

Multimedia Applications

CSC 790

WAKE FOREST
UNIVERSITY

Department of Computer Science

Fall 2009

Distributed Multimedia Applications

- Entertainment
 - Video-on-demand
 - Multi-player games
- Collaborative work
 - Remote consultation
 - Distance learning
 - Teleoperations
- General communication
 - Internet telephony (Voice over IP) and video conferencing

All of the above have been successful, right?

Effectiveness of Video Conferencing

- Many studies about multimedia applications have found
 - *Groups are neither more effective nor efficient at problem solving when using video conferencing than when using the telephone*
- Several commercial products have not been successful
 - AT&T Picturephone, 1964, 1970, 1992
 - Intel ProShare system
 - IBM Person-to-Person system
 - *This is not a complete list...*

AT&T Picturephone



Experimental, 1957



Mod 1 version, 1964



Mod 2 version, 1969

- System consisted of a handset, monitor and camera
 - Used handset or speakerphone for audio
 - Display could show either local or remote user
 - *Public* booths in 1964 between New York and Disneyland
- Service in Washington DC, New York, Chicago, and Pittsburgh

Specifications and Price

- Generally speaking, excellent video and audio quality
 - $5\frac{1}{2} \times 5$ inch, black and white picture
 - 250 scan lines (TV quality)
 - 30 fps (perfect motion perception)
 - Required 1 MHz bandwidth (3 wire pairs), POT only 3 kHz
- Original 1964 usage price was \$75/month, \$0.15/minute
 - This does not include equipment
 - Had to wear a suit and tie
 - *Truly an awesome deal*



What Was Expected

- By 1975 AT&T expected 50,000 Picturephones sold
 - Deployed in 25 cities
- By 1980, expected 1,000,000 Picturephones deployed
 - In 3% of all businesses and 1% of residences
- By 1985, expected 2,000,000 Picturephones deployed

"Before the turn of the century, Picturephone will displace today's means of communication, and in addition will make many of today's trips unnecessary" - J. P. Molnar Bell Labs Executive Vice President, 1969



Actual System Usage

- Public Picturephone booths installed in New York, Chicago, and Washington DC (1964-1970)
 - 3 calls were placed in 1969, and 0 calls in 1970
- Local Picturephone service established in Chicago and Pittsburgh
 - Less than 100 users in Chicago in 1973, only 9 users in 1977
- Specialized test markets and free promotions
 - Public room teleconferencing, large corporations, and hospitals

All failed to create a market

What Went Wrong

- There was no *compelling* use of the technology
Why would I want to video conference?
- Lack of inertia, needed other Picturephones to talk to
 - "Picture phones are only really useful if the person you want to talk to has one at their end..."
- Users did not like it
 - People were uncomfortable and self-conscious on camera
 - It did not *add enough* to audio-only communications
 - Was not similar enough to actual face-to-face communication

Given that it was not the quality of the device or service, what does this tell you about the telephone network?

Should We Expect Something Different Today?

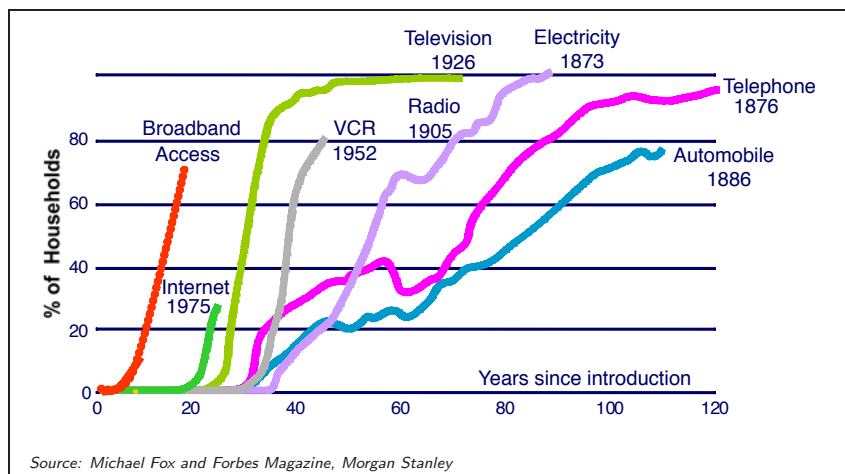
- *Is the need for this technology finally here?*
- *Is the inertia problem any better?*
- *Would the next generation of users accept this technology?*

"It's still not entirely clear that people want to be seen when on the telephone... This was not a question that was really studied before the introduction, and it's not a question as far as I know that has ever been answered," Sheldon Hochheiser, AT&T's official historian

- Internet-based multimedia applications have problems
Again, what does this tell you about the telephone network?

