be offered to business users; the Skybridge system is very cost competitive with terrestrial services and will provide access to broadband services at an attractive cost. Narrowband voice and fax service will also be supported over the system, enabling the delivery of voice to rural and undeveloped areas. Service is scheduled for commercial launch in late 2001 and around 20m users are expected to sign up world-wide when the system is operational.

Teledesic has branded its planned service as an "Internet in the sky", stating that its network will provide affordable world-wide fibre-like access to telecommunications services globally. These services encompass a range of offerings including videoconferencing, high-quality voice and data and will be aimed at business, consumers and schools throughout the world. Service will be provided over a constellation of 288 satellites plus spares (points of presence POPs), operating in the newly licensed high frequency Ka-band of the radio spectrum, and providing users with 64 Mbit/s downloads and 2 Mbit/s uploads, at a fraction of the latency or present satellite systems. Teledesic will average less than 70 m for distances of 5,000 km or less; as distance increases, Teledesic will gain an advantage over fibre as signals move through fibre comparatively slowly - at only two-thirds the speed of light. However, selling Teledesic on law latency alone may be difficult; it isn't a massive problem for a lot of Internet traffic, but for voice, any latency at all causes big trouble. Teledesic - by virtue of the fact that its network is constantly on the move - should provide the same level of infrastructure for any point on the globe. However, the network may struggle in areas where users and applications are bandwidth hungry; and the cost of service is independent of location. Teledesic hopes that the availability of high bandwidth infrastructure will pay a role in improving the economies of developing countries. However, that could be negated if the service is not affordable¹.

The marketing of Internet services will not be carried out by Teledesic; instead, the company will appoint resellers and will, if performance meets expectations, pick up some resellers which are distributing geostationary satellite service. As today no service provider can guarantee end-to-end quality of service (QoS), there will be many sites for which Teledesic will be the preferred technology, or indeed the only technology, that can provide the end-to-end QoS that enterprise applications demand. Teledesic is hopping that about 750,000 small to medium businesses in the USA (of which only 3% have access to fibre) will take up high-bandwidth services which will run over their network. Applications will come

¹ Many of the orbiting POPs will spend years travelling over areas of the world where there are not, and it will not be, enough Internet-enabled PCs to generate significant revenue.
from the broadband networks, and they will really drive the end-to-end QoS requirements.

If the Teledesic system is deployed - and bearing in mind the complexity of the project and the state of the market since Iridium's technical hiatus and missed targets - it is a big if, then many smaller operators may be left out in the cold; this is regardless of whether they are multicasting or moving large chunks of data via geostationary satellites.

Teledesic was set up in 1990 and represents the vision of US cellular pioneer Craig McCaw. The company's primary investors are Microsoft chairman Bill Gates, Motorola, Boeing, Matra Marconi Space, and Saudi Prince Alwaleed Bin Talal. Service is planned to start on a commercial basis in 2003. We are entering an era when you will soon have truly ubiquitous computing, but the power of that computing will really come from networking and we don't yet have the network infrastructure in place to support that. While most of the world doesn't even have basic telecommunications access, even in the developed countries the infrastructure in place is one hundred year-old copper technology, which is not an architecture suited to networked computers.

Teledesic - like Skybridge - plans to target its customers through a network of alliances with service providers around the world, rather than marketing directly to end-users. The company has yet to sign up any service providers. This will be not a standalone network and that is why it is necessary to be robustly connected into public networks, not just from a physical interconnection standpoint but also from a sales, service and marketing standpoint.

Teledesic's network is designed to support millions of users, with most customers having two-way connections providing up to 64 Mbit/s on the downlink and uplink. Higher speed terminals are expected to offer 64 Mbit/s or greater two-way capacity, representing speed more than 2,000 times faster than today's standard analog modems. Laptop-size terminals will be mounted on a customer's rooftop and connect inside the premises to a computer network or PC.

Whether or not Skybridge and Teledesic view each other as competitors depends on who you ask. Skybridge - a solution embedded in the infrastructure of telecommunications company - is missing the importance of end-to-end quality of service; it doesn't really know what kind of infrastructure it is coming down into. Teledesic, the competitor, offers a service business which make it unique. Having more than one player in the market does have advantages in terms of financing, however, leading Skybridge's Mark MacGann to comment that a competitor in the market is a positive thing in terms of increasing investor confidence.

