Multimedia Systems

Chapter: Multimedia Systems

- What is Multimedia
- Compression Techniques
- Requirements of Multimedia Kernels
- CPU Scheduling
- Disk Scheduling
- Network Management
- An Example: Cineblitz

Objectives

- To identify the characteristics of multimedia data
- To examine several algorithms used to compress multimedia data
- To explore the operating system requirements of multimedia data, including CPU and disk scheduling and network management

What is Multimedia?

- Multimedia data includes
  - audio and video clips (i.e. MP3 and MPEG files)
  - live webcasts

- Multimedia data may be delivered to
  - desktop PC’s
  - handheld devices (PDAs, smart phones)

Media Delivery

- Multimedia data is stored in the file system like the ordinary data.
- However, multimedia data must be accessed with specific timing requirements.
- For example, video must be displayed at 24-30 **frames** per second. Multimedia video data must be delivered at a rate which guarantees 24-30 frames/second.
- **Continuous-media data** is data with specific rate requirements.

Streaming

- **Streaming** is delivering a multimedia file from a server to a client - typically the deliver occurs over a network connection.
- There are two different types of streaming:

  1. **Progressive download -** the client begins playback of the multimedia file as it is delivered. The file is ultimately stored on the client computer.

  2. **Real-time streaming -** the multimedia file is delivered to - but not stored on - the client's computer.

Real-time Streaming

- There are two types of real-time streaming:

  (1) **Live streaming** - used to deliver a live event while it is occurring.

  (2) **On-demand streaming** - used to deliver media streams such as movies, archived lectures, etc. The events are not delivered in real-time.

Multimedia Systems Characteristics

- Multimedia files can be quite large.
- Continuous media data may require very high data rates.
  - Consider a video of resolution 800*600. If we use 24 bits to represent colour, we have 2^24 (about 16 million colours). A single frame requires 800*600*24=11,520,000 bits of data. If the frames are displayed 30 frames per second we requires more than 345 Mbps bandwidth.
- Multimedia applications may be sensitive to timing delays during playback of the media.

Compression

- Because of the size and rate requirements of multimedia systems, multimedia files are often compressed into a smaller form.
- Basic idea
  - Lossy compression
  - Store the differences between successive frames.
- MPEG Compression:

  (1) MPEG-1 - 352 X 240 @ 30 frames/second

  (2) MPEG-2 - Used for compressing DVD and high-definition television (HDTV)

  (3) MPEG-4 - Used to transmit audio, video, and graphics. Can be delivered over very slow connections (56 Kbps)

Operating Systems Issues

- The operating system must guarantee the specific data rate and timing requirements of continuous media.

- Such requirements are known as **Quality-of-Service** (**QoS**) guarantees.

Parameters Defining QoS

- **Throughput -** the total amount of work completed during a specific time interval.
- **Delay -** the elapsed time from when a request is first submitted to when the desired result is produced.
- **Jitter -** the delays that occur during playback of a stream.
  - Due to lost frames.
  - Not acceptable for continuous media applications
- **Reliability -** how errors are handled during transmission and processing of continuous media.

Requirement of Multimedia Operating Systems

- There are three levels of QoS

  (1) Best-effort service - the system makes a best effort with no QoS guarantees.

  (2) Soft QoS - allows different traffic streams to be prioritized, however no QoS guarantees are made.

  (3) Hard QoS - the QoS rquirements are guaranteed.

Further QoS Issues

- QoS may be **negotiated** between the client and server.
- Operating systems often use an **admission control** algorithm that admits a request for a service only if the server has sufficient resources to satisfy the request.
  - Resource reservation
  - Requests arrive with associated QOS.
  - Assigns a resource manager for each type of resource.
  - The resource manager rejects the service if it can not allocate resources to meet QOS.

QoS Guarantees

- Guaranteeing QoS has the following effects in a computer system:

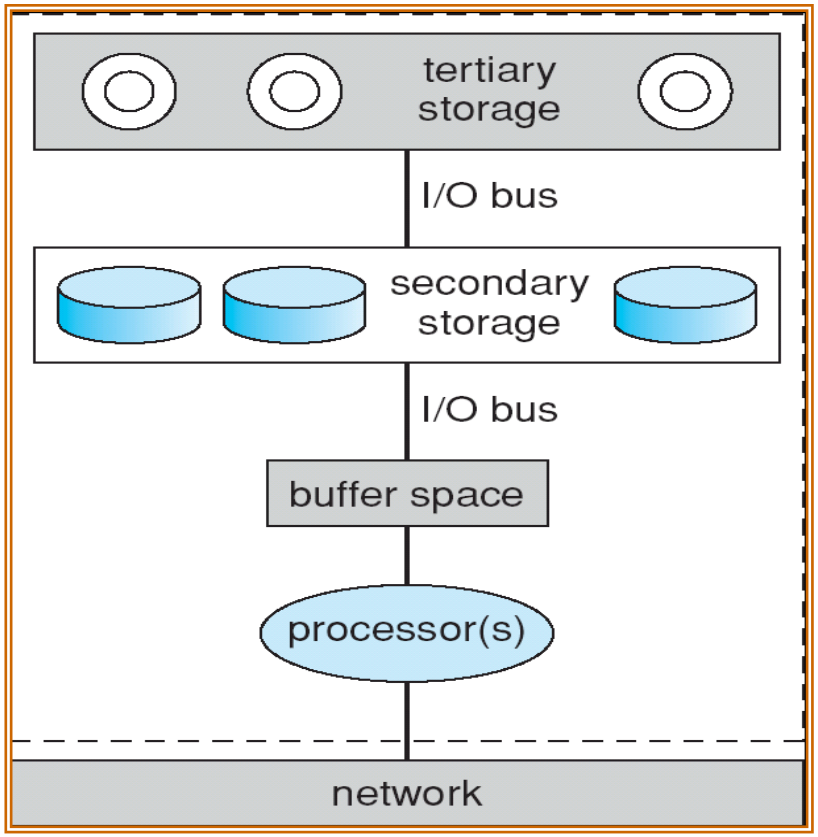
  (1) CPU processing

  (2) Scheduling

  (3) File systems

  (4) Network protocols

Figure 20.1
Resources on a file server



CPU Scheduling

- Multimedia systems require **hard realtime** scheduling to ensure critical tasks will be serviced within timing deadlines.

- Most hard realtime CPU scheduling algorithms assign realtime processes static priorities that do not change over time.

Disk Scheduling

- Disk scheduling algorithms must be optimized to meet the timing deadlines and rate requirements of continuous media.
- Earliest-Deadline-First (EDF) Scheduling
- SCAN-EDF Scheduling

Disk Scheduling (cont)

- The EDF scheduler uses a queue to order requests according to the time it must be completed (its deadline.)

- SCAN-EDF scheduling is similar to EDF except that requests with the same deadline are ordered according to a SCAN policy.

Deadline and cylinder requests for SCAN-EDF scheduling

request	deadline	cylinder
A	150	25
B	201	112
C	399	95
D	94	31
E	295	185
F	78	85
G	165	150
H	125	101
I	300	85
J	210	90

Network Management

- Three general methods for delivering content from a server to a client across a network:

  (1) **Unicasting -** the server delivers the content to a single client.

