Internetworking Technologies: The Multimedia Aspect and Related Issues

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Interaction Goals

- **Discussion on Fundamental Components of Multimedia Communication**
- **Understanding of Various Multimedia Internetworking Issues**
- **Requirement Analysis of the Shared Multimedia Applications**
- **Understanding Hidden Design Issues**
- **A Glimpse of Current Practices and Future Trends**

Fundamental Components of Effective Multimedia Communication:

- **Capability of media-based expression of information**
- **Capability of effective use of various tools / means of articulation of a concept / idea**
- **Capability of reacting / responding in the real-time**
- **Capability of collaborative communication**
- **Capability of unicasting, multicasting and broadcasting**

What is a Multimedia Internetwork?

An Internetwork of autonomous computers consisting of LANs and / or WANs, in which (depending upon the specific context of use) it could be possible for two or more participating entities to get an assured minimum quality of network service(s) during their exchange of one or more components of multimedia data is called a Multimedia Internetwork.

Examples of the Multimedia Internetwork in Action:

- **Desktop Videoconferencing over the Internet**
- **Video over the Internet**
- **Voice over the Internet**
- **Video-on-Demand**
- **Distance Learning via the Internet**
- **Virtual Libraries**
- **Collaborative Enterprises over the Net**
- **Telemedicine via the Internet**
- **Web-enabled Marketing Counters**

….And many more!

Multimedia Internetworks: When to go for them?

- **There is no single best rule that could possibly advise on the exact point when to employ such internetworks.**
- **A few rules of thumbs have evolved over a period of time; however, it may not be wise to try them all.**

Multimedia Internetworks: When to go for them ...

- **There exist, however, several factors which, when monitored, give an indication that the organization needs a multimedia-capable internetwork. These include:**
  - **Frequency of multimedia exchanges**
  - **Exact nature and volume of such exchanges**
  - **Duration of such simultaneous exchanges &**
  - **Number of users / entities involved per unit time**

Upgrading to the Multimedia Internetworks: How to do it in steps?

- **Analysis of Bandwidth Requirements**
- **Careful reallocation (preferably, dynamically) of network resources with the help of a priority policy**
- **Reconfiguration, if necessary**
- **Statistical analysis of user history profiles and authorization for selective priority based access control**
- **Structured grouping / regrouping of users**

Upgrading to the Multimedia Internetworks: How to do it in steps

- **Exploring the possibility of use of Intelligent Agents and / or Softbots (Software Robots) for critical but frequent / repetitive tasks.**
- **Upgrading the existing LAN(s), Inter-LAN Links and, where necessary and viable, WAN Subnet components for ensuring that the required number of simultaneous Multimedia Data Streams (usually, not more than five to ten) are possible to be provided by the internetwork without hampering other normal transactions / exchanges.**

Multimedia Internetwork Requirements and the Requirement Analysis: Focal Points

- **Almost all multimedia applicaions are inherently time-sensitive. The Time-Sensitivity Analysis is, therefore, often a good way of moving towards a good MM Internetwork design.**

Multimedia Internetwork Requirements and the Requirement Analysis: Focal Points ...

- **This requirement suggests that Faster Than Real-Time (FTRT) processing at various internetwork components (like Hubs, Routers, Bridges, Gateways etc.) is often necessary.**

Multimedia Internetwork Requirements and the Requirement Analysis: Focal Points ...

- **Real-Time or near Real-Time traffic requirements suggest that low latency periods are highly desirable.**
- **All of these factors point towards the need for some type of guaranteed QoS for such shared services.**

Multimedia Network / Internetwork Integration: Major Requirements and Issues:

- **Interoperability**
- **Stability**
- **Transparency**
- **Controllability**
- **Reliability**
- **High degree of Availability**

Multimedia Network / Internetwork Integration: Major Requirements and Issues ...

