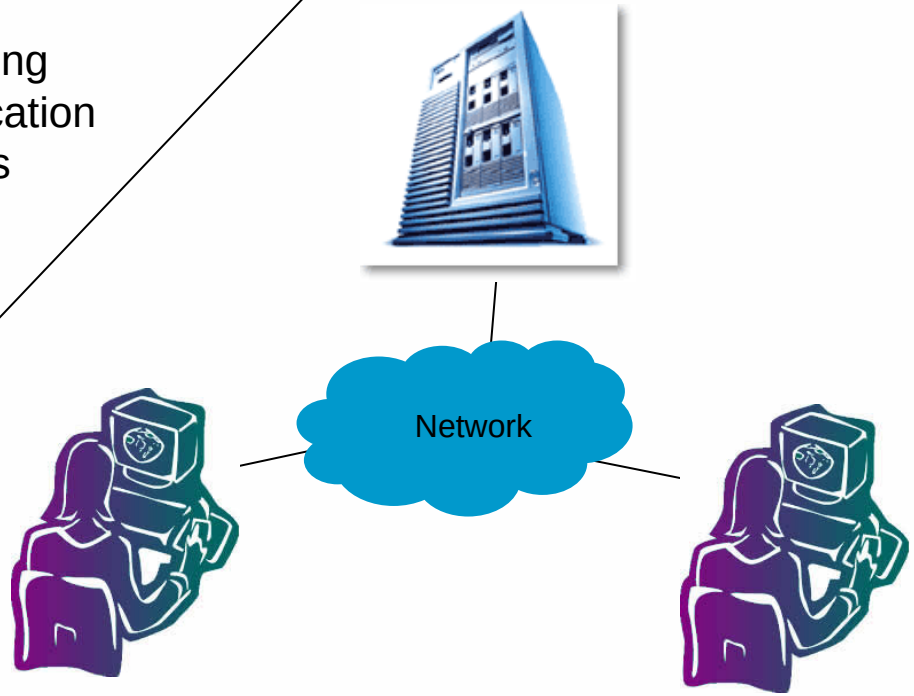
Digital Media Development
- Media Streaming -

Prof. Dr. Andreas Schrader
ISNM International School of New Media
University of Lübeck
Willy-Brandt-Allee 31a
23554 Lübeck
Germany
Schrader@isnm.de

Introduction

Introduction

- Digital Multimedia Systems – Networked Multimedia
  - ***Stand-alone Multimedia System***
    - CBT – Computer-based training
    - CBE – Computer-based education
    - Multimedia authoring systems
    - Gaming



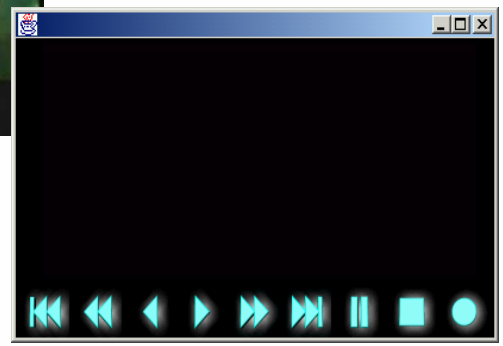
  - ***Networked Multimedia System***
    - Video-Conferencing
    - Online education
    - Online gaming
    - CSCW – Computer-supported collaborative working