The Skybridge project is expected to cost around US$4.2bn. An IPO of Skybridge equity is also due to take place in early 2000 to provide Many of the orbiting POPs will spend years travelling over areas of the world where there are not, and it will not be, enough Internet-enabled PCs to generate significant revenue the rest of financing. Teledesic's system cost is somewhat higher at around US$9bn, although many observers think it will come in at well over the projected figure. Some industry observers have estimated that the project could cost as much as US$15bn.

It may be thought that the development of satellite-based broadband providers would signal the end of terrestrial based fibre cables. Both Skybridge and Teledesic strongly disagree with this, however, believing that terrestrial broadband suppliers are not only complementary to their plans but vital for their success, too. They will never compete against terrestrial backbone networks, but will complement them. Skybridge is just an access system without transmission links between the satellites, and needs to route these backbones.

While such satellite networks do not, therefore, signal the end of broadband provision over terrestrial fibre networks, they will undoubtedly have an impact on the lack of competition in the local loop and on issues such as interconnection. As access providers, both Skybridge and Teledesic will be able to extend terrestrial networks to enable new entrant and incumbent operators to provide an instant broadband connection to users that previously were limited to narrowband access. The bottleneck in the local loop is a key problem and Skybridge can solve this.

As well as providing ubiquitous broadband coverage, global solutions such as Skybridge and Teledesic should also shake up the conventional and controversial interconnection model. Here, hefty interconnect fees imposed on new entrants by incumbents are holding back the development of alternative networks - especially those targeting the local loop market. The emergence of global coverage provided by satellite should give new entrants a means of bypassing incumbents in the local loop - an alternative that they are likely to welcome with open arms.

In addition to the broadband capacity promises and the potential for the local loop, one of the fundamental issues surrounding the use of satellite networks is their ability to adhere to the doctrine of bringing the fabled "global information structure" within reach of every person on earth. This vision of global connectivity, as seen by telecommunications companies around the world, comes one step nearer considering the ability of satellites to remove the link between cost and distance and to support the globalisation of telecommunications through the provision of a satellite-based "universal service". However, the satellite market is unpredictable and has its own inherent uncertainties. Satellite networks require upfront investments amounting to billions of dollars while at same time offering no guarantees of revenue. The lengthy planning period does not fit well with the telecommunications industry's fast moving develop-
ment and cannot compete with the low "to market" times witnessed in the fibre cable market. Moreover, while the rise of the Internet is one of the drivers of this "satellite revolution", its very growth means that it is hard to predict the shape of the telecommunications industry in the future - and thus satellite network planning becomes particularly difficult.

Despite these problems, the potential of broadband satellite providers is immense. Today most of the world is still organised around the economics of industrial infrastructure, relying on pipes, wires, highways, railways and airports. This model means that people migrate from the countryside to cities, from the developing world to the developed - in search of economic opportunity, education, healthcare and the like. Increasingly, this is no longer a sustainable model in both economic or environmental terms. The real potential in the information age is to break free of the industrial-age model and allow people to participate meaningfully in the world economy and in the global culture without having to move to the city or to the developed world. If broadband satellite systems can help achieve this, then their future looks promising. Self-education, beyond formal school educational programmes, will be accomplished by individuals at ease with networking procedures that permit easy access to on-line digital libraries and make available virtual trips to museums and science projects without leaving home. Continuing education via teleconferencing will enable the learner to participate in pre-programmed or live academic courses remotely and to receive academic credits, if desired. Acceptance of latter by educational institutes may, however, bring to the surface a wide range of issues regarding accreditation and the changing role of the institution and the instructor in the education process.

To achieve many of the benefits anticipated by educators will require access to the high-end networking that would make possible better video and multimedia exchanges. This implies higher bandwidth, reliable service, and so on. More sophisticated systems and higher bandwidth enable better graphical interfaces and functionalities, which can reduce training costs, possibly offsetting higher transmission costs. Perhaps, most importantly, information infrastructure holds the promise of changing the process of teaching, education, and learning. Where this happens, resources will be reallocated from print-based to on-line resources. Educator's roles are changing to include participation as researchers, instructional designers, and managers of information who collaborate as they develop educational programmes with the help of their remotely located colleagues and mentors from many sectors of the community. Students will need to be able to better articulate study problems, identify and access necessary resources, and work with their peers to solve their problems. The roles of both educator and learner may reverse as both explore new information resources; both will need new skills.