- **Acceptable Throughput**
- **High degree of service utilization in order to make the network / internetwork cost-effective**
- **Maintainability**
- **Low Complexity**
- **Security**

Multimedia Internetworking Categories: A Partial List

- **On-Demand Multimedia Internetworks**
- **Highly Interactive Multi-location Telecollaboration Multimedia Internetworks**
- **Intelligent Multimedia Internetworks**
- **Teleconferencing-oriented Multimedia Internetworks**
- **Web TV-oriented Multimedia Internetworks**

Link based Classification of the Multimedia Internetwork Applications

- **Point-to-Point Unidirectional Multimedia Internetwork applications**
- **Point-to-Point Bi-directional Multimedia Internetwork applications**
- **Point-to-Multi-point Unidirectional Multimedia Internetwork applications**
- **Point-to-Multi-point Bi-directional Multimedia Internetwork applications**

Point-to-Point Unidirectional Multimedia Internetwork applications

- **Examples of Point-to-Point Unidirectional Multimedia Internetwork applications include:**
  - **One-way Teleconferencing**
  - **One-way Videoconferencing using a stored video stream**
  - **One-way Videoconferencing using a real-time stream**
  - **Web-based Multimedia E-mail**

Point-to-Point Bi-directional Multimedia Internetwork applications

- **Examples of Point-to-Point Bi-directional Multimedia Internetwork applications include:**
  - **Two-way Audioconferencing**
  - **Two-way Videoconferencing (using real-time stream)**
  - **Online Training (real-time)**
  - **Shared Whiteboard based Collaboration**
  - **Shared Spreadsheet based Collaboration**

Point-to-Multi-point Unidirectional Multimedia Internetwork applications

- **Examples of Point-to-Multi-point Unidirectional Multimedia Internetwork applications include:**
  - **Web TV**
  - **Real-time Video Stream based Distance Lecture Sessions**
  - **Stored Video Stream based Distance Lecture Sessions**

Point-to-Multi-point Bi-directional Multimedia Internetwork applications

- **Examples of Point-to-Multi-point bi-directional Multimedia Internetwork applications include:**
  - **Interactive Video Distribution**
  - **Multiparty Videoconferencing**
  - **Video-on-Demand**
  - **Voice-on-Demand**

Interactive MM Internetworking: Major Factors

- **Levels of multimedia information flow**
- **Type and Volume of multimedia content**
- **Number, Location and Frequency of entities involved in simultaneous multimedia information exchange**
- **Extent of Hardware / Software support required / available**

Estimating the Bandwidth Requirements for Multimedia Internetworks: Factors and Issues

- **Each of the basic multimedia objects like text, audio, video and graphics has its own bandwidth requirement that widely varies from that of the other objects.**
- **Furthermore, factors like the proportion / degree of use of two or more of such objects in a two-way or multi-party multimedia exchange influence the bandwidth requirements.**

Estimating the Bandwidth Requirements for Multimedia Internetworks: Factors and Issues ...

- **Desired transmission and reproduction quality is another factor that influences such requirements.**
- **Number of parties involved and their geographic locations affect bandwidth requirements as well.**

Estimating the Bandwidth Requirements for Multimedia Internetworks: Factors and Issues ...

- **Physical characteristics of the medium / link and intermediate processing / switching / storage devices also influence the actual deliverable bandwidth specification.**
- **Physical and logical organization of various multimedia servers and databases have a bearing on the required bandwidth.**

Estimating the Bandwidth Requirements for Multimedia Internetworks: Factors and Issues ...

- **Router / Switch hierarchies and the network / internetwork topology play important roles in this matter.**
- **Leased or on-demand bandwidth allocation depends upon the economics of scale and / or the critical nature of the intended applications.**
- **The choice of Data Compression and Decompression / Recovery Scheme plays an important role in such matters.**

Bandwidth of a Transmission Link:

- **The maximum Rate of Data Transfer that a given transmission link may support, is called its Maximum Bandwidth. However, in an internetwork, often, it is the slowest intermediate link between two networks that influences the maximum data transfer rate actually achievable.**

Bandwidth of a Transmission Link

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- **The Effective Link-bandwidth actually depends on several physical factors like:**
  - **the transmission quality supported by a guided or unguided medium**
  - **the effect of proximity of adjacent signal frequencies**
  - **the type of physical terminators and /or connectors intended to use along with the link**
  - **effect of noise(s) and external interference(s)**

Videoservers: What are they?