Introduction

- Multimedia Applications – Typical Examples

IP-Telephony

Online Gaming

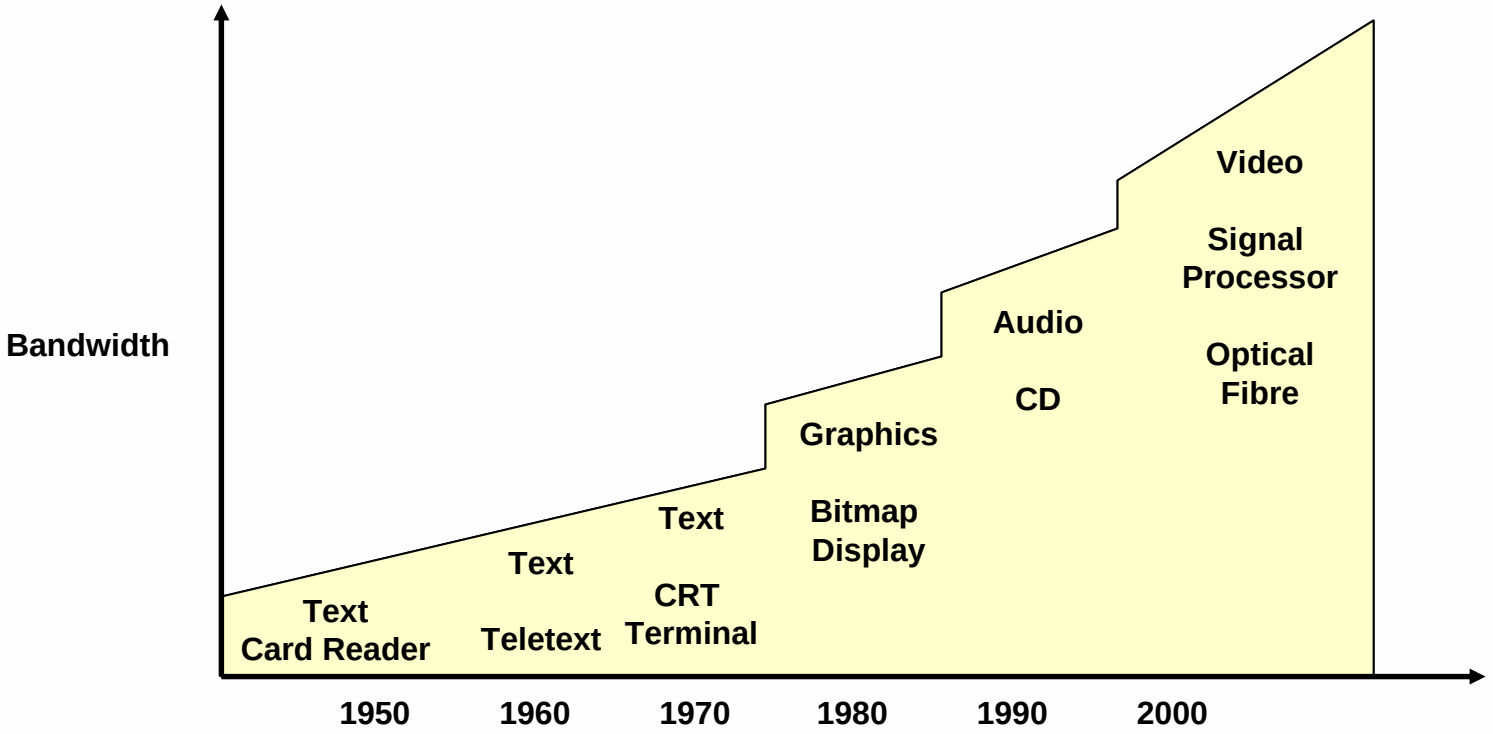


Internet Television
Video Distribution
Video-on-Demand
Distance Learning

Audio/Video-Conferencing

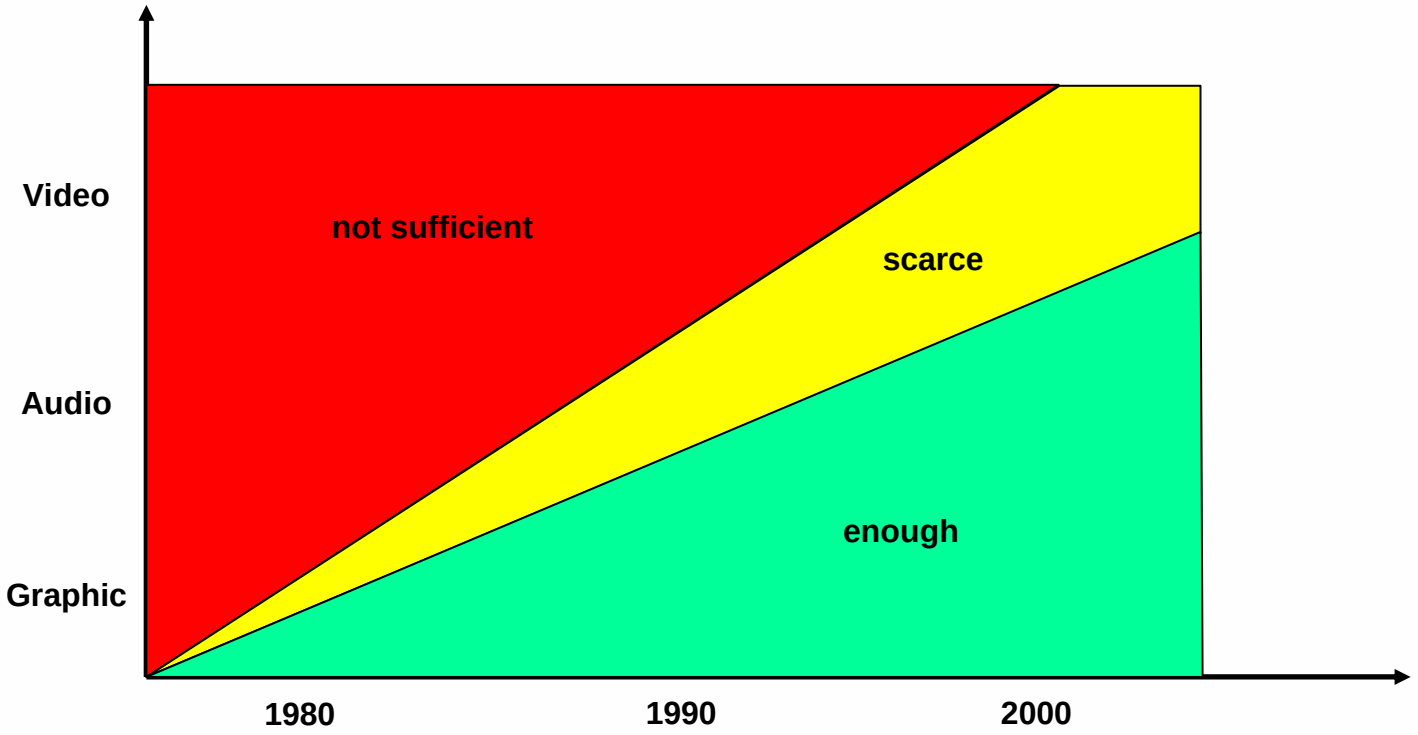
Introduction

- Multimedia in Networks – Bandwidth Development



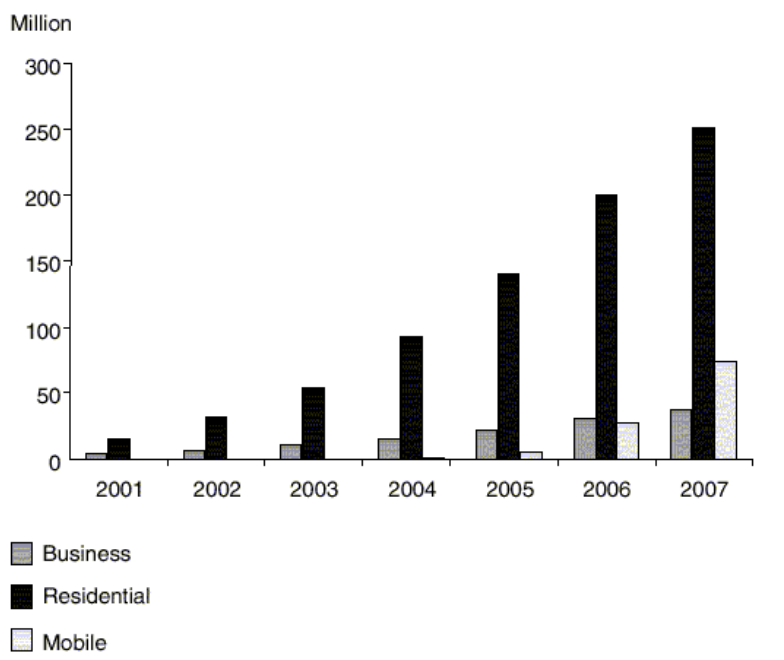
Introduction

- Digital Multimedia Systems – Possibilities and Restriction



Introduction

- Multimedia streaming will be ***key issue*** in the future Internet

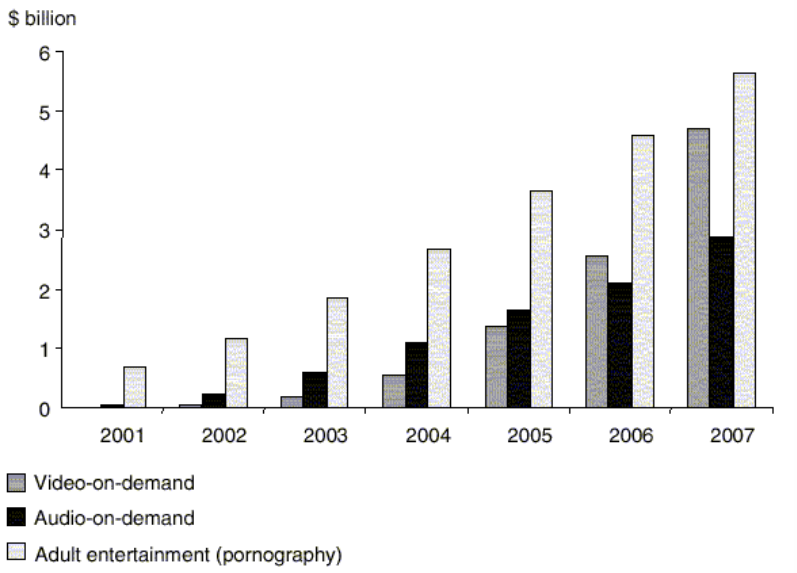


Number of Streaming End-points World-Wide

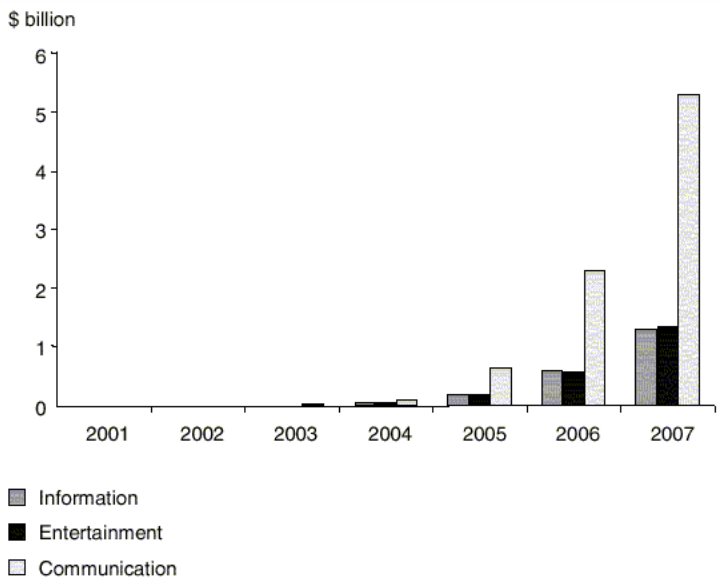
