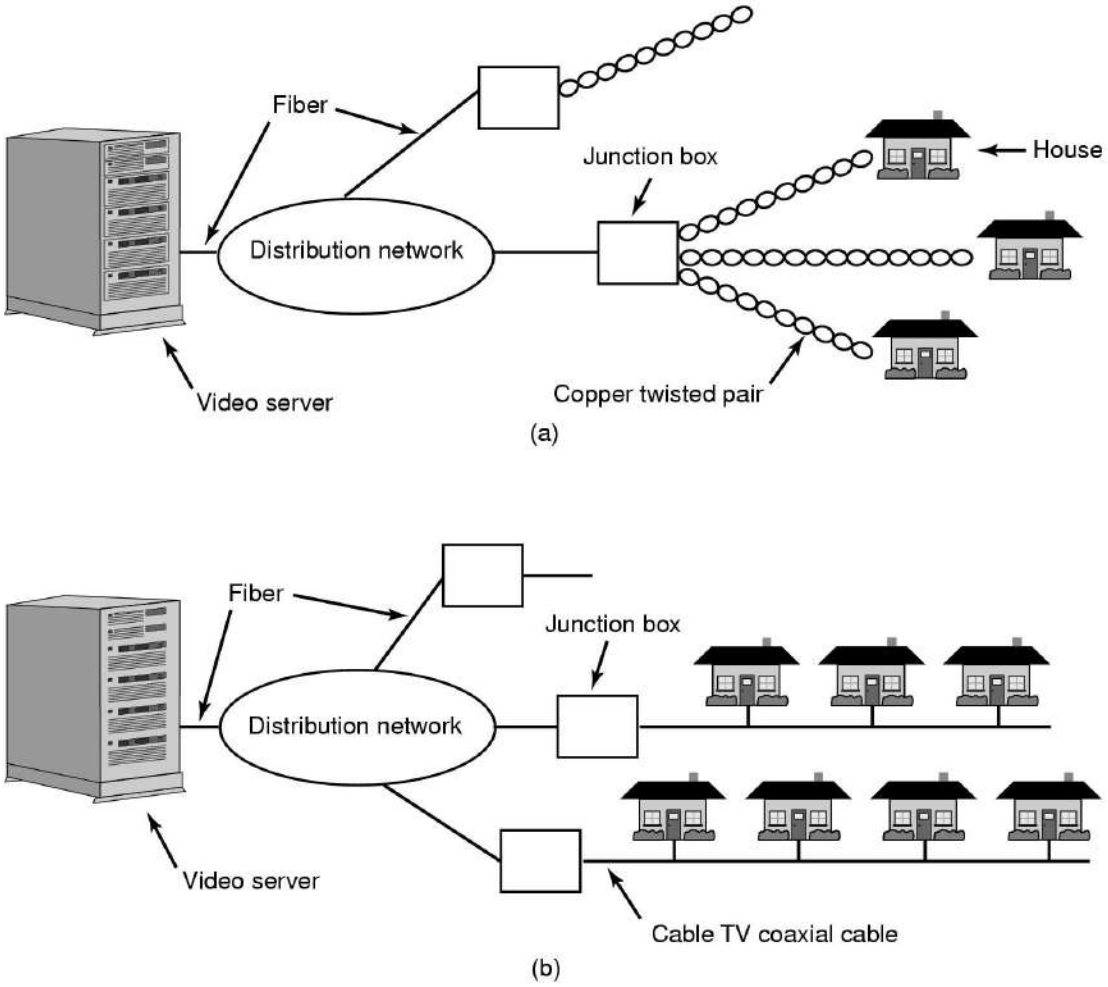
Chapter 7

Multimedia

Introduction to Multimedia (1)



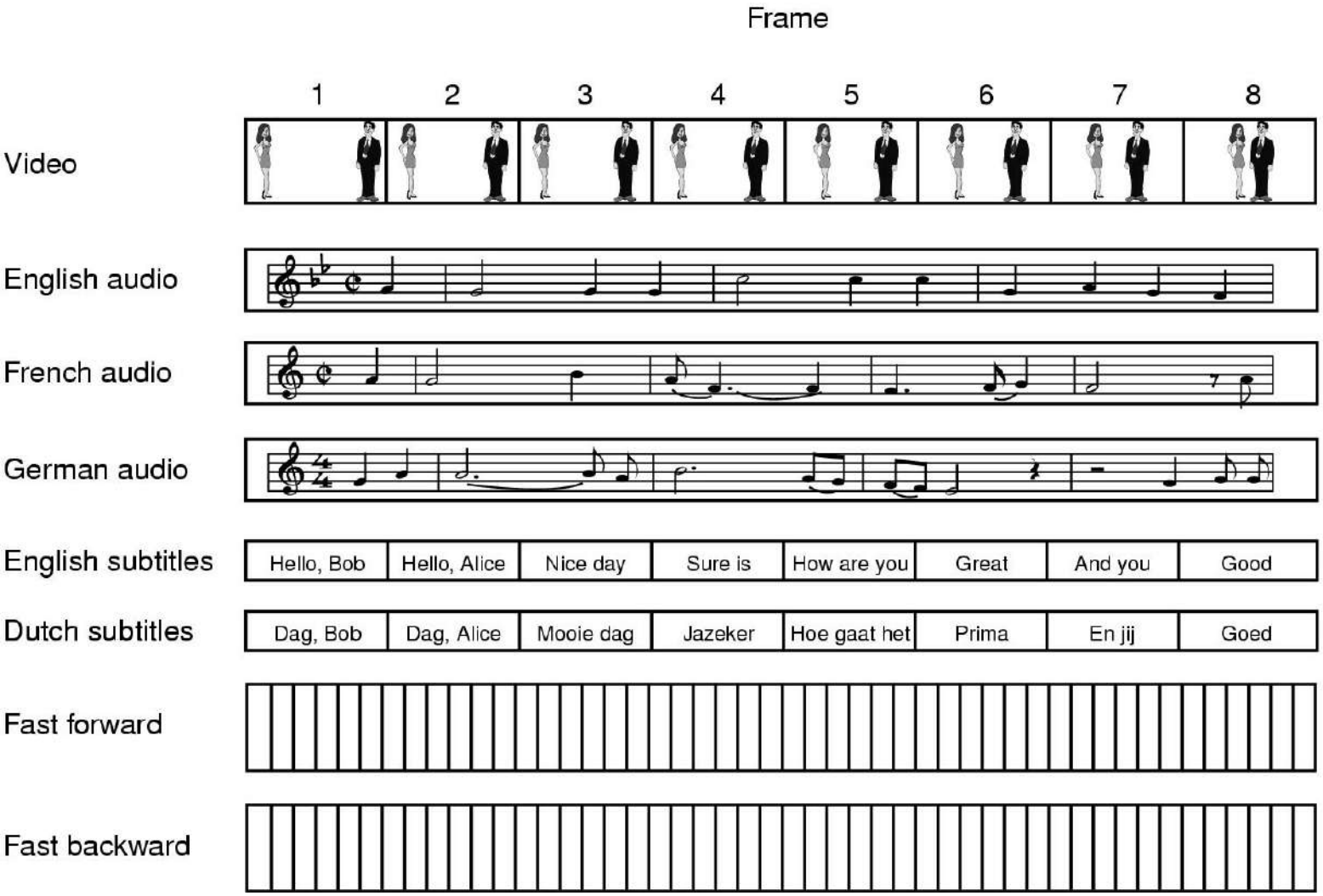
Video On Demand: (a) ADSL vs. (b) cable

Introduction to Multimedia (2)

