Chapter 2

Multimedia Networks: Requirements and Performance Issues

Yu-Chen Kuo

★ Identify important performance parameters for distributed multimedia applications

See Fig. 2-1 pp.20

❑2.2 Peer-to-Peer and Multipeer Communication

- unicast
  - peer to peer
  - client-to-server applications

    home-shopping, banking, video-on-demand
- multicast
  - peer to multipeer (1 to n / 1 to all :broadcast)

    distance-learning, teleseminar
  - multipeer to multipeer

    teleconference

See Table 2-1 pp. 21

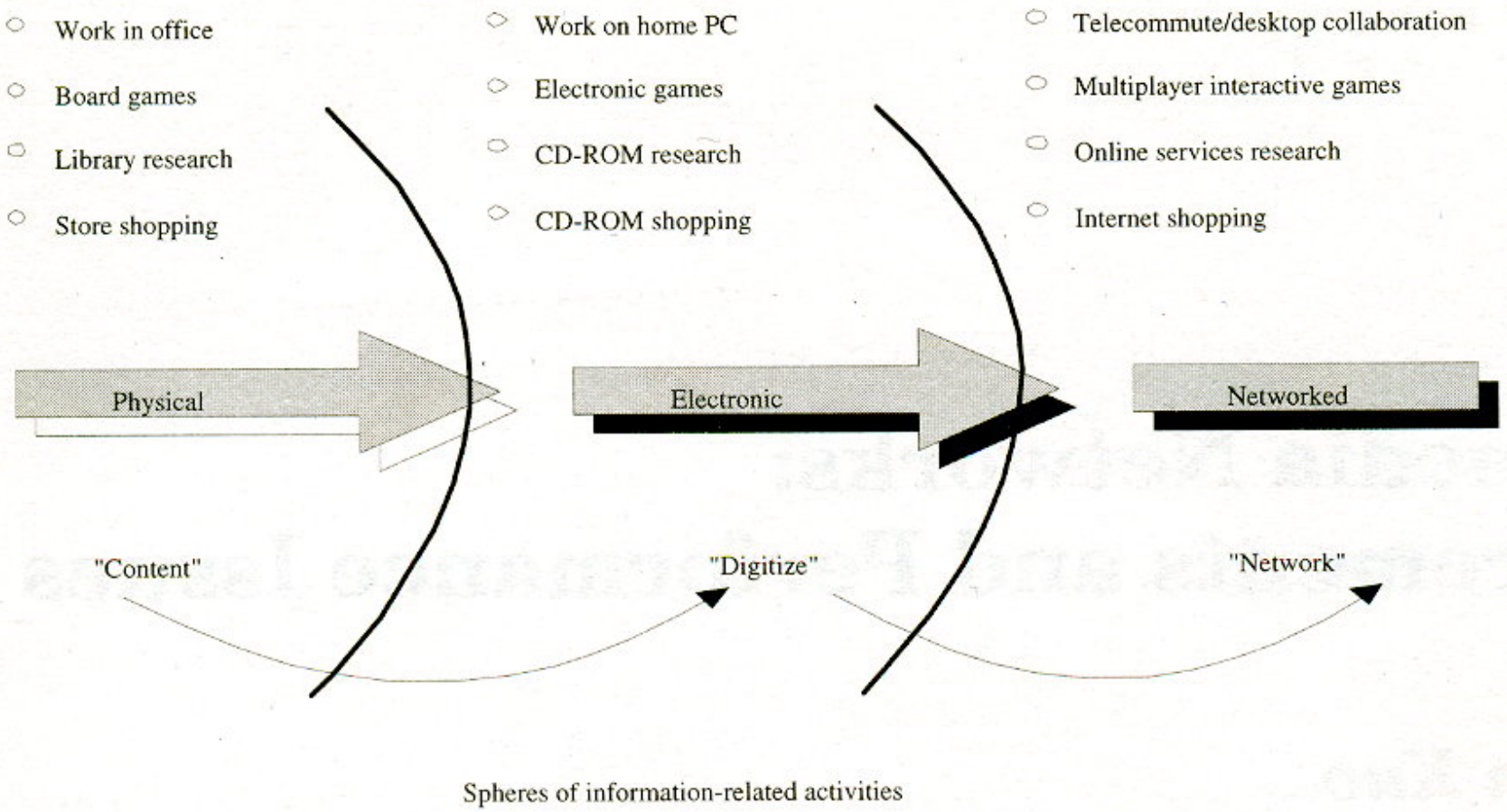

Figure 2–1 Evolution of Networked Services

Type	Description	Interaction	Data Flow	Accessibility
CSCW	All can send/receive data	Dynamic	N to N	Controlled
Virtual Cafe	All can send/receive data	Dynamic	N to N	Uncontrolled
Broadcasting	One sender, many receivers	Static	1 to N	Controlled
Monitoring	One receiver, many senders	Static	N to 1	Controlled