A Videoserver is a server that is specifically designed and configured for:

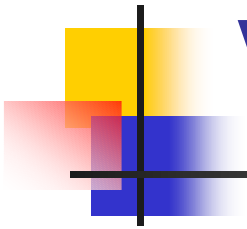
- **Handling efficiently and reliably video traffic over an existing network / internetwork.**
- **Converting VHS (Video Home System) signals into digital video signals.**
- **Converting Analog Television signals (where so applicable) into digital video signals.**

Contd...

Videoservers ...

A Videoserver ...

- **Compressing compressible digital signals before storage, forwarding or retransmission.**
- **Providing linkage between various interacting components using its services in a manner that be transparent to the participating clients.**



Videoservers …

- **Videoserver software sits atop the NOS.**
- **Exact amount of required bandwidth also depends on the capacity and speed of various components like Video Camera(s), Video Capture / Playback / Frame-grabber Adapter(s) and certain other factors including those mentioned earlier.**

Videoservers …

- In most of the real-life conditions, the major challenge of the Multimedia Internetwork is to as closely match the internetwork capabilities and traffic demands as possible.
- Like acceptable Audio Latency, Video Latency also proves a major factor in bandwidth estimation.
- Physical distance involved and number of hops play a very important role in case of the WANs.

The Bandwidth Requirements:

Multimedia Traffic over an Internetwork may include one or more instances of:

- **Image (10 - 500+ Kbps)**
- **Voice (4 - 100 Kbps)**
- **Text**
- **Data (<5 Kbps)**
- **Stereo Quality Audio (125 Kbps - 1 Mbps)**
- **HDTV Signals (200 Mbps - 1 Gbps)**
- **VCR Quality Video (4 - 10Mbps)**
- **3-D Scientific Visualization (around 1 Gbps)**
- **Animation < All values are approximate.>**

More on Bandwidth ...

Average degree of compression in each case is different and has a bearing on the required bandwidth.

- **Types of Compressed Video:**
  - **High Quality Compressed Video (6-24 Mbps)**
  - **Medium Quality Compressed Video (1.54 Mbps)**
  - **Low Quality Compressed Video (100 Kbps)**

In multimedia internetworks, the medium quality compressed video is often preferred because it offers a good compromise between cost and quality. At an average, it provides a performance comparable to 30 Frames / Second.

More on Bandwidth ...

Types of Videoconferencing:

- **One-way Video with audio callback**
- **Two-way Video**
- **Multi-point / Multi-way Integrated Videoconferencing (15 - 30 Frames / Second)**

- **Most common of these over the multimedia internetwork is the Multi-point / Multi-way Integrated Videoconferencing. This provides a costly (medium to high cost) but highly collaborative option and permits the participants to exchange, modify, visualize and simultaneously view multimedia data that may be in the forms like Graphs, Charts, Images, Text etc.**

More on Bandwidth ...

- **Videoconferencing discussed above, should not be confused with its poorer cousin the Desktop Videoconferencing.**
- **This low-cost option is almost as effective as the Integrated Videoconferencing except for its higher latency and poorer video quality. However, with the advancement of technology and the anticipated economics of scale, these drawbacks are likely to vanish in near future.**

More on Bandwidth ...