Source	Mbps	GB/hr
Telephone (PCM)	0.064	0.03
MP3 music	0.14	0.06
Audio CD	1.4	0.62
MPEG-2 movie	4	1.76
Digital camcorder	25	11
Uncompressed TV	221	97
Uncompressed HDTV	648	288
Fast Ethernet	100	
EIDE disk	133	
ATM OC-3 network	156	
SCSI UltraWide disk	320	
IEEE 1394 (FireWire)	400	
Gigabit Ethernet	1000	
SCSI Ultra-160 disk	1280	

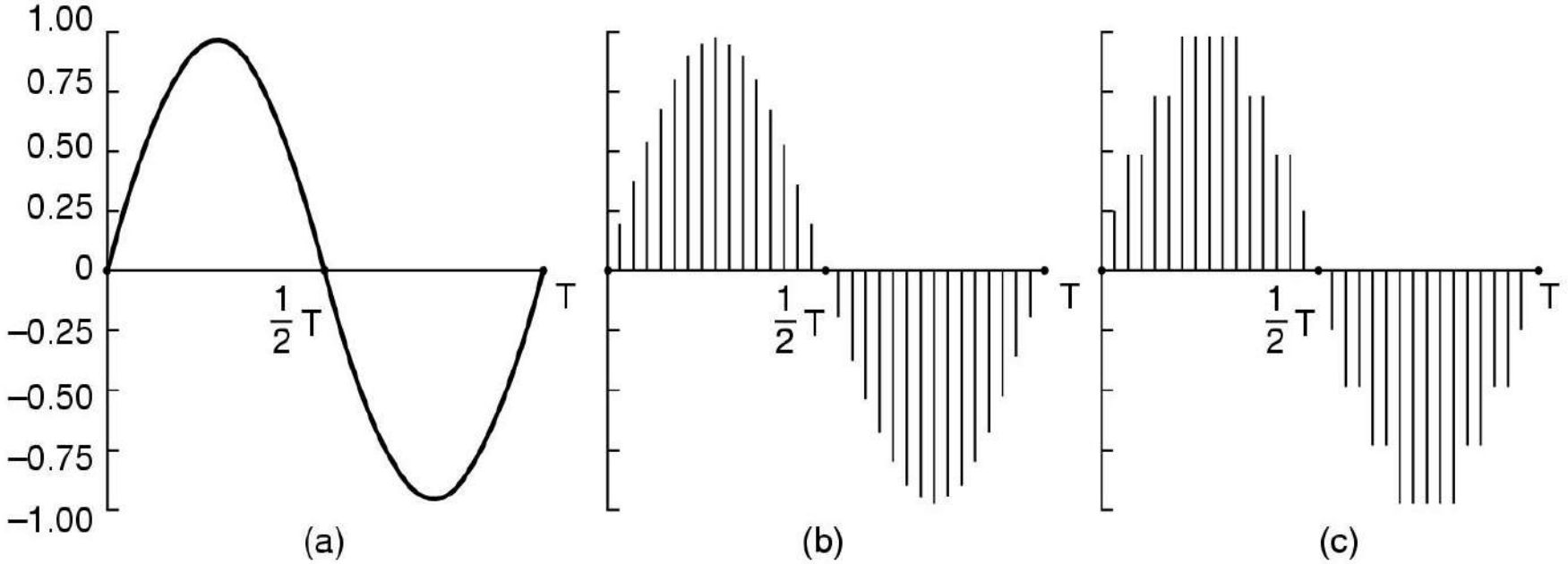
- Some data rates
  - multimedia, high performance I/O devices
- Note: 1 Mbps = 10^6 bits/sec but 1 GB = 2^{30} bytes

Multimedia Files



A movie may consist of several files

Audio Encoding (1)

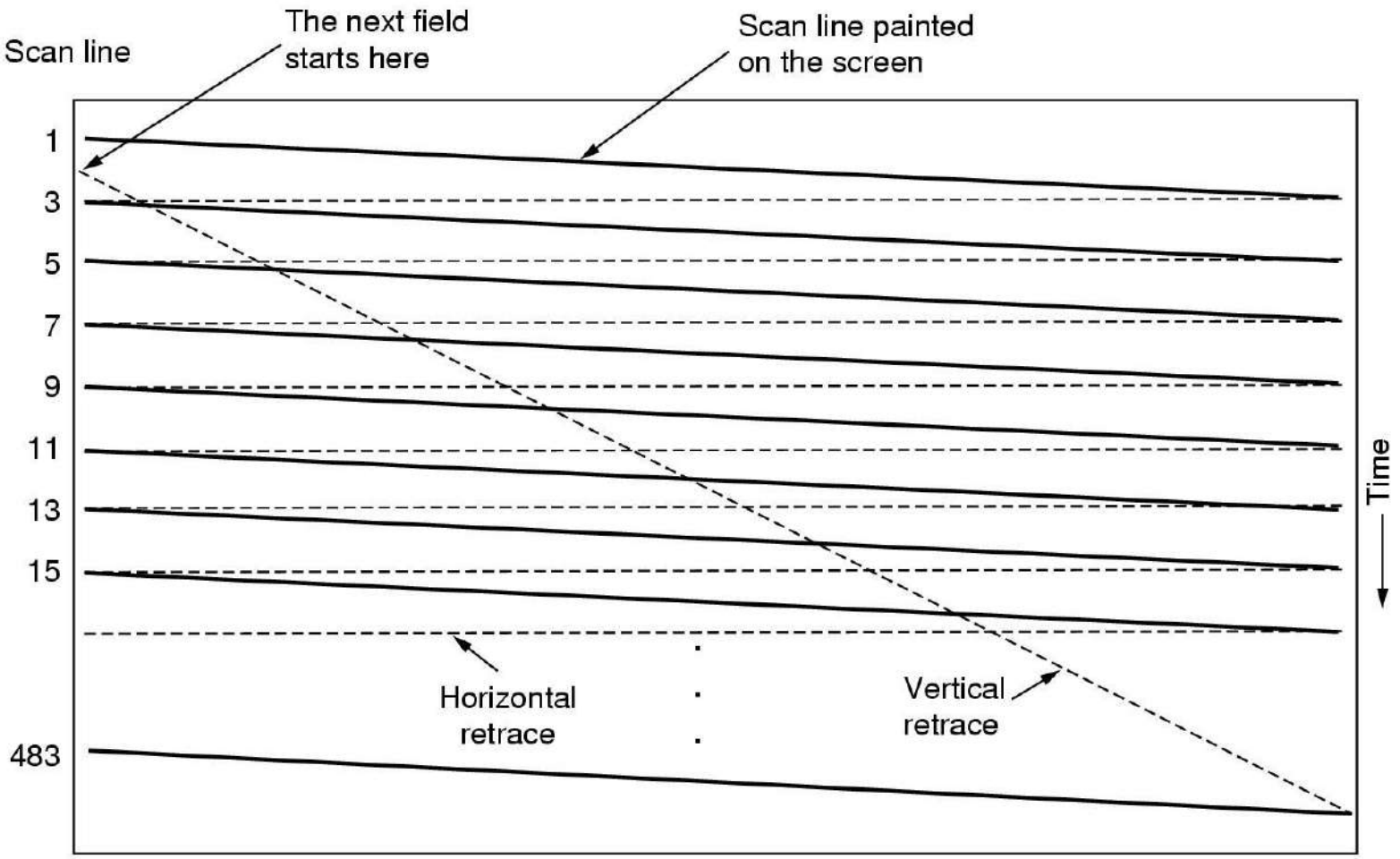


- Audio Waves Converted to Digital
  - electrical voltage input
  - binary number as output

Audio Encoding (2)