Source: Ovum, Streaming Media: Commercial Opportunities, Forecast, 2002

Introduction

- Hugh ***potential revenues*** for streaming provider



Residential Market



Mobile Market

Source: Ovum, Streaming Media: Commercial Opportunities, Forecast, 2002

Time-Based Media Delivery

Introduction

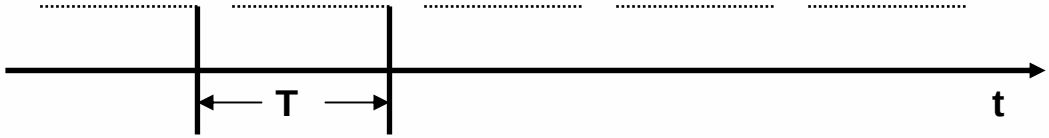
- Media Streaming
  - Transmission of discrete and continuous media data
  - Data is decomposed into ***units*** (packets) before transmission
  - Packets are sent from the source (sender) to the sink (receiver)
  - A media stream consists of a (temporal) sequence of packets.
  - It has a time component and a lifetime

  - ***Asynchronous media streams***
    - No coordination between sender and receiver - transmission start at any time
    - Independent clocks
    - Example: keystroke on keyboard
  - ***Synchronous media streams***
    - Transmission only starts at well defined times
    - Late arriving packets are of no value – bandwidth must be guaranteed
    - Example: audio and video transmission
  - ***Isochronous media streams***
    - Synchronous stream with periodic arrival times of constant distance
    - No variation of delay possible

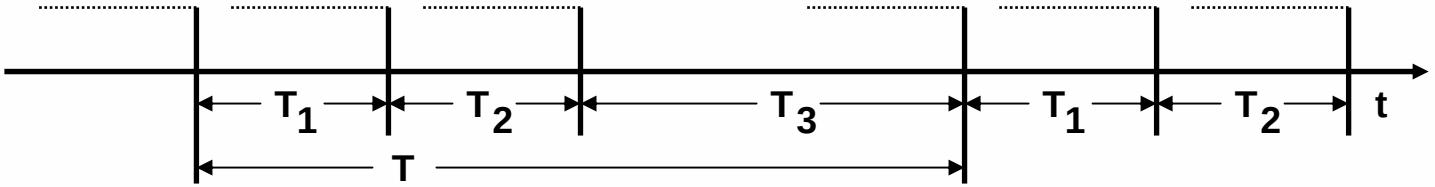
Source: Steinmetz, Nahrstedt: Multimedia Fundamentals, Volume 1, Prentice Hall, 2002

