Multimedia Application Requirements

Networking: A Historical Perspective

- **Late 1960's - Early 1970's**
  - Basic Concepts (Packet Switching etc.)
  - Resource Sharing --- ARPANET
- **Mid 1970's - Mid 1980's**
  - LANs
  - Connectivity
- **Mid 1980's - Mid 1990's**
  - Internetworking
  - Global Connectivity
- **Mid 1990's ---**
  - Meeting the needs of Applications
    - Multimedia
    - Integrated Services
  - Taking advantages of advances in technology

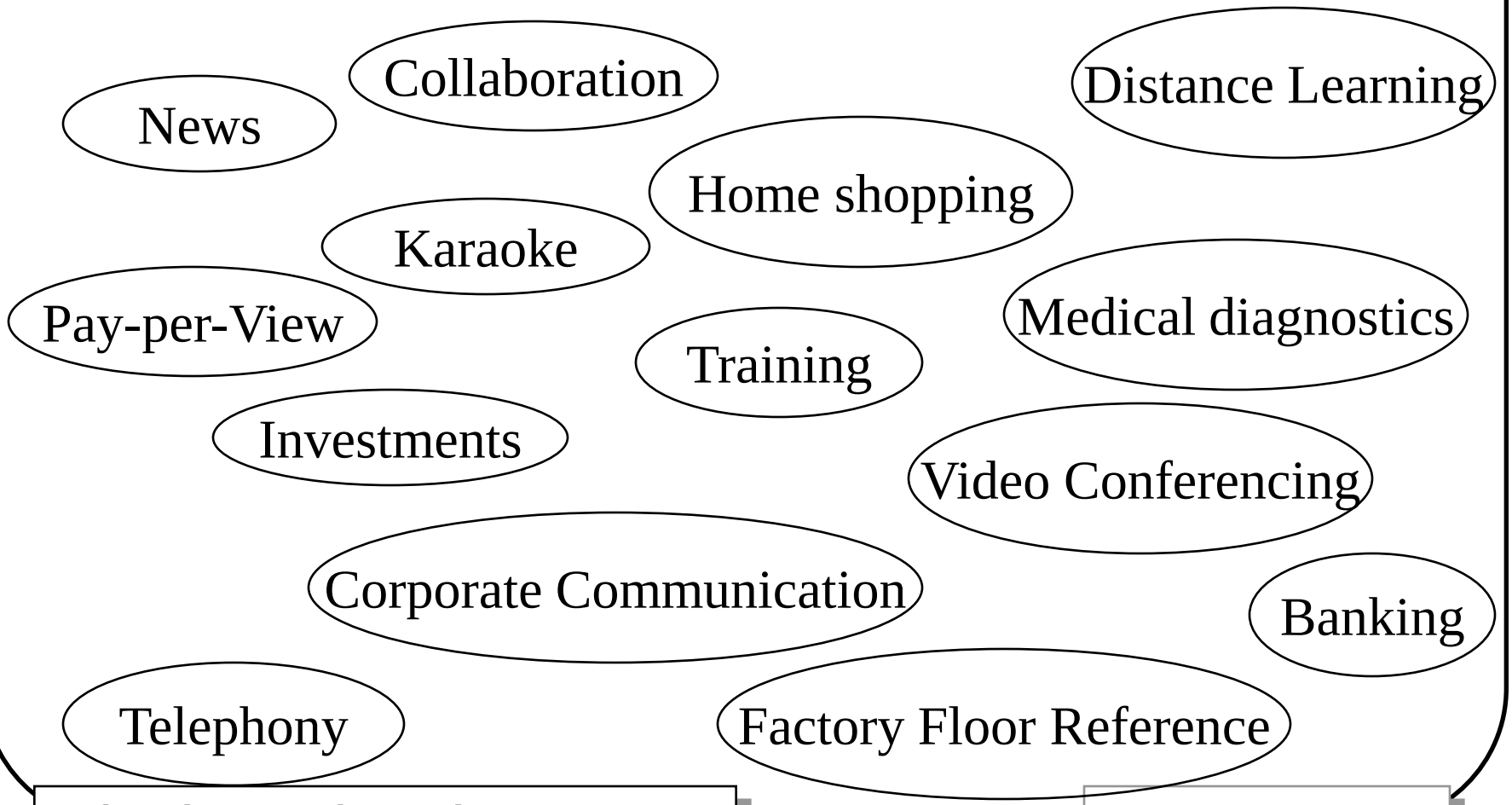
Traditional Applications

- Resource sharing
- Remote Login
- Electronic mail
- File transfer

and more recently

- World-Wide-Web

New Applications



Categories of Applications

- I. Communication among people
- II. News and Entertainment
- III. Education and Training
- IV. Business Applications
- V. Medical Applications

Communication Among People

- Voice Communication (VoIP, IP Telephony)
  - ubiquity of the Internet
  - alternative to Telcos
  - integration with other applications
  - new functionality
    - conferencing (made easier)
    - storage (record, play-back, index, edit, integrate…)

Communication Among People

- Video Conferencing
  - A picture is worth a thousand word
    - facial expressions, gestures, reactions…
  - Same advantages as with voice communication
  - Insertion of video clips
  - Fly-on-the-wall
  - Quality
- Collaboration
  - shared white board

News and Entertainment

- News in all its forms (paper, audio, video, web, combination; live and stored)
  - selectivity (on-line, by profile…)
  - accessibility without frontiers
  - urgent notification
  - linkage among various sources
  - archival

News and Entertainment

- Movies and TV programming
  - Movie-on-demand (pay-per-view)
    - large selection
    - full VCR functionality
  - Live broadcasts (sports, weddings, …)
  - Wider audience
- Interactive Games

Education and Training

- Distance Learning
  - distance independence
- Asynchronous Learning
  - time-independence
- Flexible curriculum
- Flexible pace
- Monitoring

Business Applications

- Information kiosks
- Corporate communication
- Factory floor reference
- Banking
- Home Shopping
- E-Commerce
- Publishing
- etc.