Internet Adoption

- Internet and broadband has had a fast adoption rate



Technology Maturity after 30 Years

- Airplanes, beginning in 1903 (Wright Flyer)
 - 1938 Stratoliner and beginning of jet engine development
- Automobiles, beginning in 1876 (Karl Benz's Motorwagen)
 - 1904 Model-T and Oldsmobile, production-line manufacturing
- Analog telephones, beginning in 1876
 - 1915 transcontinental lines available
- Railroad, beginning in 1820
 - 1860 transcontinental railway

So is inertia not an issue for Internet-based multimedia applications?

Observations on Progress

- Development model: military → professional → consumer
 - “can it be done” → “affordable” → “can grandma use it?”
 - Although this trend has reversed...

- Tends to oscillate: convergence → divergence

What are some examples? Networking examples?

- Communication technologies rarely disappear
 - Analog telephone lines still in service
 - AT&T still offers frame relay, ATM, and private lines
 - Still using original TCP even with problems at high-speed

Network Research

- Seeks changes within 10 - 20 year time frame
 - IPv6, multicast, QoS, and security
- Research community track record for applications it not good
 - Web, IM, and P2P developed by *others*
- Certain applications get more attention by researchers
 - Active networks, ad-hoc networks, (structured) P2P. etc...
 - *but successful applications don't care about scalability*
- Disconnect from standardization
 - Few attempts to bring research to standards
 - Standards committees oftn slow to catch up (e.g., P2P)

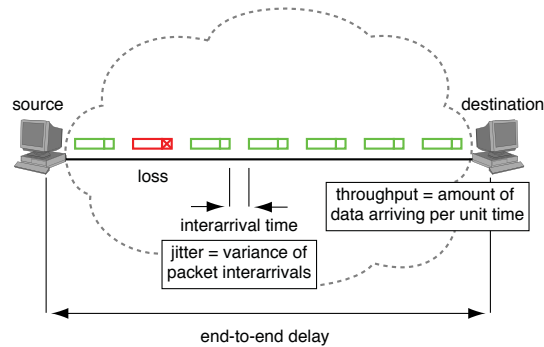
Cause of Death

- There have been several interesting ideas for the Internet
 - Most can be considered supportive to multimedia
 - However most have stalled...

	QoS	Multicast	mobile IP	active networks	IPsec	IPv6
Not manageable	†	†	†	†		
Difficult to configure	†			†	†	
No business model	†	†	†	†	†	†
No initial gain	†	†	†	†		†
Existing solution is 80%	†	†	†	†	†	†
Increases vulnerabilities	†	†	†	†		

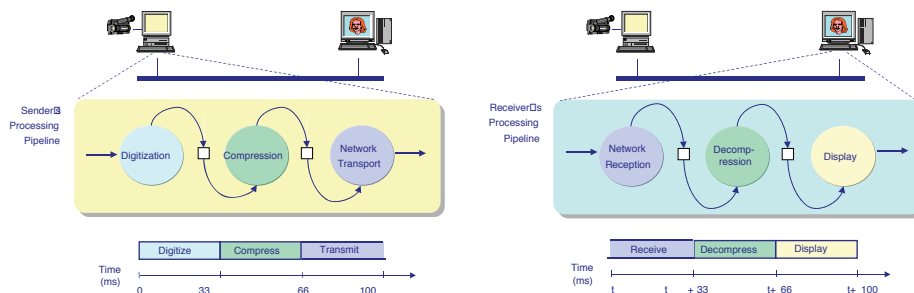
Multimedia Applications Requirements

- Multimedia benefits realized with performance bounds
 - End-to-end delay (latency)
 - Jitter
 - Throughput
 - Loss