Table 2–1 Characteristics of Selected MIM Applications

❑2.3 Network Performance Parameters for Multimedia

- Throughput

  network effective bit rate or effective bandwidth

  physical bit rate — various overheads

  (network congestion, bottlenecks, node/line faults)

  e.g., ATM(155Mbps)—9.5%overhead ≅ 136Mbps

- Error Rate

  —bit error rate (BER) : 10^{-9} ~ 10^{-12}(fiber), 10^{-7} (satellite)

  —packet error rate (PER)

  —frame (cell) error rate : ATM

  —more important for electronic funds application

  less important for video application

- Delay (End-to-End Delay) :

  the time for transmitting a block from sending to receiving

  - Transit delay : satellite link
  - Transmission delay:

    transmission time + processing time

    bit rate of network routing+buffering
  - Network delay: Transit delay + Transmission delay
  - Interface delay : setup connection (dialup)

  See Fig. 2-2 pp. 23
- Round-trip delay
  - total time between sending a block and receiving an ack.
  - connection-oriented networks (TCP/IP) for retransmission (time out)

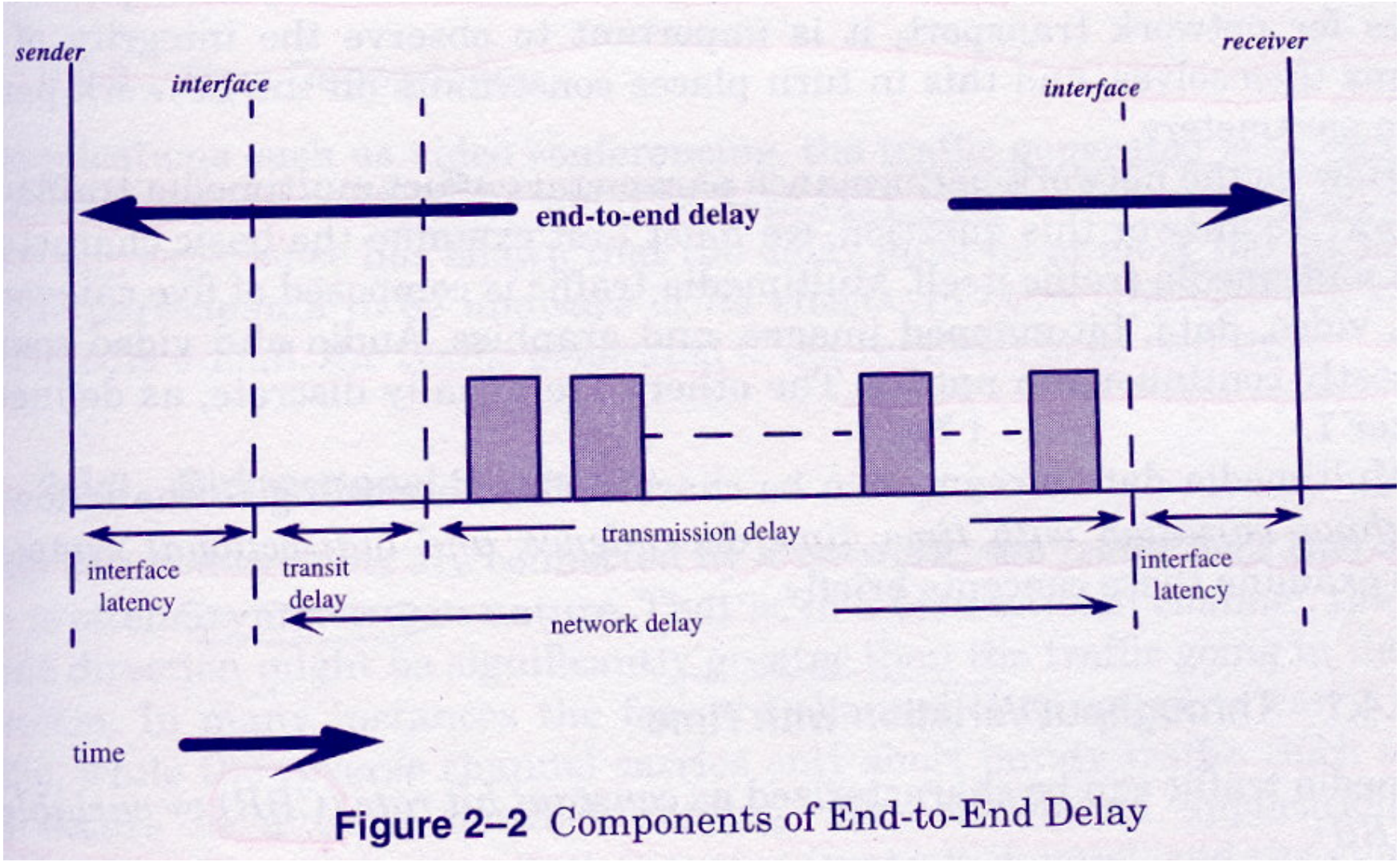

Figure 2–2 Components of End-to-End Delay

- Delay variation or Jitter
  - end-to-end delay may be varied
  - uniform delay
  - upper limit on permissible jitter

❑2.4 Characteristics of Multimedia Traffic Sources

audio, video, data, bit-mapped image, graphics

- Throughput variation with time
  - constant bit rate (CBR)