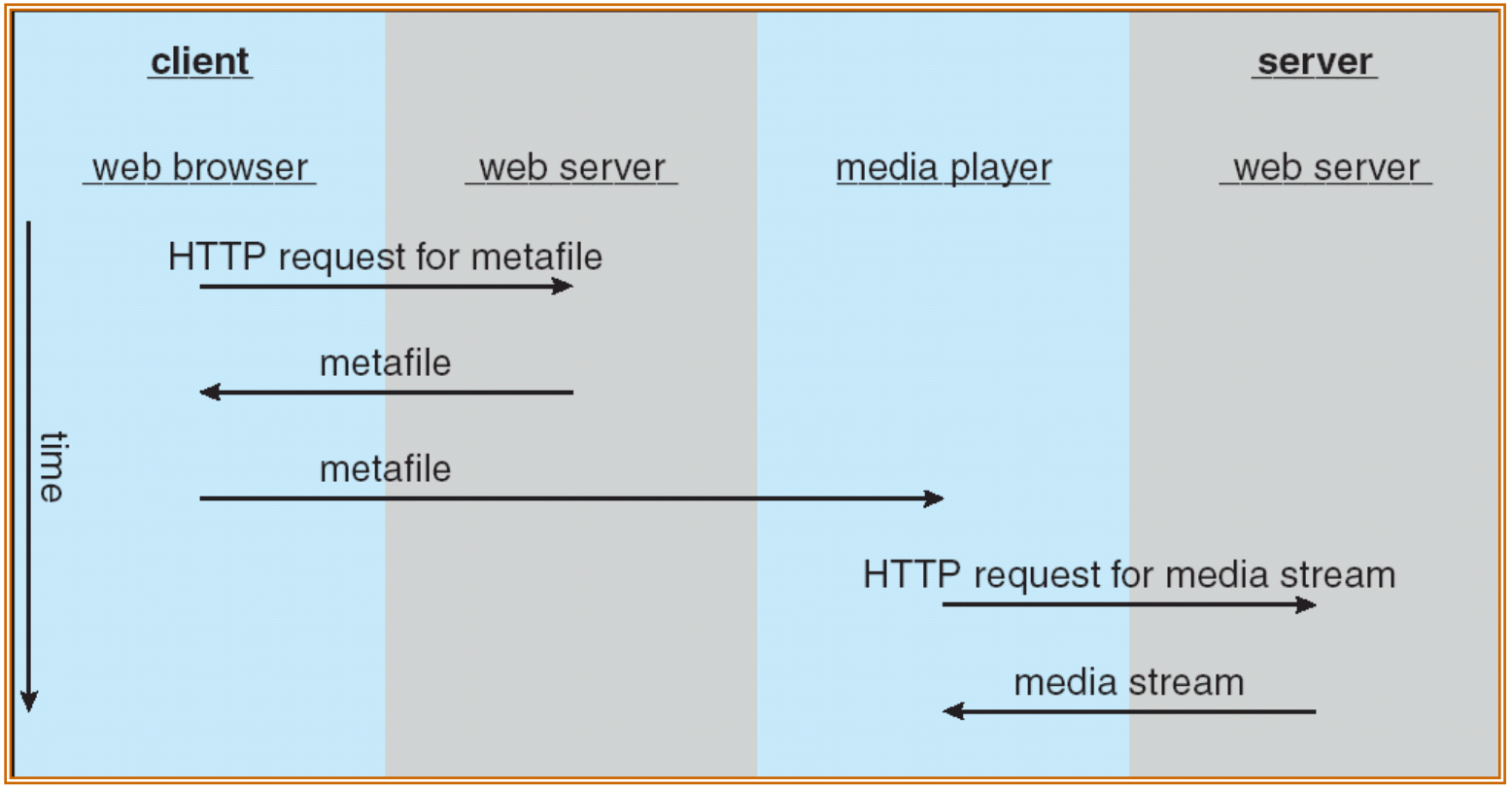
  (2) **Broadcasting -** the server delivers the content to all clients, regardless whether they want the content or not.

  (3) **Multicasting -** the server delivers the content to a group of receivers who indicate they wish to receive the content.

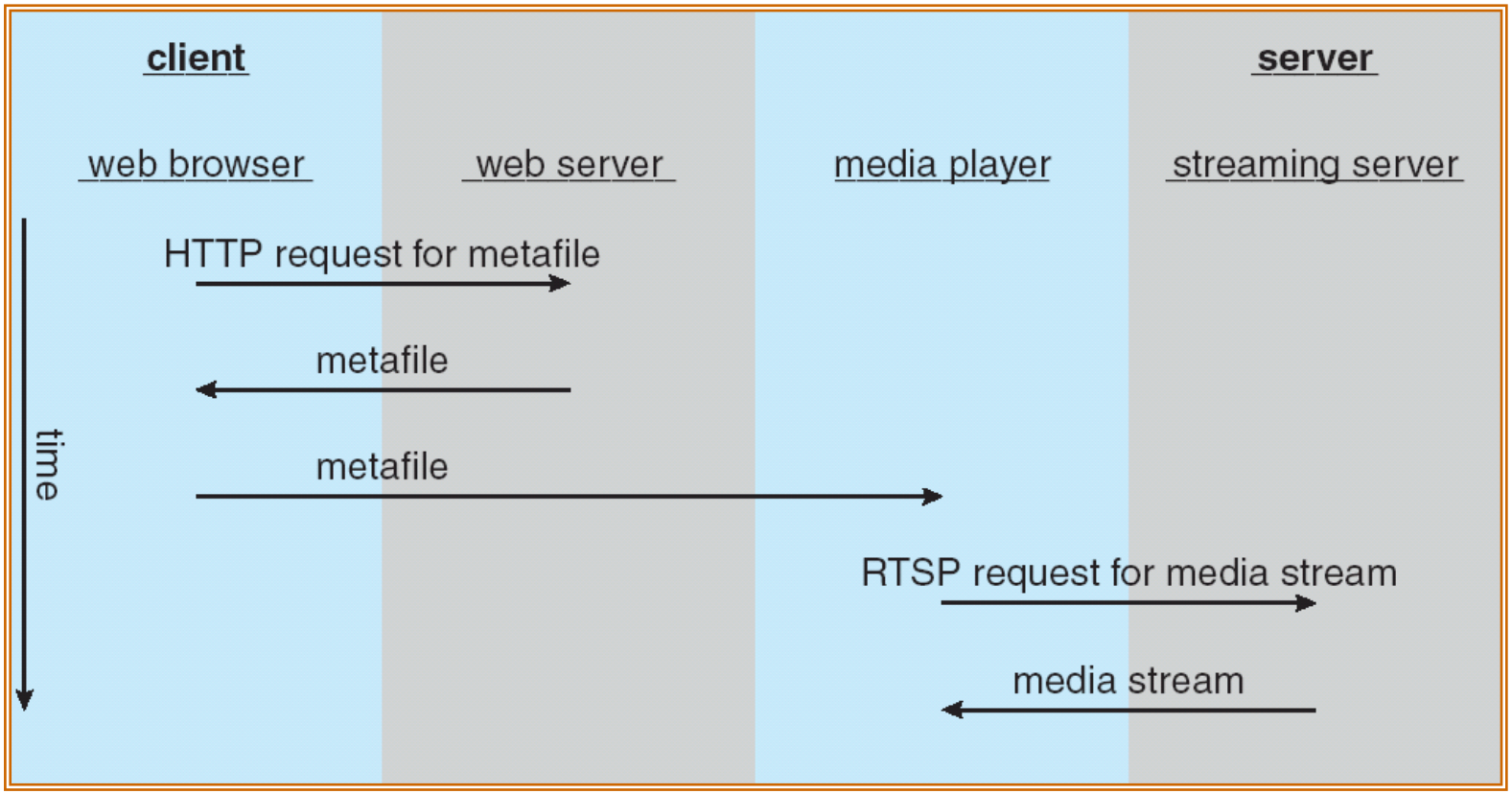
RealTime Streaming Protocol (RTSP)