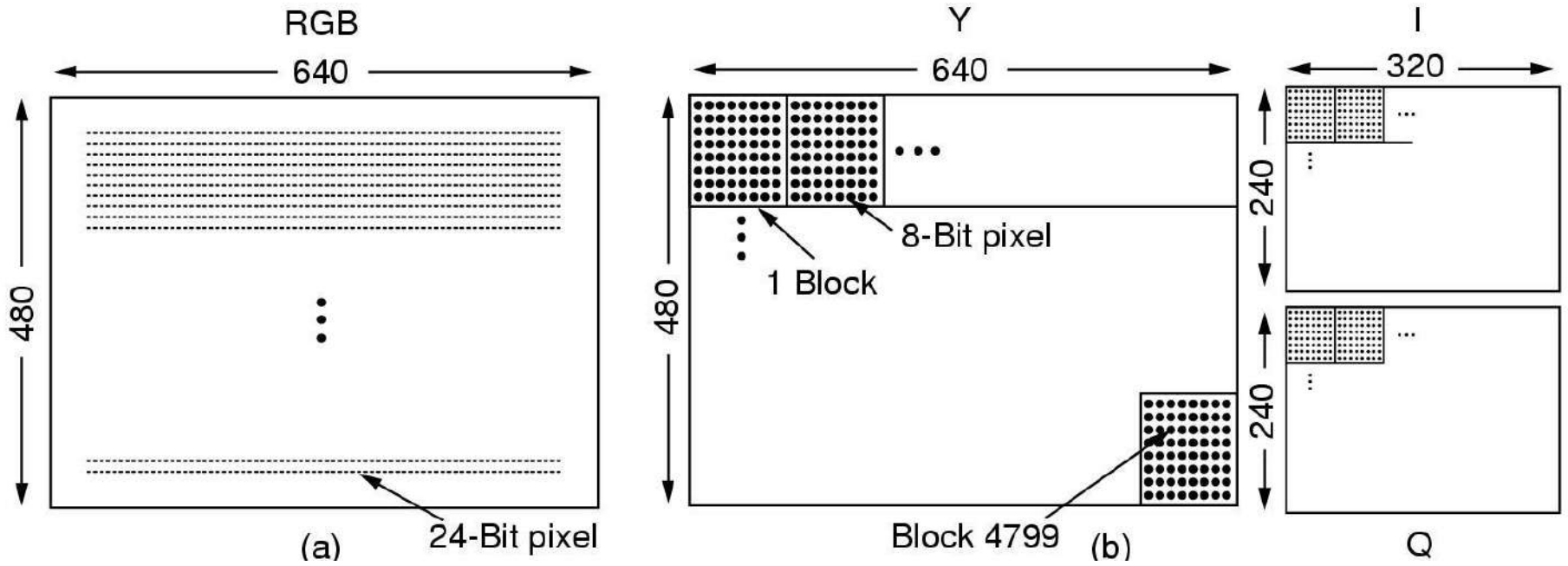
- Error induced by finite sampling
  - called quantization noise
- Examples of sampled sound
  - telephone – pulse code modulation
  - audio compact disks

Video Encoding



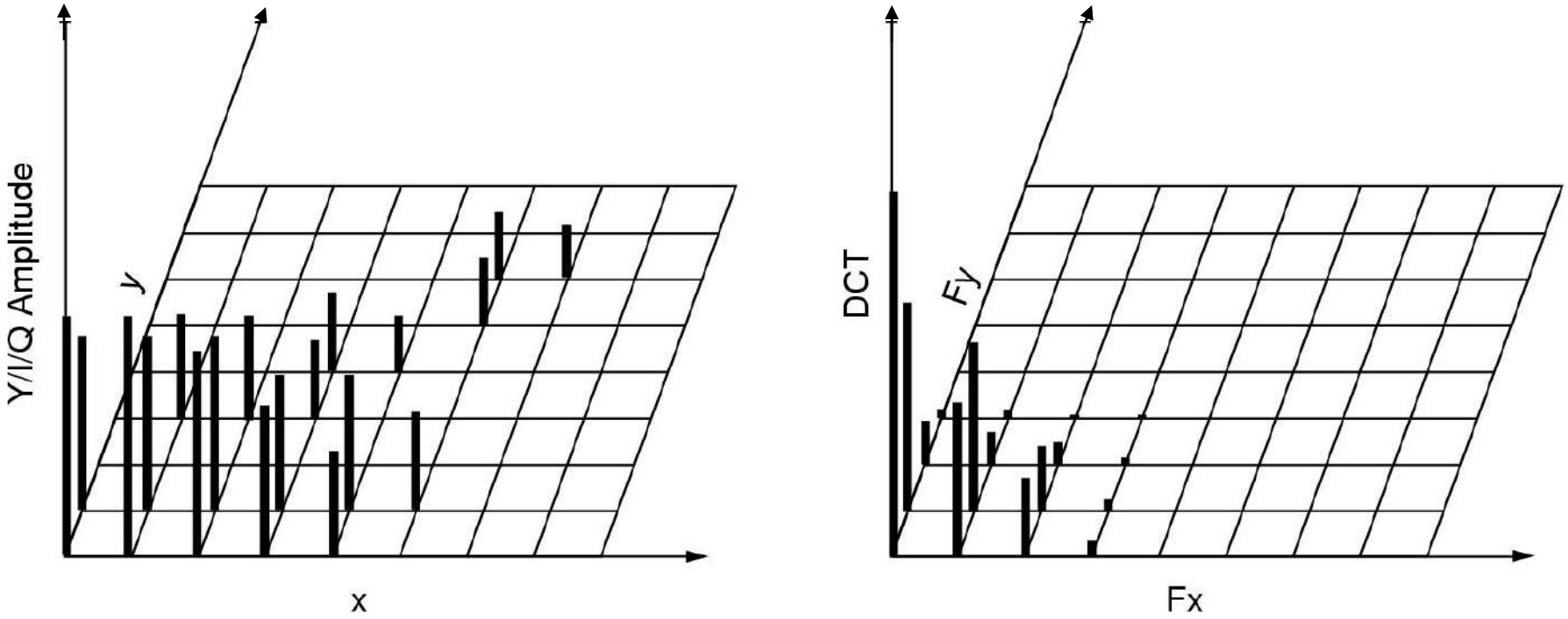
Scanning Pattern for NTSC Video and Television

Video Compression
The JPEG Standard (1)



RGB input data and block preparation

The JPEG Standard (2)



One block of the Y matrix and the DCT coefficients

The JPEG Standard (3)

DCT Coefficients

150	80	40	14	4	2	1	0
92	75	36	10	6	1	0	0
52	38	26	8	7	4	0	0
12	8	6	4	2	1	0	0
4	3	2	0	0	0	0	0
2	2	1	1	0	0	0	0
1	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Quantized coefficients

