CSc 461/561
Multimedia Systems
Multimedia Networking

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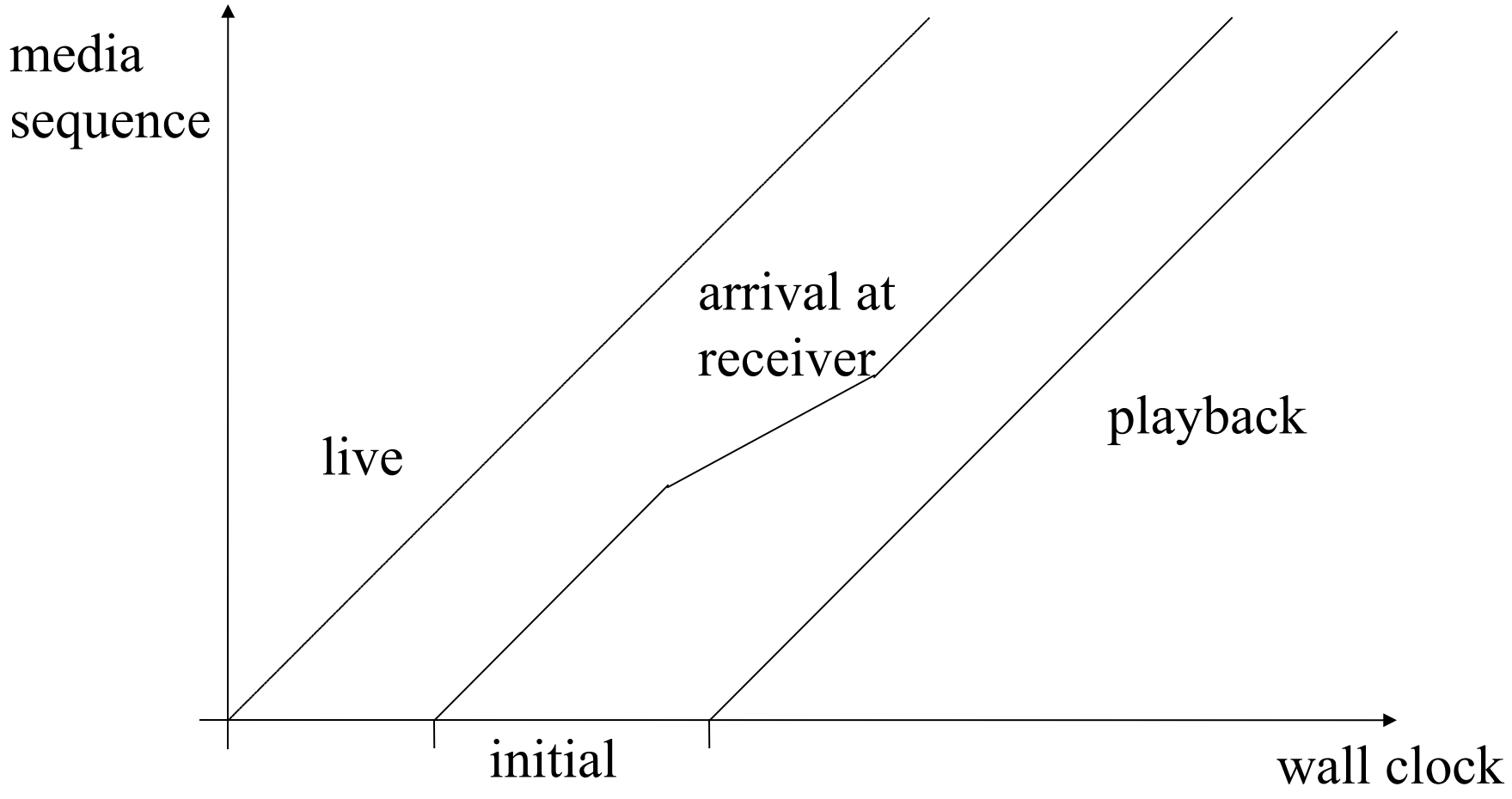
Apps-oriented view (again)

- Multimedia applications
  - normally applications involving audio/video
  - with timeliness constraints
  - and interactivity requirements
- Networked multimedia applications
  - multimedia app delivered over networks
  - usually over the Internet, often over wireless
  - with potentially many concurrent users

Multimedia applications

- Networked multimedia applications
  - stored media streaming
    - e.g., VoD (short or long video library)
  - live media streaming
    - e.g., webcast, live TV shows/games/etc
  - interactive multimedia
    - e.g., IP telephony, video conferencing, immersion
  - and many more

Multimedia streaming



* buffer twice the jitter?