- Standard HTTP is stateless whereby the server does not maintain the status of its connection with the client.

Streaming media from a conventional web server



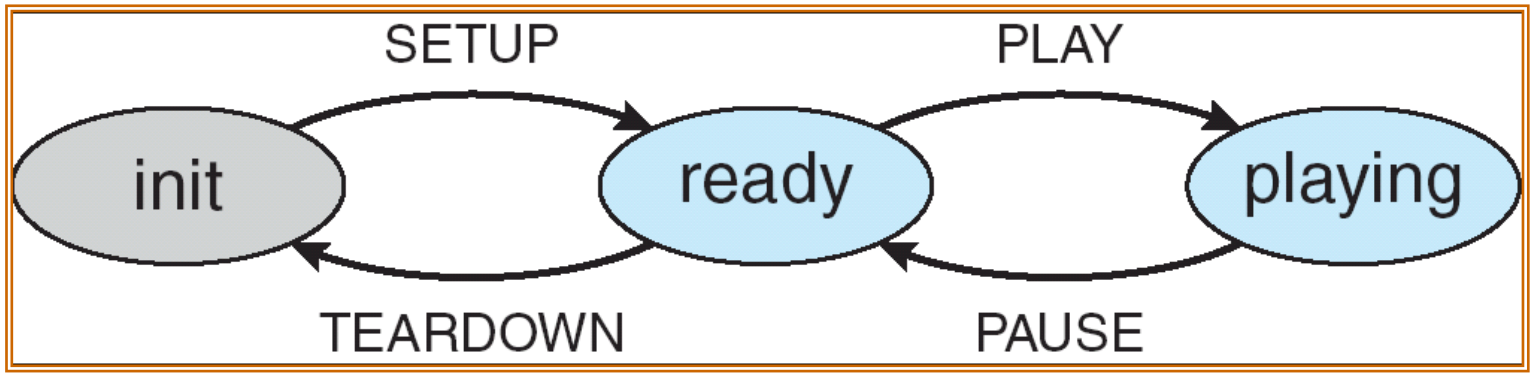
Realtime Streaming Protocol



RTSP States

- SETUP - the server allocates resources for a client session.
- PLAY - the server delivers a stream to a client session.
- PAUSE - the server suspends delivery of a stream.
- TEARDOWN - the server breaks down the connection and releases the resources allocated for the session.