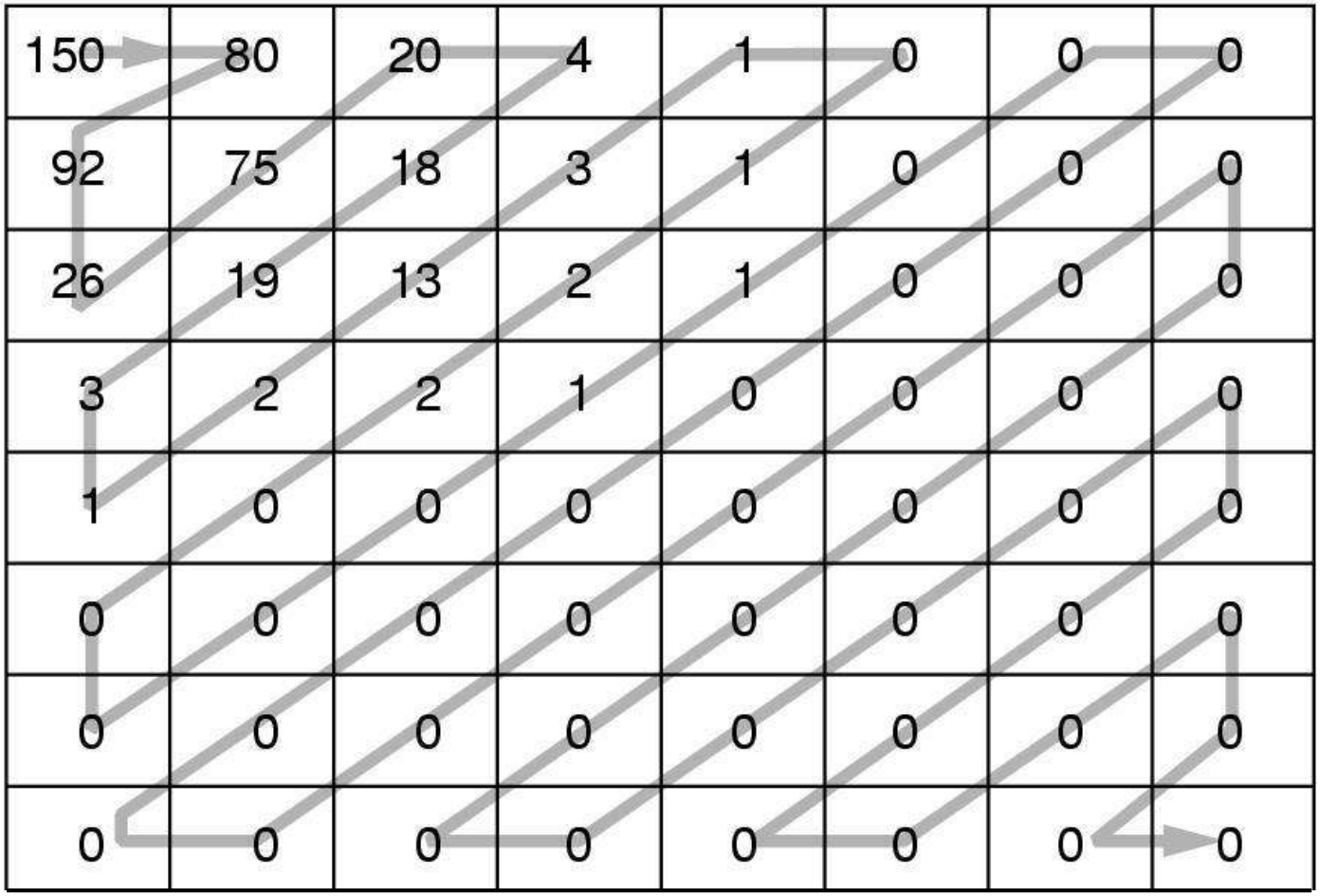
150	80	20	4	1	0	0	0
92	75	18	3	1	0	0	0
26	19	13	2	1	0	0	0
3	2	2	1	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Quantization table

1	1	2	4	8	16	32	64
1	1	2	4	8	16	32	64
2	2	2	4	8	16	32	64
4	4	4	4	8	16	32	64
8	8	8	8	8	16	32	64
16	16	16	16	16	16	32	64
32	32	32	32	32	32	32	64
64	64	64	64	64	64	64	64

Computation of the quantized DCT coefficients

The MPEG Standard (1)



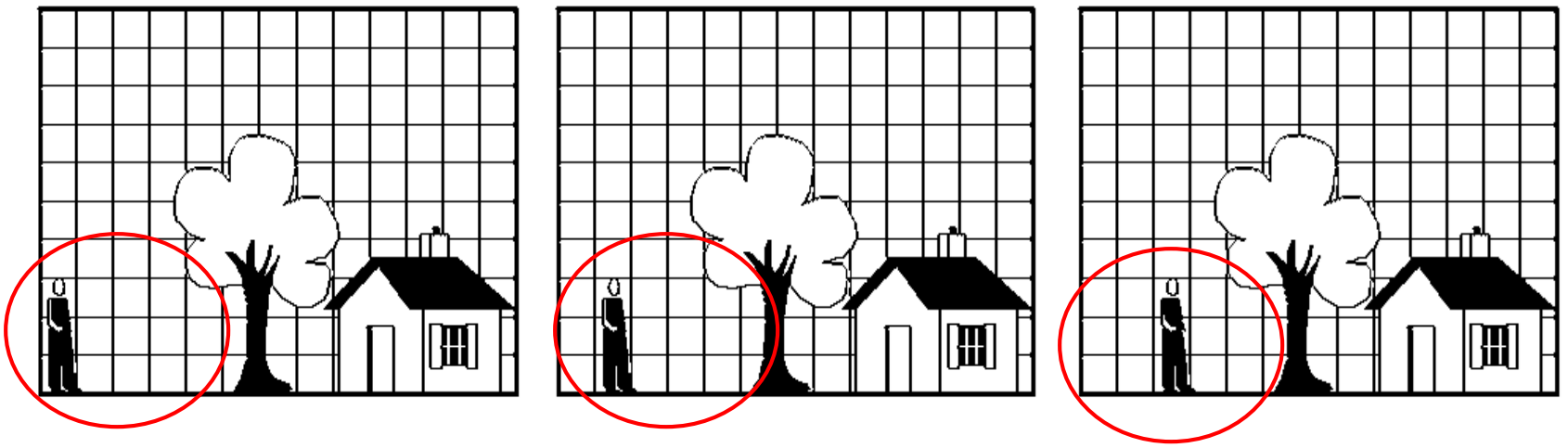
Order of quantized values when transmitted

The MPEG Standard (2)

MPEG-2 has three kinds of frame: I, P, B

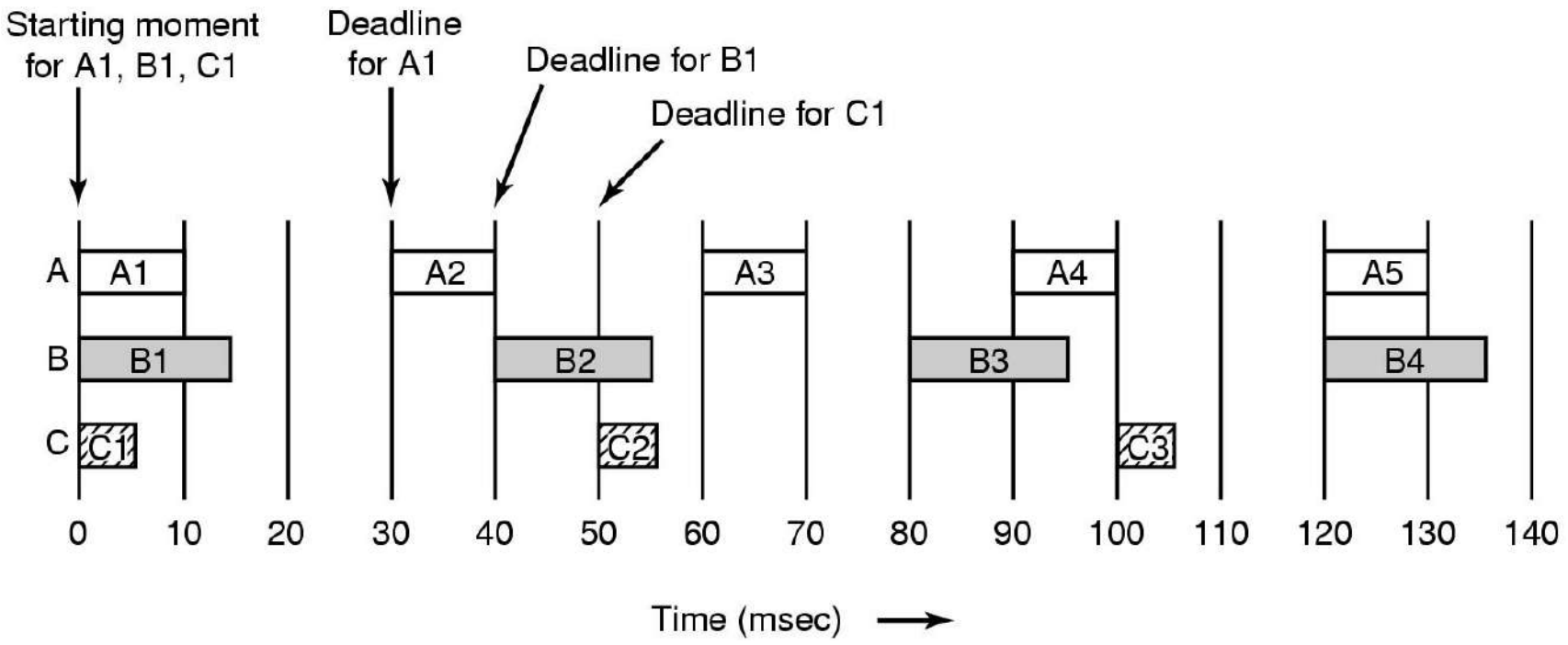
1. **I**ntracoded frames
   - Self-contained JPEG-encoded pictures
2. **P**redictive frames
   - Block-by-block difference with last frame
3. **B**i-directional frames
   - Differences with last and next frame