Introduction

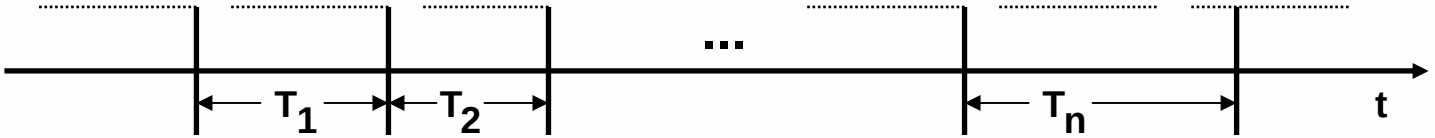
- Media Streaming – Packet Timing
  - ***Strongly periodic***
    - Constant intervals



  - ***Weakly periodic***
    - Function describes periodicity within certain intervals



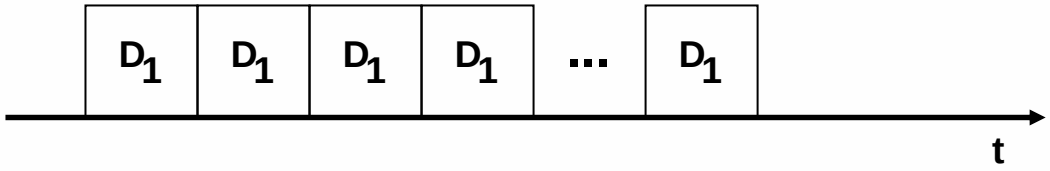
  - ***Aperiodic***
    - No analytic function description



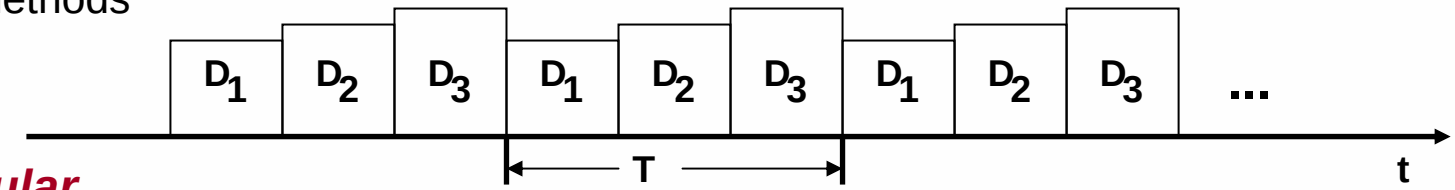
Source: Steinmetz, Nahrstedt: Multimedia Fundamentals, Volume 1, Prentice Hall, 2002

Introduction

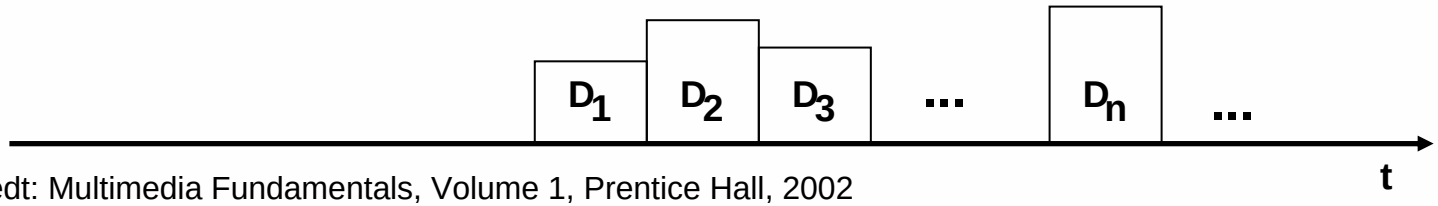
- Media Streaming – Packet Volume
  - ***Strongly regular***
    - Constant data volume (packet size), typical for umcompressed audio or video streams



  - ***Weakly regular***
    - Data quantity varies periodically, typical for some video compression methods