Multimedia apps requirements

- The amount of multimedia data is huge
  - many need certain (minimum) bandwidth
  - some can tolerate packet loss to a certain extent
- Multimedia applications often interactive
  - many have upper bound on end-to-end delay
  - some are sensitive to delay variance (jitter)
- Multimedia may involve multiple endpoints
  - some need multicast, session management

* Internet now is mostly driven by video, i.e., elephants (vs mice)

More specifically

- In addition to min bandwidth, max delay
  - stored media streaming
    - pause (hold), fast forward, fast rewind, etc
    - initial buffering allowed, interruption undesired
  - live media streaming
    - pause (skip), etc
    - smaller initial delay, fewer interruptions
  - interactive media
    - more stringent delay budget to allow interactivity

The (traditional) Internet

- Best-effort service
  - no admission control
  - no guarantee on bandwidth, delay, loss
- Mainly point-to-point transmission
  - one sender and one receiver
- Mostly client-server transaction
  - request/reply between client and server
  - in-band signaling

* the mismatch: the (original) Internet vs multimedia applications

A (better) Internet

- Integrated service (IntServ/RSVP)
  - flow-level QoS guarantee
- Differentiated service (DiffServ)
  - a much coarser level of QoS provisioning
- Better than best-effort service
  - over-provision when affordable
  - client-proxy-server, CDN, peer-to-peer
  - application-layer QoS, multicast support

* FIND: future internet network design; clean-slate design vs evolution

Multimedia, mobility, multicast

- IP multicast support
  - IP multicast, multicast routing
  - group management
- Application-layer multicast support
- IP mobility support
  - Mobile IP
  - MIP routing optimization
- Application-layer mobility support

* link-layer multicast capability and mobility support

TCP and multimedia

- TCP
  - point-to-point
  - window-based flow control
  - retransmission error recovery
  - embedded congestion control
- Multimedia
  - multi-point
  - min bandwidth
  - max delay/jitter
  - loss tolerant
  - smooth playback
- There're more TCP-based streaming apps, but there're tricks!

* TCP or UDP? how about firewalls and NATs?

New protocol support

- "Real-time" transport protocol (RTP)
  - payload type (i.e., *multi*media)
  - sequence number
  - timestamp (i.e., *temporal* information)
- RTCP: control companion
  - receiver report: packet loss, inter-arrival, etc
  - sender report: information about sent data
  - *out-of-band* control information exchange

More protocols

- Session initiation protocol (SIP)
  - a session may contain many media streams
  - SIP: like SS7 for PSTN, essential!
  - coordinate caller and callee
  - negotiate media streams
    - SDP: session description protocol
  - maintain ongoing session
    - add/change media, hold/transfer calls, etc

This lecture

- Introduction to multimedia networking
  - why multimedia is different and difficult
  - enhancement to Internet architecture
  - addition to layered protocols
    - link, network, transport, session, application, etc
- Explore further
  - multimedia streaming with TCP!
  - RTSP: real-time streaming protocol [RFC2326]

Next lecture

- 2nd Ed Chapter 15
- Multicast [Ref CHW]
  - Internetworking Multimedia
  - by Jon Crowcroft, Mark Handley, Ian Wakeman

    http://www.cl.cam.ac.uk/~jac22/books/mm/book/book.html

Also: Computer Networking: A Top-down Approach featuring the Internet, Fourth (or newer) Edition

James F. Kurose, Keith W. Ross

Pearson, ISBN: 0-321-49770-8