The MPEG Standard (3)



Consecutive Video Frames

Multimedia Process Scheduling



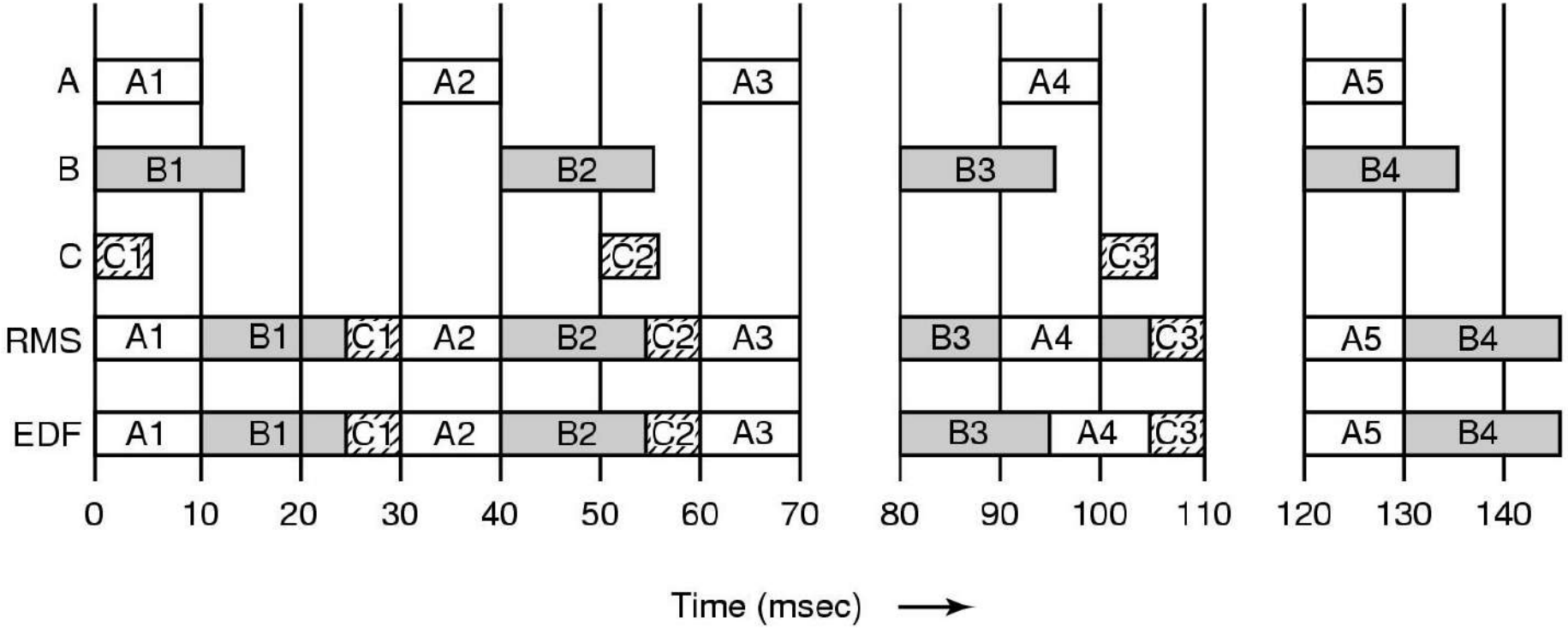
- Periodic processes displaying a movie
- Frame rates and processing requirements may be different for each movie

Rate Monotonic Scheduling

Used for processes which meet these conditions

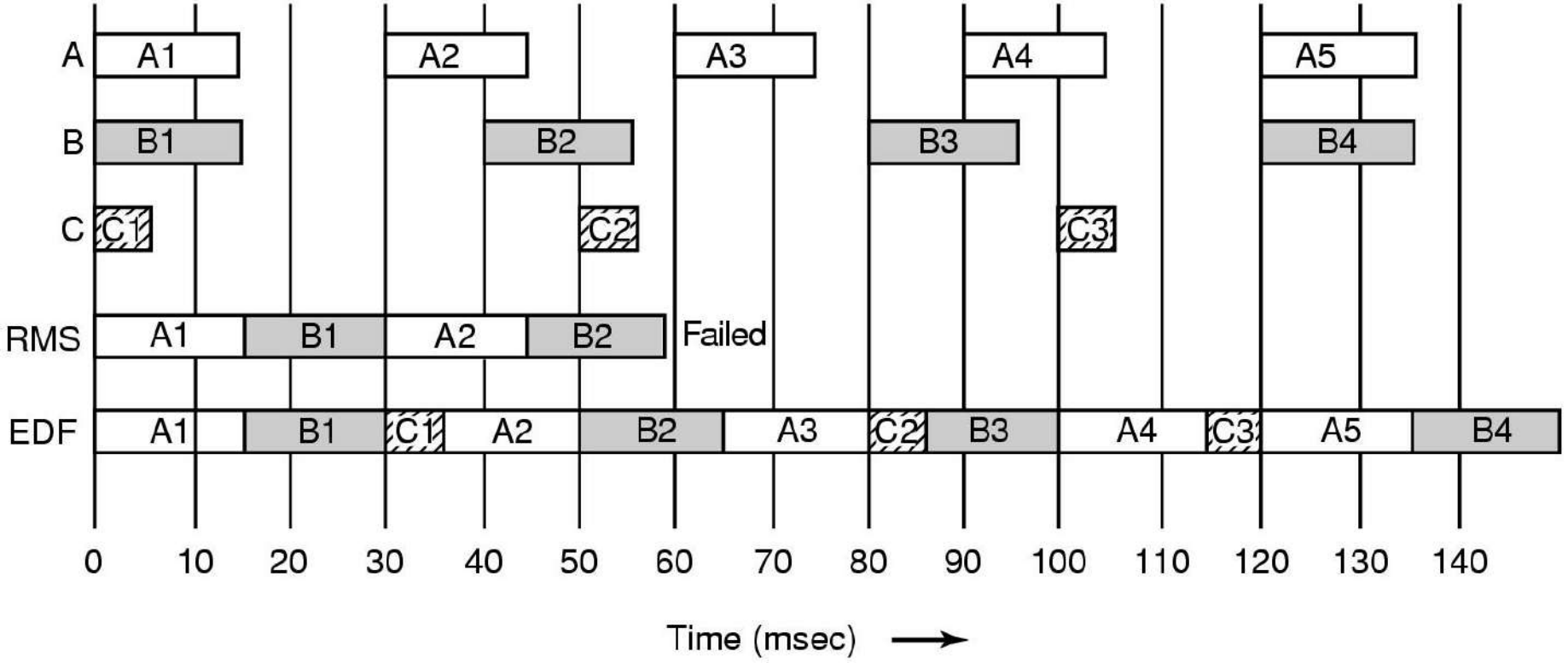
1. Each periodic process must complete within its period
2. No process dependent on any other process
3. Each process needs same CPU time each burst
4. Any nonperiodic processes have no deadlines
5. Process preemption occurs instantaneously, no overhead