  - ***Irregular***
    - Data quantity is neither constant nor changing by a periodic function

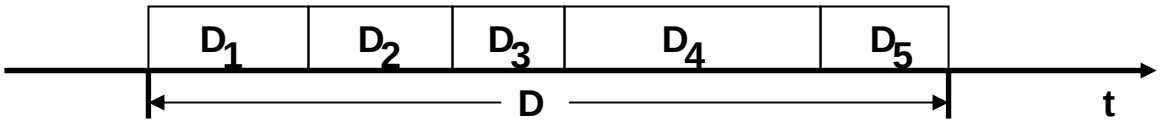


Source: Steinmetz, Nahrstedt: Multimedia Fundamentals, Volume 1, Prentice Hall, 2002

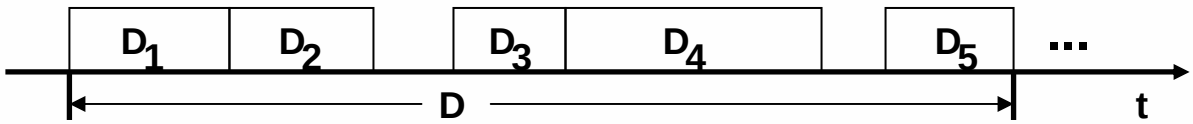
Introduction

- Media Streaming – Interrelation of consecutive packets

  - ***Coherent stream***
    - No gaps between media packets
    - Unit identification information is included in stream
    - Resource is utilized 100%
    - Example: ISDN telephone channel with 64kbps audio stream



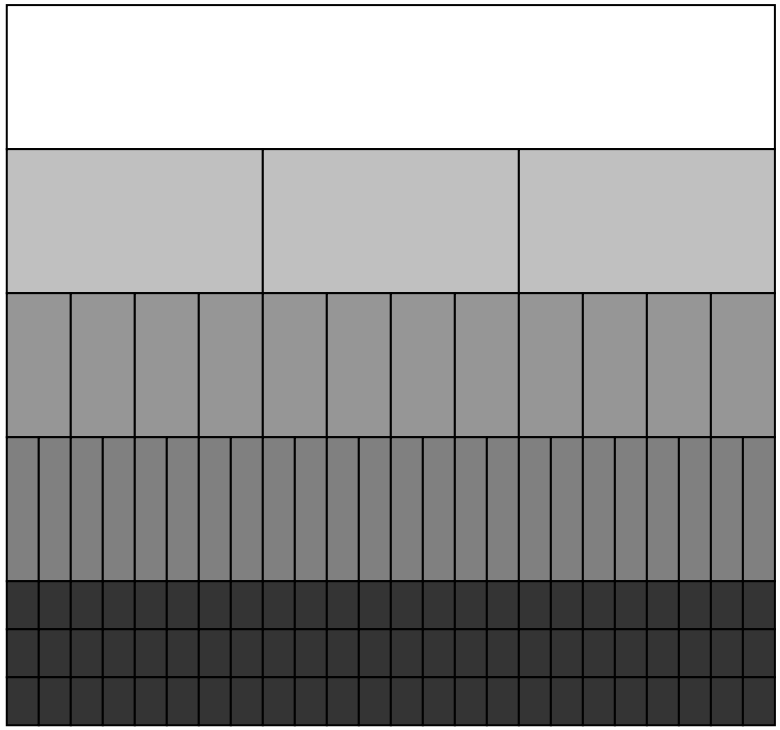
  - ***Non-coherent stream***
    - Possibly gaps occur between consecutive packets
    - Example: irregular data stream over channel with constant bandwidth



Source: Steinmetz, Nahrstedt: Multimedia Fundamentals, Volume 1, Prentice Hall, 2002

Introduction

- Media Streaming – Media Units
  - ***Logical data units (LDU)***
    - Different levels
    - Different granularities
  - Different types of operations for different LDUs, e.g.:
    - Score shifting
    - Refrain filtering
    - Song compression
    - CD transmission



Example LDUs for Video

Source: Steinmetz, Nahrstedt: Multimedia Fundamentals, Volume 1, Prentice Hall, 2002

Service Quality Parameters

Introduction

- ***Bandwidth***
  - Is directly proportional to the possible amount of data transmitted or received per unit time
  - Analog systems: difference between highest-frequency signal component and lowest-frequency signal component (in Hz)
  - Digital systems: possible amount of data transmitted per unit time (in bps, Kbps, or Mbps)

  - ***Bandwidth***
    - raw bits, including synchronization, FEC, etc.
  - ***Throughput***
    - user data or link layer data
  - ***Goodput***
    - useful user data excluding re-transmission, errors, etc.