    - CD-ROM
    - constant bit rate transmission (ISDN)
  - variable bit rate (VBR)
    - MPEG Video
    - burst traffic
    - measure by peak traffic rate / mean traffic rate
    - carefully control when transmission even in CBR/VBR network

- Time dependency
  - multimedia traffic generated in real time
    - video conference
  - end -to-end delay must keep very low
    - unlike VOD, video can be transferred before needed
- Bidirectional Symmetry
  - asymmetric traffic
    - down stream traffic ≠ upstream traffic

      VOD downstream > = upstream
  - symmetric traffic
    - down stream traffic = upstream traffic

      peer-to-peer teleconference

❑2.5 Factors that Affect Network Performance

factors for throughput, error rate, delay, delay jitter

- Throughput performance factors
  - — nodes or link failures

    packet delay/loss, congestion on other nodes
  - — congestion
    - ◆ demand network capacity >> availability
    - ◆ heavy traffic
    - ◆ bottleneck

    ⇨
    - ▪ throughput ↓ when network load ↑
    - ▪ drop packets when buffers overflow
    - ▪ network management start to decrease traffic on certain links
    - ▪ heavily nodes become bottlenecks

- bottlenecks
  - node/link failures
  - inadequate link/node capacity
- buffer capacity
  - may inadequate to send or receive in video app.

    See Fig. 2-3 pp 27
  - overflow/underflow
- flow control
  - limit data rate to prevent data loss at receive side