Earliest Deadline First Scheduling (1)



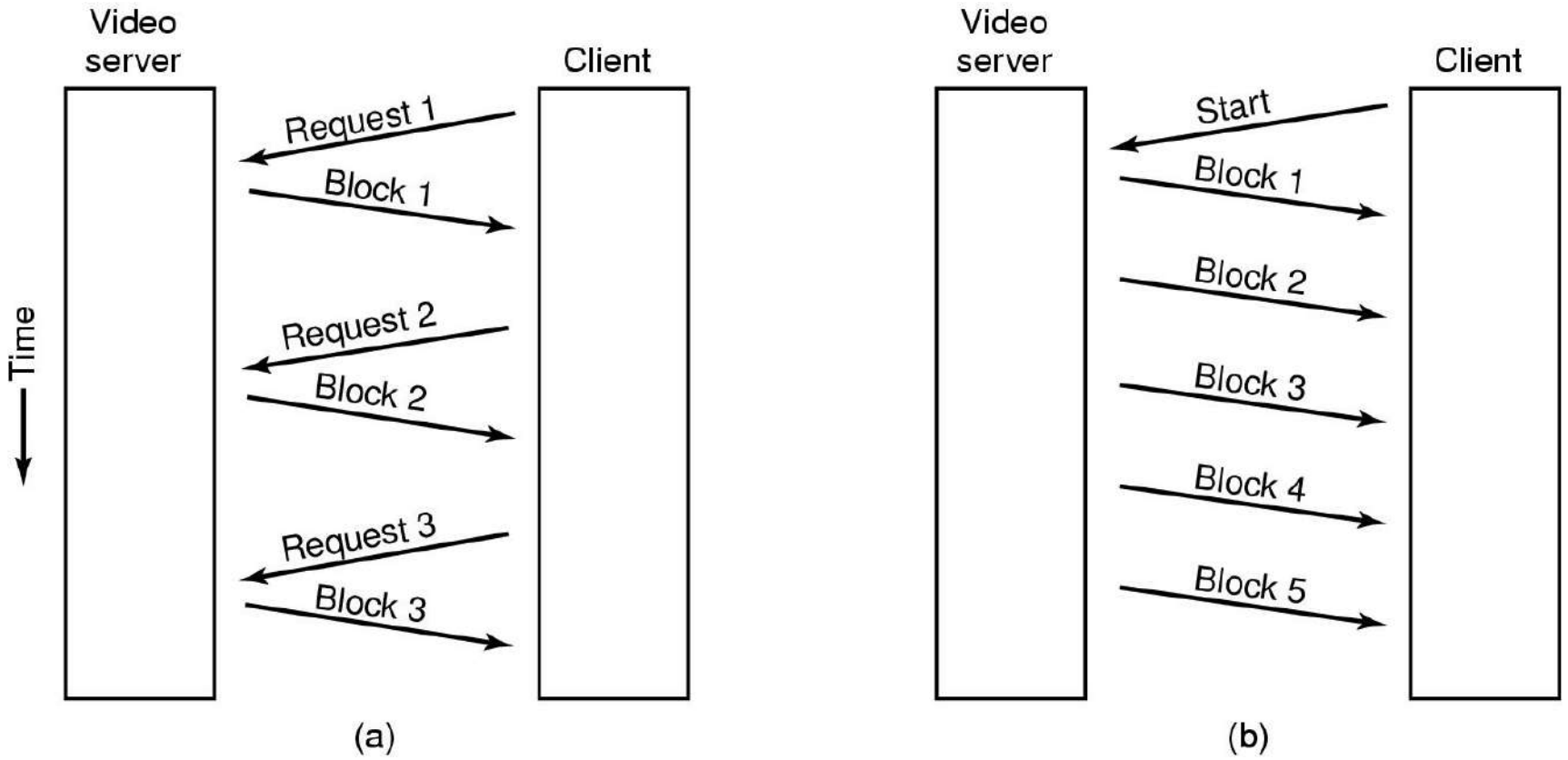
- Real Time Scheduling algorithms
  - RMS
  - EDF

Earliest Deadline First Scheduling (2)