Introduction

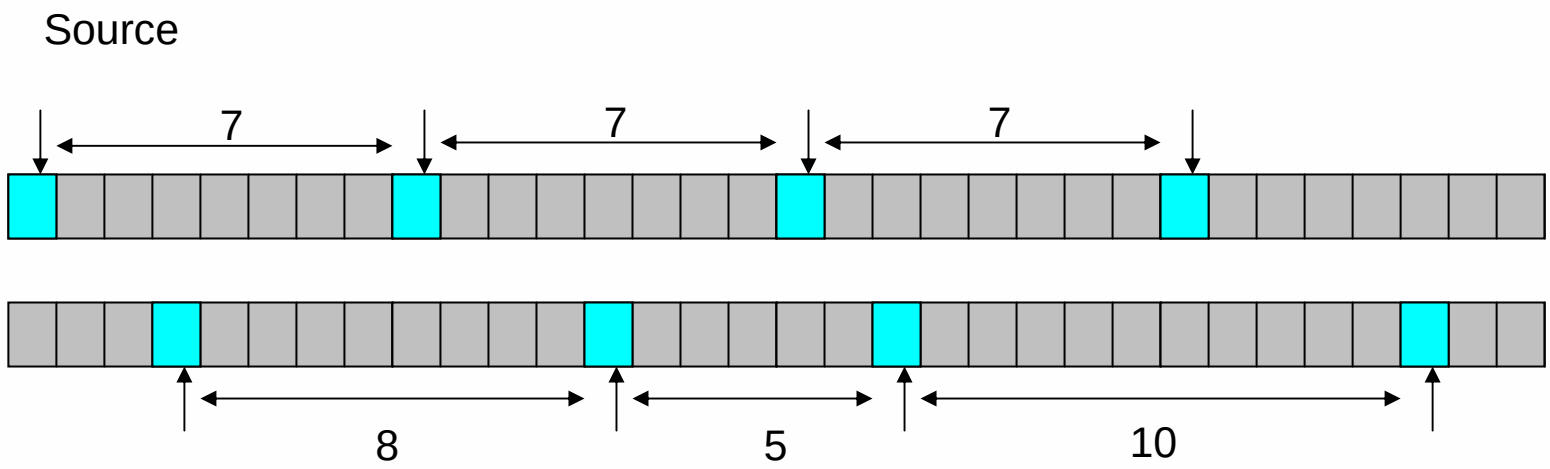
- ***Latency (or Delay)***
  - Time to send message from point A to point B
  - Delay is difficult to measure
  - Synchronized clocks needed
  - One-way versus round-trip time (RTT – estimated delay):

$$\lambda = p + t + q$$

  - with latency propagation time p, transmit time t, and queing time q
    - p=d/c, with *distance* d and *speed of light* c (physics)
    - t=s/b, with *size* of packet s and *bandwidth* b of the network (network type dependent)
    - *queuing delay* q (load dependent)

Introduction

- ***Jitter (Delay Variance)***



Source delay: 7, 7, 7

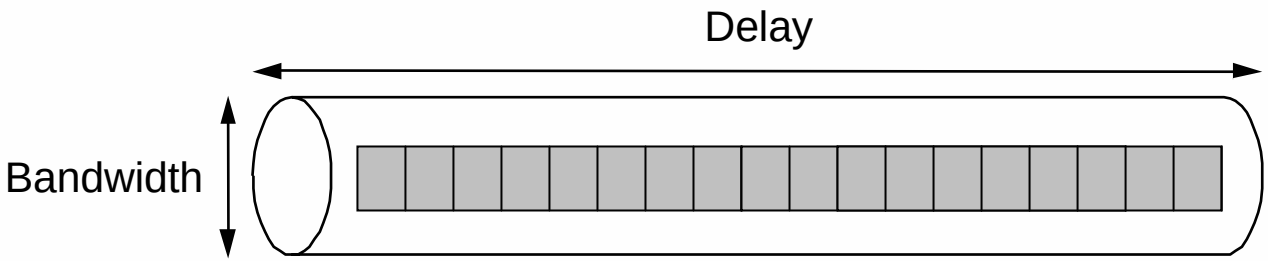
Destination delay: 8, 5, 10

Average: 23/3=7.66

Jitter: [-2.66 ... + 2.33]