- **WebTV and LAN TV technologies are other variations of networked multimedia interactive video.**
  - **Examples of associated products include Philips' WebTV Plus, Datafleet's NetworkTV and recently, Onida's Web Cruiser.**
- **Video-on-Demand technology is a related technology.**

Multimedia Broadcast Standards

There exist three major standards for analog transmission of multimedia broadcast:

- **The NTSC (National Television Standards Committee) standard:**
  - **followed in the Central American countries, USA, Canada, Japan etc.**
  - **features 525 lines per frame and recommends 30 FPS (frames per second) refreshing rate. (Lines refer to Vertical Scan Lines here.)**

Multimedia Broadcast Standards

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Analog standards ...

- The PAL (Phase Alternation Line) Standard:
  - followed in India, several European countries, gulf countries and many other countries.
  - features 625 lines and 25 FPS refreshing rate.

Multimedia Broadcast Standards ...

Analog standards ...

- **The SECAM (Système Electronique pour Couleur Avec Mémoire) Standard:**
  - **primarily used as the analog multimedia broadcast standard in France, Russia and a few other countries**
  - **features 625 lines and 25 FPS refreshing rate.**

In a way, SECAM is a variant of the PAL standard.

Network Operating Systems providing support for Multimedia:

- Novell NetWare 5.x and Novell Intranetware
- Microsoft Windows NT Server 4.x and 5.x Beta
- Banyan Vines
- IBM LAN Manager etc.

Other Popular Operating Systems providing Multimedia Support:

MS Windows 98 MS Windows NTC IBM OS/400

Linux 2.x SCO Unix SCO Openserver

BeOS 4.x MacOS etc.

Related Documents:

- C. Huitema: IPv6, Second Edition, Prentice-Hall PTR, 1998.
- Marilee Ford et al: Internetworking Technologies Handbook, Cisco Press, 1997.
- Cisco staff: Internetworking Case Studies, Cisco Press, 1996.
- G. Maral: VSAT Networks, John Wiley & Sons, 1995.
- B. O. Szuprowicz: Multimedia Networking, McGraw-Hill, 1995.
- R. K. Arora et al (Ed.): Multimedia 98 --- Shaping the Future, Tata McGraw-Hill, 1998.
- Garry R. McClain (Ed.): Handbook of Networking and Connectivity, AP Professional,1994.
- D. Comer: Internetworking with TCP / IP , Vol..-1, PHI, 1995.
- D. Comer & D. L. Stevens: Internetworking with TCP /IP, Vol.. 2-3, PHI,1994, 1993.

Related Documents ...

- Uyless D. Black: TCP / IP & Related Protocols, Second Edition, McGraw-Hill, N. Y., 1995.
- W. Buchanan: Advanced Data Communication and Networks, Chapman & Hall, London, 1997.
- http://bmrc.berkeley.edu/papers/1997/143/kpatel.html (CMT)
- http://bmrc.berkeley.edu//projects/cmt/cmtdoc/intro.html (CMT)
- http://www.eece.napier.ac.uk/~bill_b/dbook.html (DataCom)
- http://osiris.sund.ac.uk//~cs0msa/bcsir96.ps (Digital Lib.)
- RFC 1009 (Requirements for Internet Gateways)
- RFC 1254 (Gateway Congestion Control)
- RFC 1360 (Official Protocol Standards of the Internet Architecture Board)
- RFC 1124 (Policy Issues in Interconnecting Networks)
- RFC 1125 (Policy Requirements for Inter-Administrative Domain Routing)

Related Documents ...

- RFC 1175 (FYI : A very useful reference-list on Internetworking related information)
- RFC 1147 (FYI: A list of Network Management Tools)
- RFC 1630 (Universal Resource Identifiers in the WWW)
- RFC 1738 (Uniform Resource Locators)
- H. Ghosh and S. Chaudhury: An Abductive Framework for Retrieval of Multimedia Documents in a Distributed Environment, Proceedings of the KBCS '98 International Conference, NCST, Bombay, Dec. 1998, pp. 153-165.
- H. Ghosh and S. Chaudhury: A Distributed Architecture for Retrieval of Multimedia Documents, Proceedings of the 5th ADCOMP, Tata McGraw-Hill, New Delhi, 1997.