Another example of real-time scheduling with RMS and EDF

Multimedia File System Paradigms

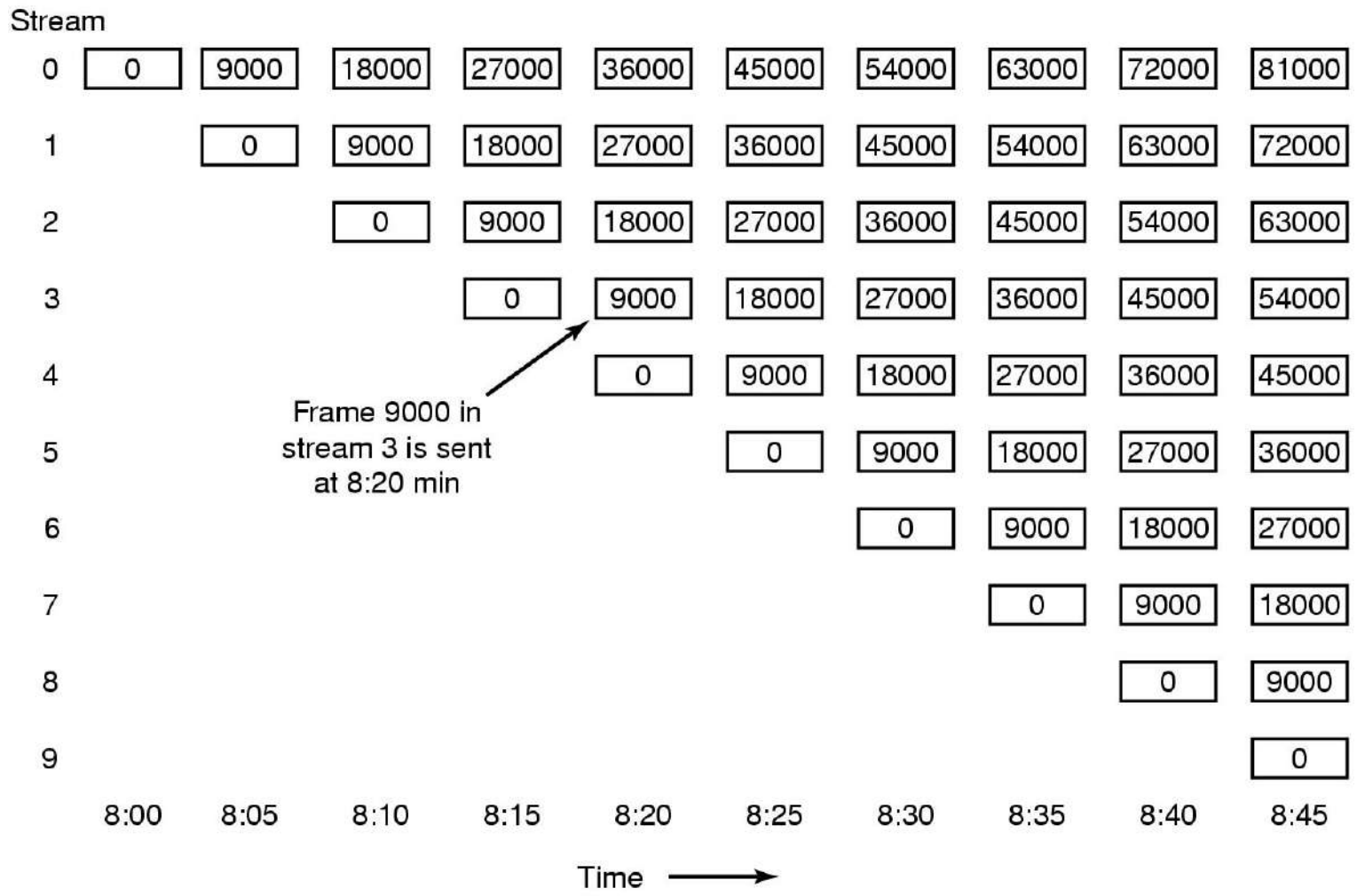


Pull and Push Servers

VCR Control Functions

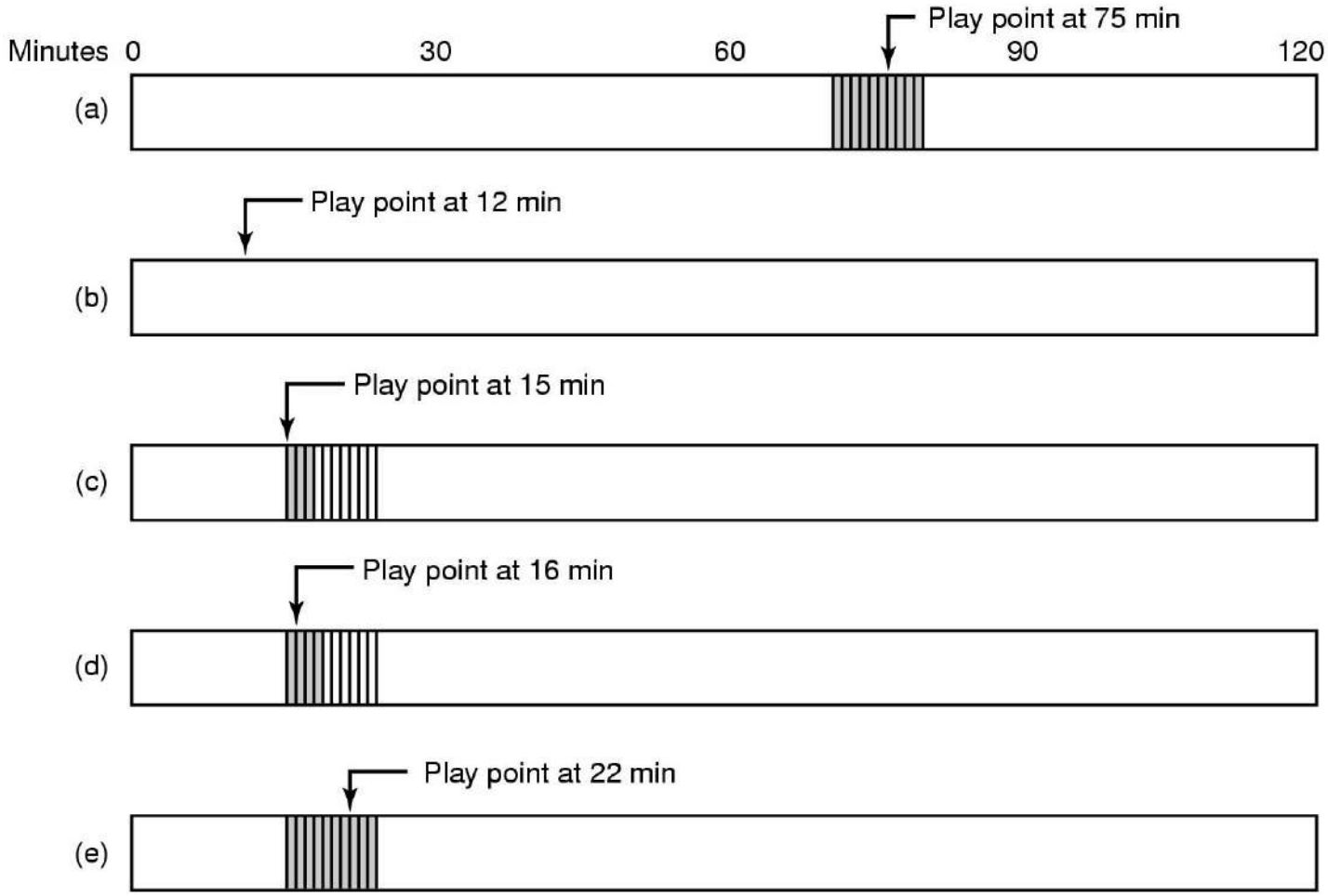
- Rewind is simple
  - set next frame to zero
- Fast forward/backward are trickier
  - compression makes rapid motion complicated
  - special file containg e.g. every 10^{th} frame

Near Video on Demand



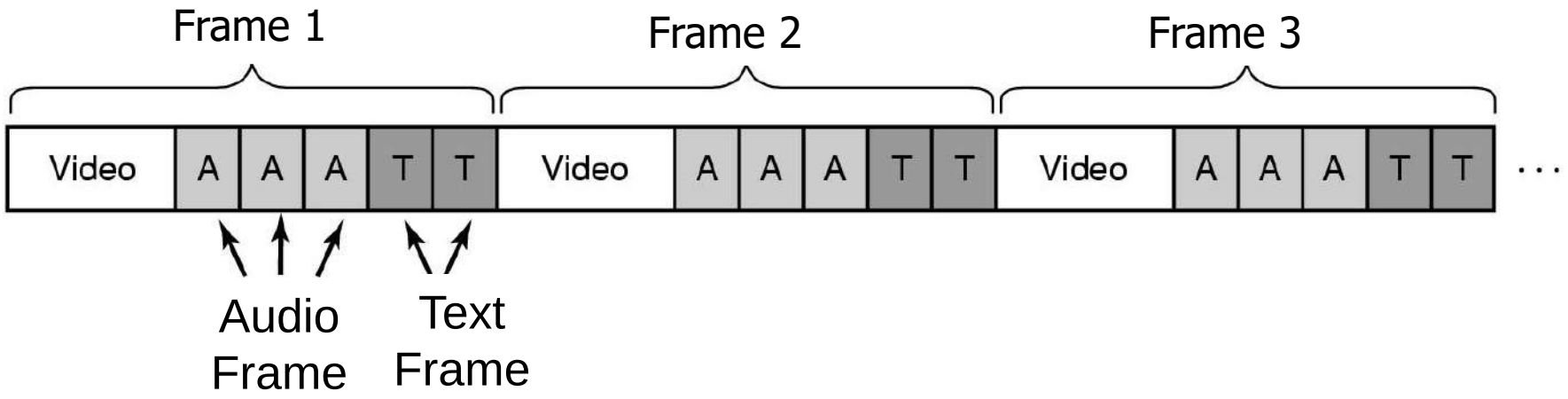
New stream starting at regular intervals