RTSP state machine



CineBlitz Multimedia Server

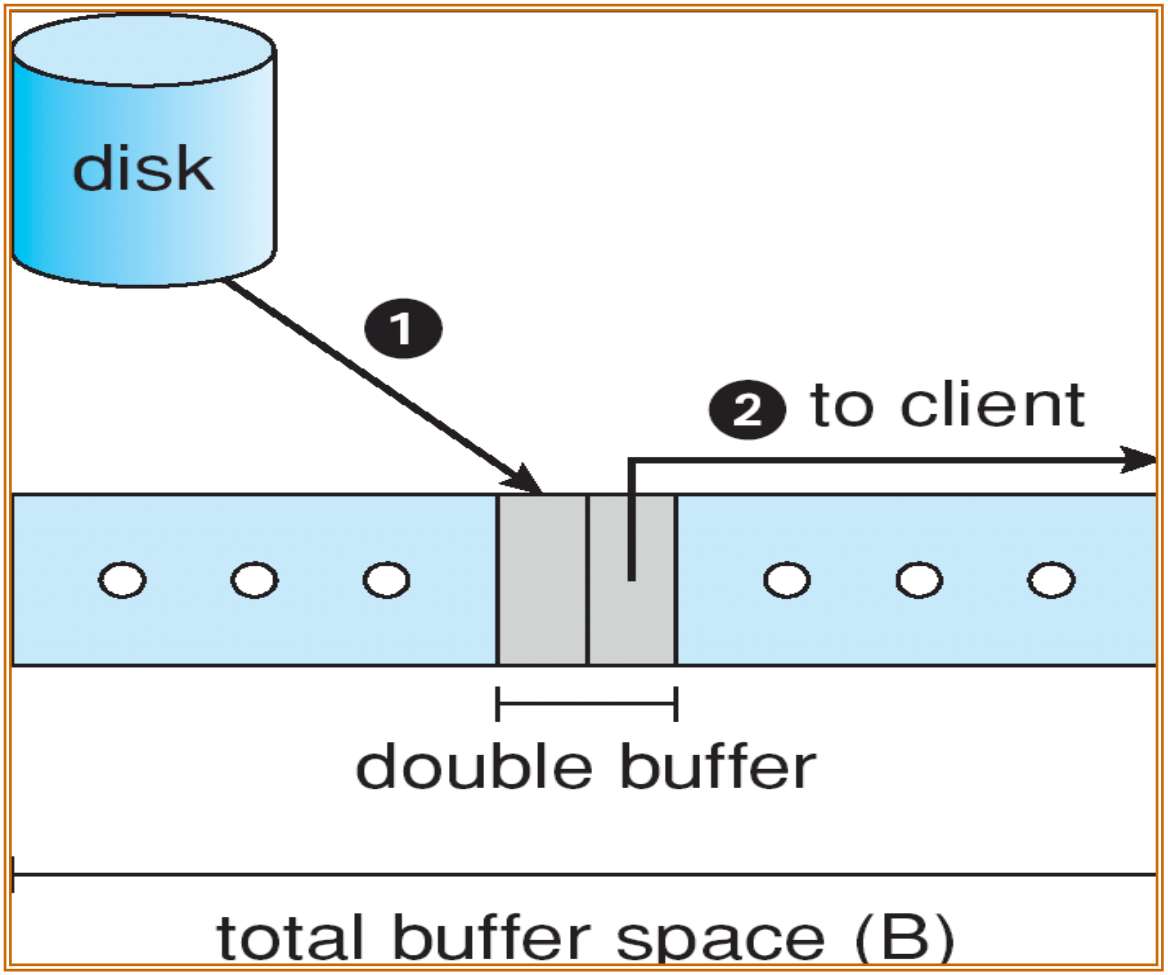
- CineBlitz supports both realtime and non-realtime clients.
- CineBlitz provides hard QoS guarantees to realtime clients using an admission control algorithm.
- The disk scheduler orders requests using C-SCAN order.

CineBlitz Admission Controller

- Total buffer space required for N clients where client has rate requirement of r_i

$$\sum_{i=1}^{N} 2 \times T \times r_i \leq B.$$

Double buffering in CineBlitz



CineBlitz Admission Controller (cont)

- If tseek and trot are the worst-case seek and rotational delay times, the maximum latency for servicing N requests is

$$2 \times t_{seek} + \sum_{i=1}^{N} \left(\lceil \frac{T \times r_i}{b} \rceil + 1 \right) \times t_{rot}.$$

CineBlitz Admission Controller (cont)

- The CineBlitz admission controller only admits a new client if there is at least $2 \times T \times r_i$ bits of free buffer space and the following equation is satisfied

$$2 \times t_{seek} + \sum_{i=1}^{N} \left(\lceil \frac{T \times r_i}{b} \rceil + 1 \right) \times t_{rot} + \sum_{i=1}^{N} \frac{T \times r_i}{r_{disk}} \leq T.$$