Realising process-change benefits will not be automatic. Compounding insufficient physical resources have been cultural barriers. Telecomputing projects have been seen as add-on, requiring extra effort. Changing in schooling require support and involvement from all segments of the education hierarchy - the administrators, parents, community, support staff, and classroom practitioners. But until a system approach is taken that applies to all types of education professional and activities and addresses the requirements of implementing a new communications system, much work will be needed to truly integrate networking and information infrastructure into schooling. The absence of consensus on how to incorporate network-based applications into education suggests a need for research into appropriate technology, appropriate levels for providing networking and internetworking support, the economics of school networking (funding policies), content standardisation, and information-age skills and knowledge assessments. Educators will not use networks to teach just because the technology is pervasive in society.

In some career fields the relevant base of information is doubling every three or four years, a situation that is redefining what is meant by "certified" or "qualified" as regards professional competency. This is perhaps most apparent in areas that are affected by science and engineering or are heavily positioned within the regions of public interest and subject to regulatory controls.

The potential for using Information and Communication Technologies ICT in the education and training sector is immense. Learning can be personalised, interactive, and explorative rather than passive and text based. Techniques as Computer-Based Training (CBT) and Computer-Aided Training (CAT) have been widely used for some time, as have Compact Disc-Read Only Memory (CD-ROM) materials. What is changing is the level of distance-independence now possible with modern communication technology and the ease of access to the latest information from around the world. The range of information now available online is truly staggering. Material from the U.S. Library of Congress, the National Library of Canada, and many other libraries, museums, and national archives is being digitised and put online. Many other bodies, both voluntary and commercial, also make information available. Even more impressive than the volume is the sheer diversity. Photos, illustrations, audio, video, and animation are all available and often far more contemporary than could ever be found in any

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2 The advancements of scientific technology utilised by modern forensic and crime laboratories require knowledge in the natural science areas of biology, chemistry, physics, and mathematics, but in multimedia interactive communications, too. These laboratories usually require a degree in one or more of these areas for employment at the basic level.
ICT is playing an ever-increasing role in the medical and general health care areas. A New England medical centre [Weinberg] uses electronic image transfer to allow specialists in Boston to view foetal ultrasound images from clinics across Massachusetts. Meanwhile, a tele-medicine network in Marquette, Michigan conducts remote psychiatry sessions by videophone. As medical technology develops, the quantities of information to be transferred in tele-medicine applications continue to increase. As part of this trend, a number of Irish hospitals have completed successful trials of high-capacity public networks that allow advanced diagnostic procedures to be carried out remotely. A large hospital in Denver [Clarke] demonstrates another approach to harnessing the power of communication; it uses wireless laptop computers to ensure the ready availability of clinical information on all patients. The system also makes the hospital's knowledge base available to its clinicians. Nor all medical applications involve diagnosis or general management; communication systems also have a role to play in improving the patient's overall environment. One particular project [Oullette] combines computer networks and videoconferencing to enable sick children to communicate and play games from their hospital beds.

The author believes that having a basic understanding of the underlying technology is of great benefit to individuals involved in this area. This is true regardless of whether the final solution is developed solely in-house, with the help of a consultant or fully outsourced. Such an understanding is also helpful for managers who - while not directly involved in development work - have to give financial approval or other backing for a project.

1.1 VTC overview

At the highest level, a VTC (Video TeleConference) system consists of a number of VTC terminals, or nodes, interconnected by means of a communication network (*Figure 1*).

Full duplex communication channels are used to create a real-time interactive environment (for example, motion video, audio, and graphics) between remote sites. The VTC terminals can vary greatly in complexity, ranging from a large multiroom configuration down to a desktop videophone device. In general, the transmission bit rate varies with the complexity. Large complex rooms used by many people and executive level personnel employ high transmission bit rates (1,544 Mbit/s and 768 Kbit/s, for example). Intermediate-sized rooms used typically for project work will employ intermediate bit rates (384 and 128 Kbit/s). Desktop videophones will employ the lowest rate (64 and 128 Kbit/s). Although point-to-point VTC connections are very important, multipoint connections have been found to be even more important. VTC systems are conveniently classified into three categories as defined by their physical configuration: customised conference room, rollabout module and desktop. *Table 1* summarises the key characteristics of these three different types of systems.