Introduction

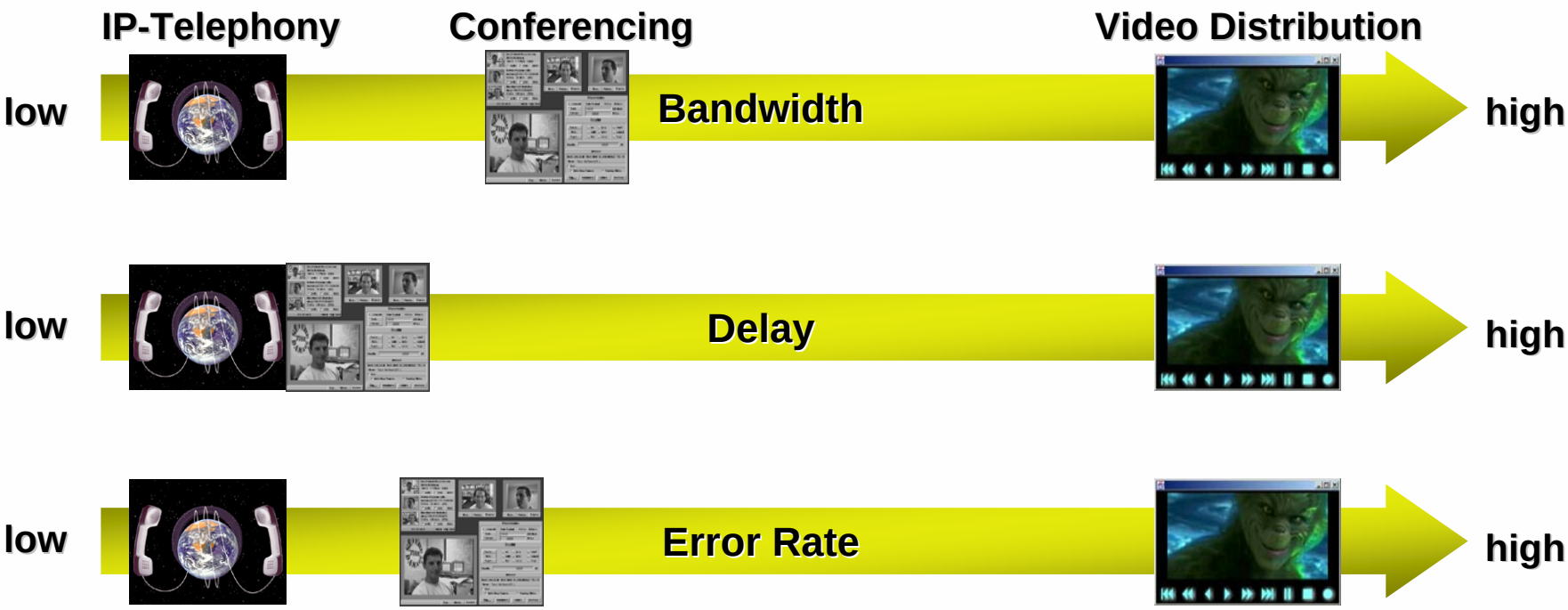
- ***Delay x Bandwidth Product***
  - Amount of data ‚in flight' or ‚in the pipe'
  - Example: 100ms x 45Mbps = 562.5 KByte



- ***Loss Ratio***
  - Buffer overflows in router queues
  - Fading in wireless networks
  - Bursty errors are most harmful

Introduction

- Multimedia Applications – Service Quality Requirements
  - Varying Quality-of-Service requirements:
  - Interactive/non-interactive, realtime/non-realtime, unicast, multicast



Introduction

- Example network values
  - Very heterogeneous constraints
  - Large range of bandwidths: 2.4Kbps : 2Gbps ~ 1:1 million
  - Difficult to decide the appropriate codec

Technology	Bandwidth (bps)	Loss Rate
GSM	Speech 13K ; Data 2,4K - 9,6K	high
Modem	9,6K - 56K	high
ISDN	64K / 132K	low
UMTS	64K - 2M	high
xDSL	128K - 5M	low
DAB	384K	medium
Token Bus	1,5M - 10M	low
Wireless LAN	2M / 11M	medium
Token Ring	4M / 16M	low
Ethernet	10M / 100M	low
FDDI	100M	low
ATM	155M - 2G	low