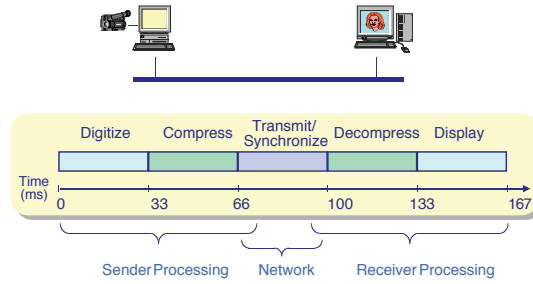
Performance Requirements

- Latency is the duration between acquisition to display
 - The network is a, but not the only, component of the delay
 - Must consider sender and receiver delays (*processing*)



- Video conferencing latency requirements, < 300 msec

End-to-End Delay Analysis



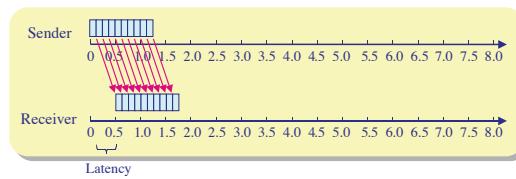
- Must consider the time from acquisition to display

delay = encode + compression + transmission + decoding + decompression + display

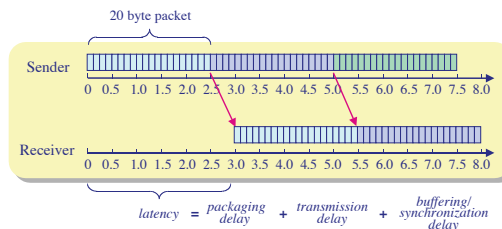
- Total must be less than targeted end-to-end delay, 300 msec

Sender Buffering and Packets

- Additional delay may be due to buffering and creating packets
 - Consider sending one sample per packet



- Consider sending multiple samples per packet

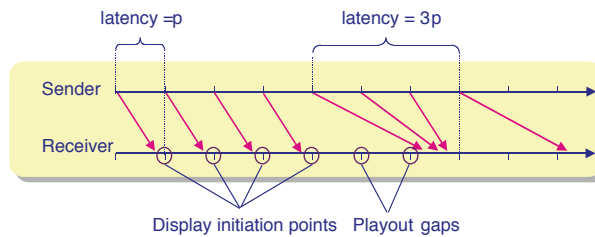


Realistic Buffering and Packaging

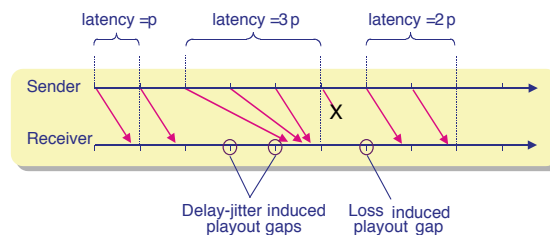
- Time to create a packet
 - 500 B requires 62.5 msec
 - 1500 B requires 187.5 msec
- A typical Internet audio packet typically contains
 - 20 to 30 msec of audio data
 - Actual size will depend on coding and compression methods

Jitter and Loss

- Delay and jitter lead to *gaps* in the play-out of media



- Loss has the same effect as delay and jitter (gaps)



Performance Requirements

- Audio can handle 1 to 2 % loss
 - Individual sample losses are noticeable
 - 5 - 10 lost samples per minute are tolerable
 - What about the distribution?*

- In terms of throughput, video requires 10 to 15 fps for *minimal motion perception*
 - Highly application dependent

Measuring Quality

- *How can you measure performance?*
 - **Mean Opinion Score (MOS)** ranking (ITU-T, P.800)
- MOS is a subjective measurement
 - Users assigned a task, give the following score

Quality	Score	Listening Effort		MOS
excellent	5	no effort	good acceptable poor	5
good	4	no appreciable effort		4.3
fair	3	moderate effort		4.0
poor	2	considerable effort		3.6
bad	1	nothing understood		3.0
				2.6
				1.0

Videoconference Performance

- Some actual videoconferencing test results [P. Calyam "Performance Measurement and Analysis of H.323 Traffic" Passive and Active Measurement Workshop (PAM), 2004.]
 - Tested using LAN and Internet connections

Metric	Good	Acceptable	Poor
Delay	0-150 msec	150 - 300 msec	> 300 msec
Jitter	0-20 msec	20 - 50 msec	> 50 msec
Loss	0-0.5%	0.5-1.5%	> 1.5%

- Found that jitter impacts perception more than loss or delay