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3 Multipoint permits a large number of terminal nodes to simultaneously participate in a conference; the connections are accomplished by each terminal connecting to a Multipoint Control Unit (MCU).
If the VTC requirement calls for a number of people at a facility to routinely take part in remote conferences, there is a need for a customised room or a room with a rollaboot to accommodate people and to provide a convenient mechanism for integrating graphics and documents into the conference. If there is a requirement for a large number of people in the room ( > 6) and if the personnel taking part in the conference are very senior, it may be necessary to implement a large customised conference room. If, however, the typical number of people using the room will be six or less, it is usually possible to place a rollaboot modular unit in an existing room to minimise installation cost.

2 The ten golden rules of videoconferencing [Source: Ciba-Geigy]

1. The meeting has to be well prepared. Exchange and discuss the detailed agenda with your counterpart before the meeting (e-mail, fax).

2. Do not invite too many people as active participants; the recommendation is 3…4 on each side.

3. Only one person should operate the keypad (cameras). Determine the "operator" among the participants before the conference starts.

4. Videoconferencing needs discipline in talking. Do not cut the other's word (line delay) and speak loudly and clearly.

5. To get a good picture quality on the other side, keep your movement slow and small.

6. Always move the camera to the person who is currently talking.

7. Only manipulate the cameras on your side (even if it is technically possible to operate the far end). Each side should be allowed to control what is shown to the others.

8. If you intend to use the document camera, make sure the documents/slides do not contain too many pieces of information per page. Choose landscape format and large characters whenever possible (as with overhead projectors).

9. Always send documents/slides with the "Document camera - send graphics" function and then return to the person explaining the chart. This way, the document is more readable (higher resolution) and the far end (even if you are using the main camera again) can recall the last transmitted document from memory when necessary.

10. Last but not least - keep it simple and short: time is money!

3 Some policy and regulatory environments

The network evolution is primarily one of organic growth driven by demand. This has been the factor determining the technical developments resulting in the high level of functional integration, service layer fragmentation, transport stratification, and increasingly distributed control. Most of these developments have taken place while the major networks were under control of large, though generally benign regional monopolies. Not surprisingly, these monopolies have attracted the attention of legislators in most of the industrialised world. This intervention has taken different forms in different regions, but in all cases has led to some form of liberalisation accompanied by some compensating regulation. Legislators and regulators have not found their task easy. The architectural complexities have proved to be a considerable challenge to political and legal minds, and there can be few interests of the ordinary subscriber, the business community, the network operator, and the equipment supplier in a regulatory framework that is seen to be fair and open.

At one extreme is the view of telecommunications as a natural monopoly that must be strictly regulated; at the other extreme is the view that it is a service industry like any other and can be expected to function best in a pluralist, competitive environment with minimal regulatory constraints. Most solutions have fallen somewhere between these two extremes.
An important challenge to the PTOs has come from the liberalisation of the satellite market in Europe. In 1990, European satellite were carrying only 2 to 3 percent of intra-European traffic. Private Very Small Aperture Terminal (VSAT) receive-only networks have existed only since the 1988 European Commission terminal equipment Directive liberalised ownership and operation of one satellite terminals. In the USA, the VSAT market experienced strong growth in 1984 with the AT&T divestiture and new opportunities to establish bypass networks. But by 1986 several of these has failed. By 1989, there were 16,000 two-way VSAT terminals installed in the USA. The trend was away from systems based on one-way terminals to interactive networks, and most suppliers had learned to provide cradle-to-grave service. A recent development can facilitate the supply of connectivity to remote areas and significantly enhance local infrastructure. International connectivity is also available via cable (coaxial or fibre), and experience suggests that the importance of fibre-optic cable for international transmission is likely to grow. One reason for this is that cable provides for better-quality service for interactive applications.