Medical Applications

- Medical Imaging
- Tele-surgery!
- Health education
  - *e.g., Mayo clinic*

Multimedia Applications

Applications involving many types of media

- Data/Text
- Audio
- Video
- Images
- Graphics

Data Applications Requirements

- Bursty sources
- Relatively low average data rate per source
- Full end-to-end reliability is required
- No latency requirements
- Mostly point-to-point
- Traffic pattern is bursty
- All applications exhibit similar behavior and have similar requirements
  - no service differentiation requirement

Voice Communication

- Voice traffic is Stream-Oriented
  - continuous flow of data
  - duration of a call is on the order of minute to an hour
- Relatively low data rate per stream (2 to 64 kbps)
- Some data loss may be tolerated (1 to 2 %)
  - clipped segments below 50 ms cause degradation in the form of background noise
  - larger segments cause intelligibility to be affected
- Strict end-to-end latency requirement
  - below 150 ms for interactive voice communication
- Very low degree of burstiness (silence suppression)

Video Based Applications

- Video traffic is stream-oriented
- Wide range of data rates
  - 10's of kb/sec to 10's of Mb/sec
  - data rate depends on content and quality requirement
- Latency requirements depend on the application:
  - interactive communication: 150 ms
  - one-way broadcast: around 1 sec
  - Video-on-Demand: around 1 sec
- Burstiness depends on a number of factors
  - content and quality requirement
  - compression scheme

Shared White Board

- Relatively low data rate
- full reliability requirement
- low latency requirement

Digital Video Data Rates

- Low quality or talking heads (video conferencing)
  - 64 kb/s to 784 kb/s
- Business quality (training, video mail)
  - 1 Mb/s to 2 Mb/s
- Broadcasting quality (NTSC, PAL)
  - 4 Mb/s to 8 Mb/s
- High-Definition TV
  - 20 Mb/s
- Studio quality
  - 10 Mb/s to 45 Mb/s

High Bandwidth Requirement

Type	Bandwidth per Stream	20 users
Low end	64 kbps - 384 kbps (teleconferencing)	3 Mbps
Corporate video	1 Mbps - 2 Mbps (training, video mail)	30 Mbps
High quality	4 Mbps - 8 Mbps (presentations, video editing)	100 Mbps
Advanced	8 Mbps - 20 Mbps (advanced professional, HDTV)	2 Gbps

Multicasting Requirement

- Many multimedia applications involve multiple participants
- Size of multicast depends on applications
  - Videoconferencing (3-4 participants, many-to-many)
  - group meeting (10's of participants, one-to-many)
  - video broadcasting (100's of participants, one-to-many)
- Two models
  - fixed (closed) predefined set of participants
  - open set of participants

Integrated services Requirement

- Coexistence of different media within same application
- Coexistence of different applications within the same network
- Must deal with:
  - high and low data rates
  - bursty and stream traffic
  - real-time and non-real-time traffic
  - point-to-point and multi-point modes of communications

Requirements of Multimedia Applications

1. Bandwidth Requirement

- High bandwidth
- Guaranteed bandwidth

2. Latency Requirement

- Guaranteed maximum end-to-end latency & maximum jitter

3. Multicasting Requirement

4. Integrated Services Requirement

Applications Characteristics (1)

	Data Traffic	MM Traffic
Data rate	Low	High
Traffic pattern	Bursty	Stream-oriented Highly bursty
Reliability req.	No Loss	Some loss
Latency req.	None	May be small (e.g., 20msec)

Applications Characteristics (2)

	Data Traffic	MM Traffic
Mode of communication	Point-to-point	Multipoint
Temporal relationships	None	Synchronized transmissions
Type of service	Single traffic type	Multiple types

Networking Requirements

- Network Infrastructure
  - network technologies
  - network protocols:
    - routing
    - Multicasting,
    - resource reservations
- Higher Layer Protocols
  - end-to-end data transport protocols
  - session layer protocols
- Media Servers

Need for Audio/Video Compression

Data Rate Requirements for Uncompressed Digitized Signals:

AUDIO:

- Stereo, 15 kHz bandwidth
- 44.1 kHz sampling rate (same as CD rate)
- 16 bits/sample
- 2 channels

Data Rate = **1.4 Mb/s**

Need for Audio/Video Compression

Data Rate Requirements for Uncompressed Digitized Signals:

VIDEO:

- NTSC analog signal, 6 MHz bandwidth
  12 MHz sampling rate, 8 bits/sample

Data Rate = **96 Mb/s**

- HDTV analog signal, 20 MHz bandwidth
  40 MHz sampling rate, 8 bits/sample

Data Rate = **320 Mb/s**