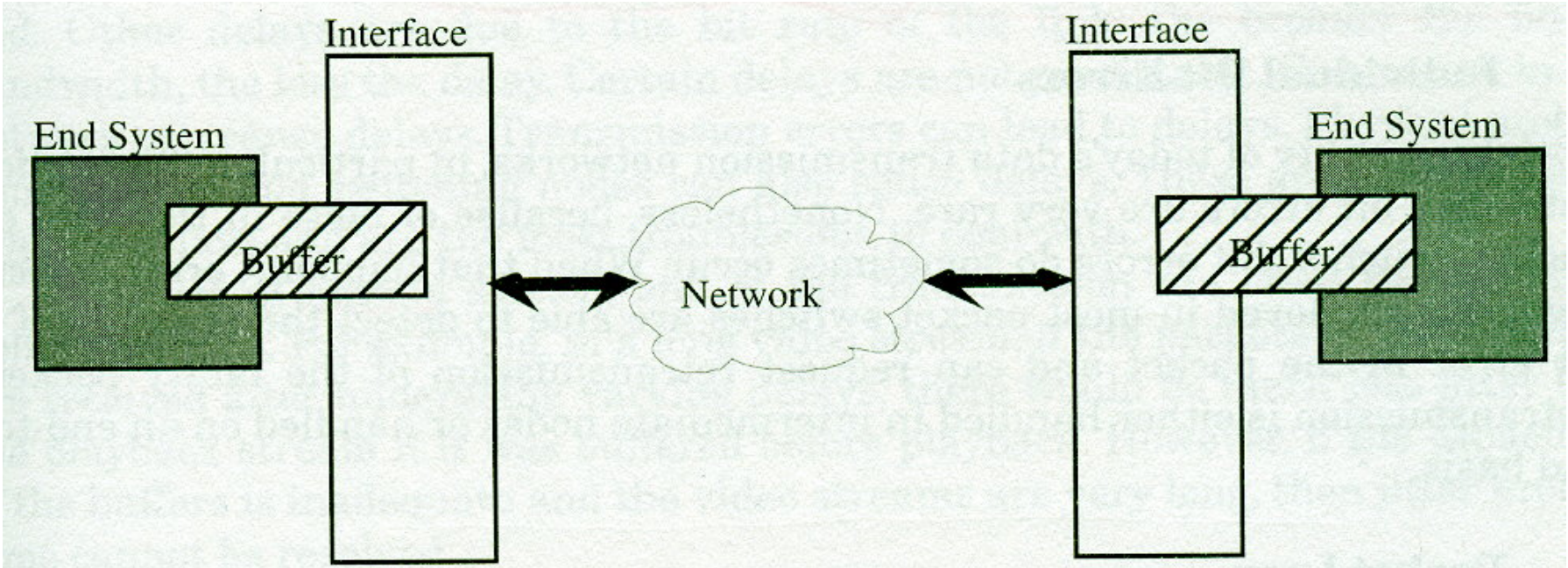

Figure 2–3 Buffering in End-to-End Connections

- Issues in Network Error Performance
  - individual bit errors
    - rare in today‘s network
    - detect by CRC checksum
    - retransmission by intermediate node or sender
  - packet loss
    - connection oriented
      - setup connection first
      - acknowledge for each packet
      - easy to detect packet loss by receiver
      - retransmission by sender

- connectionless (best effort)
  - hard to detect
  - due to insufficient buffer
  - handle by upper applications

— out-of-order packets
- data is divided into some small packets
- individually sending packets
- rearrange those packets according to the sequence

- Network Delay Performance Issue
  - inevitable (satellite one-way transit delay: 0.25 sec)
  - Congestion
  - Transmission error
  - Physical problem in lines or switching node

  ⇨ use buffer at each end to smooth out delay problem

❑2.6 Multimedia Traffic Requirements for Networks

*network requirements for multimedia traffic

- Throughput requirements

– high transmission bandwidth requirement to handle busty real-time video and audio traffic

⇨ insufficient bandwidth

→ longer end-to-end delay, packet loss

– high storage bandwidth requirement sufficient buffer capacity to receive incoming data

input data rate r → buffer → output data rate s

buffer data when $r > s$, and overcome delay when $s > r$

- streaming requirement (continuous)

  network to meet the streaming requirement (1.5Mbps)

  network capacity >= aggregate bit rate of streams

  for many streaming

- Reliability (error control) requirements
  - difficult to precisely quantity error control
  - multimedia applications can tolerant some errors
  - losing video /audio is undetectable by human
  - dropped packets are more noticeable in audio than in video
  - dropped packets are more noticeable in text than in video/audio
  - handle packet loss / error cause some delays; in real-time application delay is more important than error

- Delay requirements
  - asynchronous network
    no upper limit on delay → delay jitter may be larger
  - synchronous network
    a fixed predictable delay → delay jitter =0
  - isochronous
    delay between T and T+dT → delay jitter <= dT

※ delay jitter sometimes is more important than end-to-end delay

delay jitter → arrival rate → buffer capacity→real time (Qos)

❑2.7 Quality of Service (QoS)

how well a network performs in dealing with multimedia application

QoS requirements (parameters)

- max allowable delay
- delay jitter
- throughput
- error rate

e.g., real-time conferencing may impose QoS requirements on latency and throughput; others may require zero error rate

→ how well the network is able to meet the QoS requirements for a application

- New QoS concepts
  - resource reservation and scheduling
    request pattern is known in advance (period)
  - resource negotiation
    negotiate the requester and offer a lower QoS when overload
  - admission control
    reject the application whose QoS requirement is so high that network can meet it
  - Guaranteed QoS
    network status $\rightarrow$ meet application QoS requirement