In early 1989, the Department of Trade and Industry (DTI) in the United Kingdom awarded seven Specialised Satellite Service Operators (SSSOs) licenses and restricted operators initially to providing national point-to-multipoint service without interconnection with the public switched network. This move was designed to protect British Telecom and Mercury from bypass of their public networks. In November 1989, SSSOs were allowed to uplink signals from Britain, to broadcast them to Europe, and to downlink signals anywhere in the United Kingdom. Two-way VSAT have also been liberalised in Germany, and then they can be interconnected with the public switched network. In 1992, the Commission introduced its Satellite Directive challenging both the PTOs and Eutelsat - the main space segment operator - to liberalise the market further.

Finally, the mobile radio market in Europe has grown significantly. Although these operators have concentrated on the voice telephony market, have been licensed. Cable TV licensees in Britain have shown that - at least in the short term while they compete on price and quality of service - there is considerable demand for their telephone services. The large telecommunications suppliers and users are in a strong position to allocate economic resources to the development and use of advanced telecommunications technologies. Their requirements are sophisticated, and they can often sustain the risk of failure of a costly investment programme in an innovative technique. For smaller business and consumers, the risk is greater and their resources are smaller. An important role for public policy is to ensure that the unevenness of public and private network development.

The DBP Telekom of the 1990s is coping with the construction of a new telecommunications infra-structure in the eastern Federal states. The east German modernisation plan, Telekom 2000, has cost some DM 60 billion over seven years. In August 1990, the Ministry of Posts and Telecommunications announced the conditional suspension of the DBP Telekom monopoly on voice traffic in order to stimulate the establishment of satellite links between east and west Germany. By March 1991, only one company, Preussen Elektra, has successfully applied for a satellite voice traffic licence, but many others had received licences for non-voice satellite links. A further relaxation of restrictions on competition in the voice telecommunication service market resulted in the introduction of six-years licences for voice service competitors. Thus, DBP Telekom, like its counterparts in the United Kingdom and France, was struggling with widespread challenges to its monopoly power. Nevertheless, the German operator claimed that it intended to remain one of the top three network operators in the global market.

In Sweden, the competition had been felt with the increasing penetration of cable TV which, by mid-1989, served about 40 percent of the potential market. The Swedish railway and electricity organisations also posed a potential competitive threat to Swedish Telecom as did Tele X, the satellite operated by the Swedish Space Corporation. All these organisations controlled transmission capacity which could be used to provide data and voice services in the domestic and international markets. From Alcatel's perspective, there were two strategies with respect to the business communications market; the first would use public switched network services such as Centrex to link customers and bringing their traffic back onto the public network. As in the USA, the aim would be to fight against the erosion of market share as a result of bypass technologies. Alcatel suggested that this strategy was typical for British Telecom's planning and reflected the large number of private corporate networks in the United Kingdom. In France, and Europe more generally, there were far fewer private networks, and the PTOs' strategy would be enable corporate customers to link all their sites with PBX and Centrex services. As a result, the same functionality would exist within the public network and the periphery within an intelligent network environment.

Network management was considered to be the key to whether large corporate users would move more of their traffic onto the public switched network. In France - in contrast to other European countries - the hybrid public/private network configuration was already predominant. Two other options - namely, networks completely independent of the public network using satellites and VSAT technologies, and public switched network-only solutions - were considered extremely unlikely to evolve much further.

Siemens representatives [Mansell] suggested that three main services would be embedded in the public network:
Interactive high-speed data communication providing connectionless services, i.e., LANs operating at 10 to 135 Mbit/s; connection-oriented services running at 2 to 135 Mbit/s, and document transfer and retrieval services running at anywhere from 2 Mbit/s to as fast as 600 Mbit/s services.

Interactive video communication for high-quality graphics, videoconferencing at 64 Kbit/s to 135 Mbit/s, video telephony at 64 Kbit/s to 135 Mbit/s, and broadband videotex and video retrieval.

Distributed video communication for TV production and conventional and HDTV distribution.

The Siemens model for the intelligent network (IN) would allow existing switches in the public network to be upgraded to Service Switching Points (SSPs) or to Service Control Points (SCPs) via the addition of software.

The author takes an easy-to-understand approach to the interactive satellite videoconferencing principle, and gives a compact, practical procedure to exploit the satellites possibilities and to provide a satellite service for tele-education, tele-imaging, tele-teaching, and tele-training. Our contribution also looks ahead to forthcoming technologies, including satellite phone systems using both geostationary and nongeostationary orbits.

4 Benefits of video teleconferencing

- Avoided travel costs. This is the most easily quantified benefit. The traveller must pay for conveyance to the airport or pay for parking. At the destination city, there may be the need for a rental car or taxi. Some trips require an overnight stay in a hotel. Nearly all trips call for payment of meal costs. And, of course, the cost of airline ticket or alternate transportation must be included.

- Increased productivity. Valuable employees need not waste time travelling to and from airports, waiting in check-in lines, and sitting on the tarmac awaiting takeoff clearance. If a meeting takes two hours, the participants will expend only two hours of their valuable time.

- Better decisions. Because there is no additional cost for additional meeting participants, the conference can include all the people that are involved in the undertaking. If travel were involved, this might not be possible. People may join a video conference as easily as they can an in-house meeting.

- Faster decision making. Since video conference can be established with little more difficulty than an in-house meeting, people separated by miles can come together and share ideas and information when the need arises. There is no need to delay a decision until all participants can clear day for travel on their calendars.

- More meetings. VTC permits an organisation to have more meetings than otherwise would be feasible. More meetings to manage a project, for example, could result in a higher quality result or more rapid completion.

- Increased employee safety. Travel involves some risk. A videoconference eliminates this concern.

- Tighter security. If co-workers travel together and discuss business, information even though unclassified, may be comprised if their discussions are overheard.

- Reduced fatigue. Business travel is frequently a tiring, frustrating experience that can result in fatigue and consequent poor performance during the meeting as well as after the traveller has returned home. In the case of long-distance travel, it can take several days for this fatigue, or jet lag, to diminish.

- Efficient use of key personnel. The ability to efficiently employ and apply critical personnel.

- More disciplined, productive meetings. In many cases, more is accomplished at a VTC meeting at a face-to-face meeting because all participants realise that is necessary to operate in a more disciplined manner at the VTC meeting. There are fewer interruptions, there is more listening, and the VTC meetings have a fixed time duration.

- Team building. When meetings are held at the normal frequency, it is typically necessary for a project to be organised on a basis where all decisions and control originate at the top and are fed down throughout the organisational structure.

- Interning: It is frequently convenient to include nonparticipatory observers in a VTC because it can be done with very little cost relative to face-to-face meetings. This provides an inexpensive way to train personnel by exposing them to a particular project and management procedures.

- Reliability. In many cases, a face-to-face meeting is cancelled, or its effectiveness reduced, because of terminated flights or bad weather, for example. VTC eliminates this problem.

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The markets for video teleconferencing and videophone are exploding. There are three major reasons for this breakout: improved audio-visual quality, reduced cost, and communication standards. Recent breakthroughs in video and audio compressing technology are responsible for the improvement in quality. The cost of video teleconferencing and videophone (VCT/VP) systems has been drastically reduced in two fundamental areas: communications and the VTC/VP terminal itself. The communication cost has been radically reduced because the transmission bit rate has dropped sharply, and the cost/bit from the common carrier has also been cut. VTP/VP terminal cost has been drastically reduced because the (IC) development. Last - but not least - the VTC/VP revolution could not have occurred without the development of communication standards, the key of teleconferencing services'. A few years ago the

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1 The purpose of H.3xx standards is to ensure compatibility between different teleconferencing systems, without defining all
VTC/VP market was frozen because different vendors' terminals could not talk to each other. They each used different proprietary coding algorithms. In 1990 the International Telecommunications Union⁵ (ITU) finalised the H.320 VTC/VP standard⁶, and today every manufacturer provides the standards in its codec. These standards were drawn up based on a generic model derived from the original H.320 standard and were designed so as to be able to adapt to different networks: H.320 for ISDN, H.324 for STN, H.310 and H.321 for ATM, H.323 for packet networks (particularly IP) etc. Each network has a corresponding standard (the system standard) defining the assembly rules for elementary standards corresponding to technological bricks.

The first generation of equipment complies with H.320 - the parent standard. ATM network equipment complying with H.321 and H.310 is now appearing on the market. H.323 for Internet protocol operation, could play a major role in the introduction of teleconferencing services - certain equipment compliant with this standard is already available.

The market for videophone is not as mature as VTC due to the marginal quality that has been available from recent products and the high cost. This will change rapidly because of the quality improvement inherent in H.324 and H.320 standards as well as the price reduction will result from mass production of standardised products. The videophone will penetrate the business market first but, more importantly, will be rapidly adopted for use in the home by the customer. The two major applications will be the person-to-person videophone and database interactivity (for example, shopping, banking, reservations, and consulting). It is likely that the most important use will be the nonconversational database application.

Figure 2 illustrate the key ITU recommendations that have been, and are being, developed for VTC/VP. H.320 - designed for operation over the N-ISDN - is the most mature standard and forms the cornerstone of all videoconferencing systems, room-based as well as desktop. H.320 is available from all vendors and guarantees interoperability between systems from different manufacturers.

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³ The key ITU standards and their function in a VTC terminal are as follows: H.320: Narrowband visual telephone system and terminal equipment; H.261: Video codec for audio-visual services at P=64Kbit/s; H.221: Frame structure for a 64-Kbit/s channel in audio-visual teleservices; H.242: System for establishing communication between audio-visual terminals using digital channels up to 2 Mbit/s; H.230: Frame synchronous control and indication signals for audio-visual systems; G.711: Pulse Code Modulation (PCM) of voice frequencies; G.722: 7-kHz audio-coding within 64 Kbit/s; G.728: Coding of speech at 16 Kbit/s using Low-Delay Code Excited Linear Prediction (LD-CELP); H.231: Multipoint control unit for audio-visual systems using digital channels up to 2 Mbit/s; H.243: System for establishing communication between three or more audio-visual terminals using digital channels up to 2 Mbit/s.

⁶ The standard accomplishes a number of objectives. It assures interoperability between terminals manufactured by different vendors. It also reduces terminal cost because chip manufacturers produce devices implementing the standard in high volume - therefore, low cost.
### Table 1. Physical configuration of VTC systems. [Schaphorst]

<table>
<thead>
<tr>
<th>VTC configuration</th>
<th>Physical layout</th>
<th>Typical display</th>
<th>TV camera(s)</th>
<th>Lighting</th>
<th>Typical scene: number of people</th>
<th>Microphone/speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customised room</td>
<td>Large conf. room; additional chairs. Electronic equipm. is in a back room.</td>
<td>Rear screen projector(s) or multiple large TV monitors built into a wall.</td>
<td>Usually multiple cameras with pan, tilt, zoom.</td>
<td>Usually customised.</td>
<td>Large group of people; can be more than six.</td>
<td>Multiple microphones or one table top unit.</td>
</tr>
<tr>
<td>Rollabout</td>
<td>Self-contained module(s), tabletop within a conf. room</td>
<td>1 or 2 large monitors built into rollabout module; small TV window for self-view.</td>
<td>Usually normal room lighting and acoustics.</td>
<td>Small group of people, up to six.</td>
<td>Typically one table-top unit.</td>
<td></td>
</tr>
<tr>
<td>Desktop</td>
<td>Camera/monitor on desktop; electronics in videophone or on floor.</td>
<td>One small TV monitor.</td>
<td></td>
<td></td>
<td>Handset or integrated into Videophone.</td>
<td></td>
</tr>
</tbody>
</table>

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**Figure 2. Multimedia communication standards. [Schaphorst]**

H.261 is mandatory for the recommendations listed here. The VTC market in the business community is relatively mature and is growing rapidly. In this application the transmission bit rates range from 128 Kbit/s for lower level elements of an organisation up to 384 Kbit/s for management levels. Fixed and roll-around units are installed in conference rooms, while systems using the personal computer platform are proliferating on the desktop. Growth in the desktop area is being spurred by the recent acceptance, and recognised productivity, of telecommuting. Workers are using their personal computers (PCs) at home as platforms for desktop videoconferencing back to work and with the world at large. In many of these applications, it is recognised that the data element of the multimedia communications (for example white board, spread sheet, and document editing) is extremely important, perhaps more important than motion video.
References