Near Video on Demand with VCR Functions



Buffering for Rewind

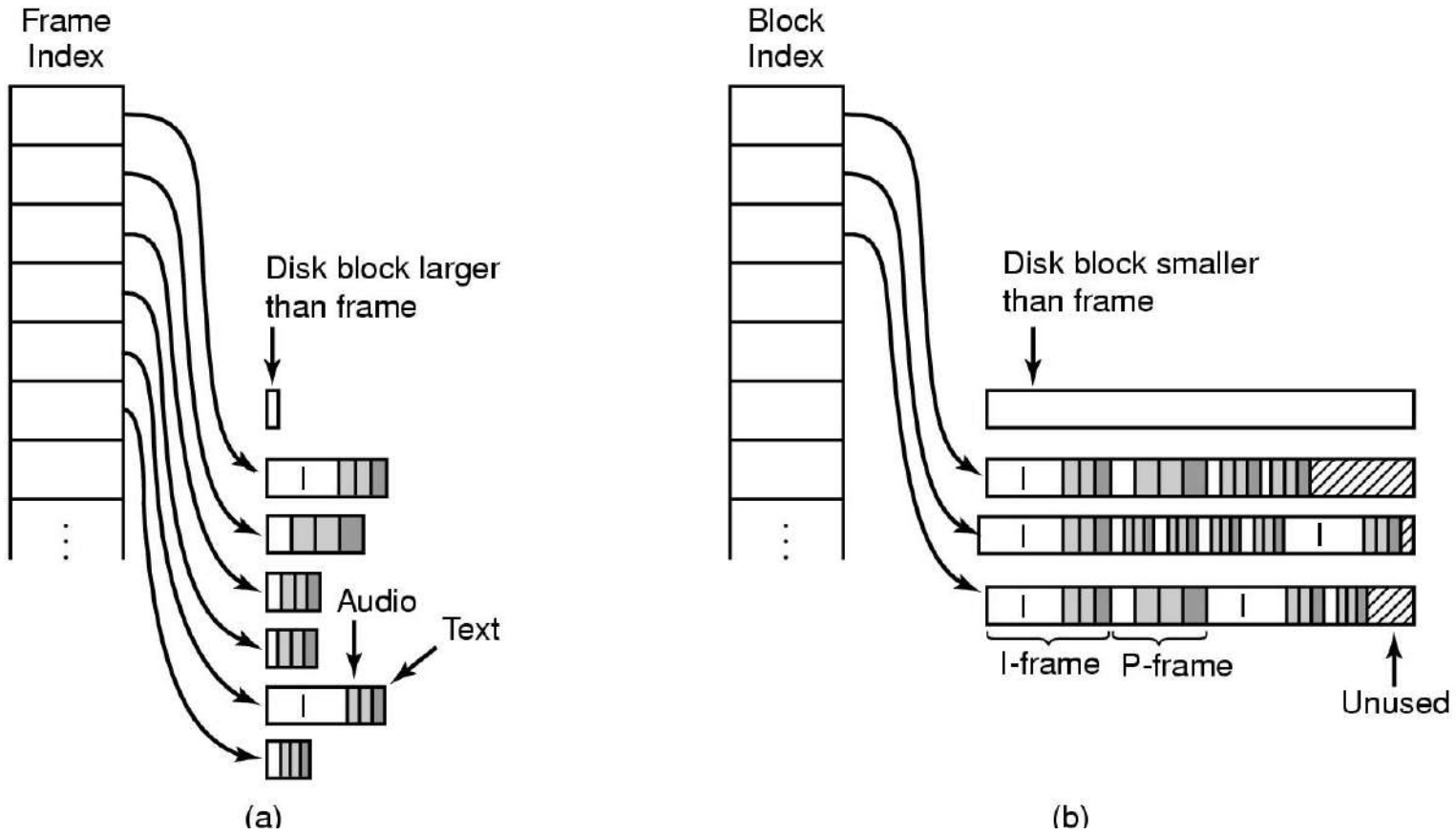
File Placement



Placing a File on a Single Disk

- Interleaving
  - Video, audio, text in single contiguous file per movie

Two Alternative File Organization Strategies (1)



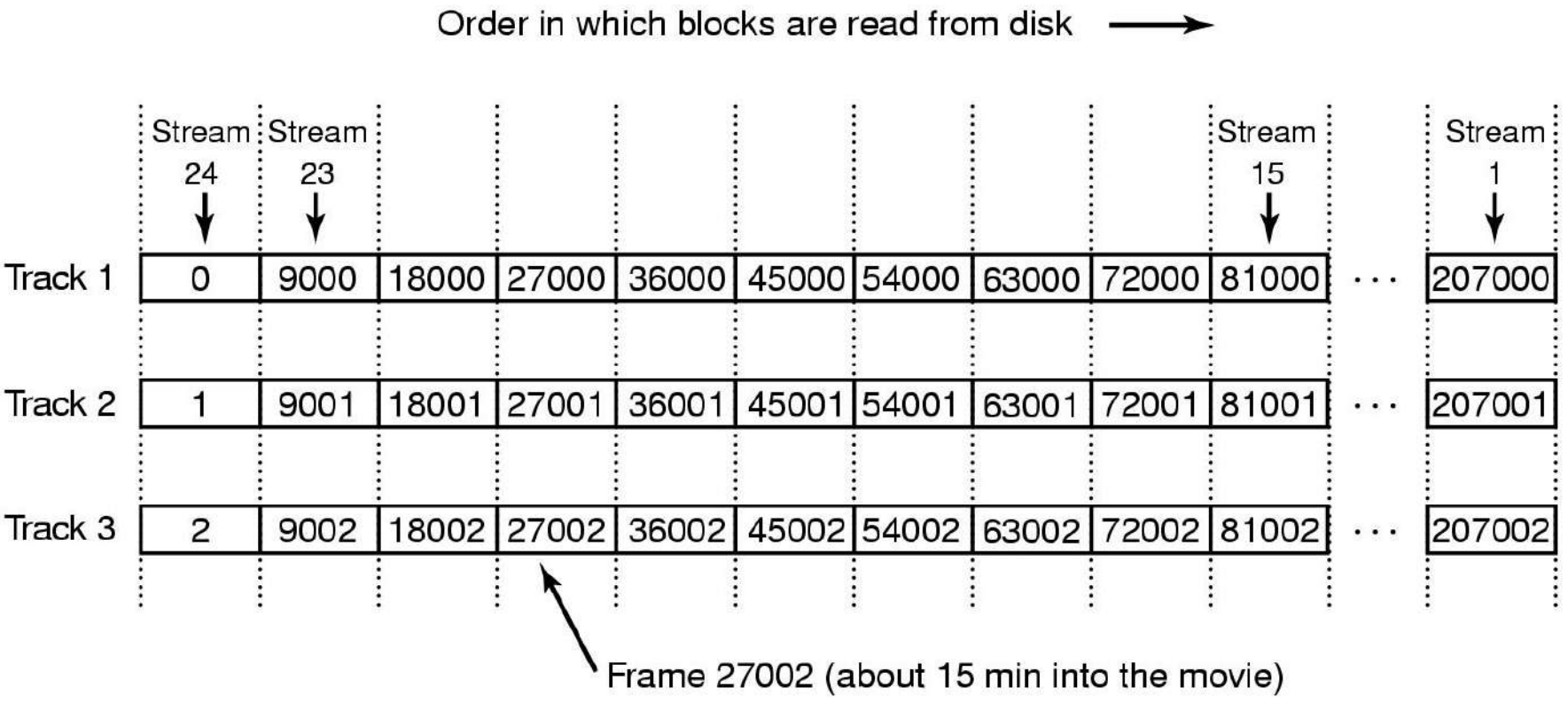
- Noncontiguous Movie Storage
  (a) small disk blocks
  (b) large disk blocks

Two Alternative File Organization Strategies (2)

Trade-offs between small, large blocks

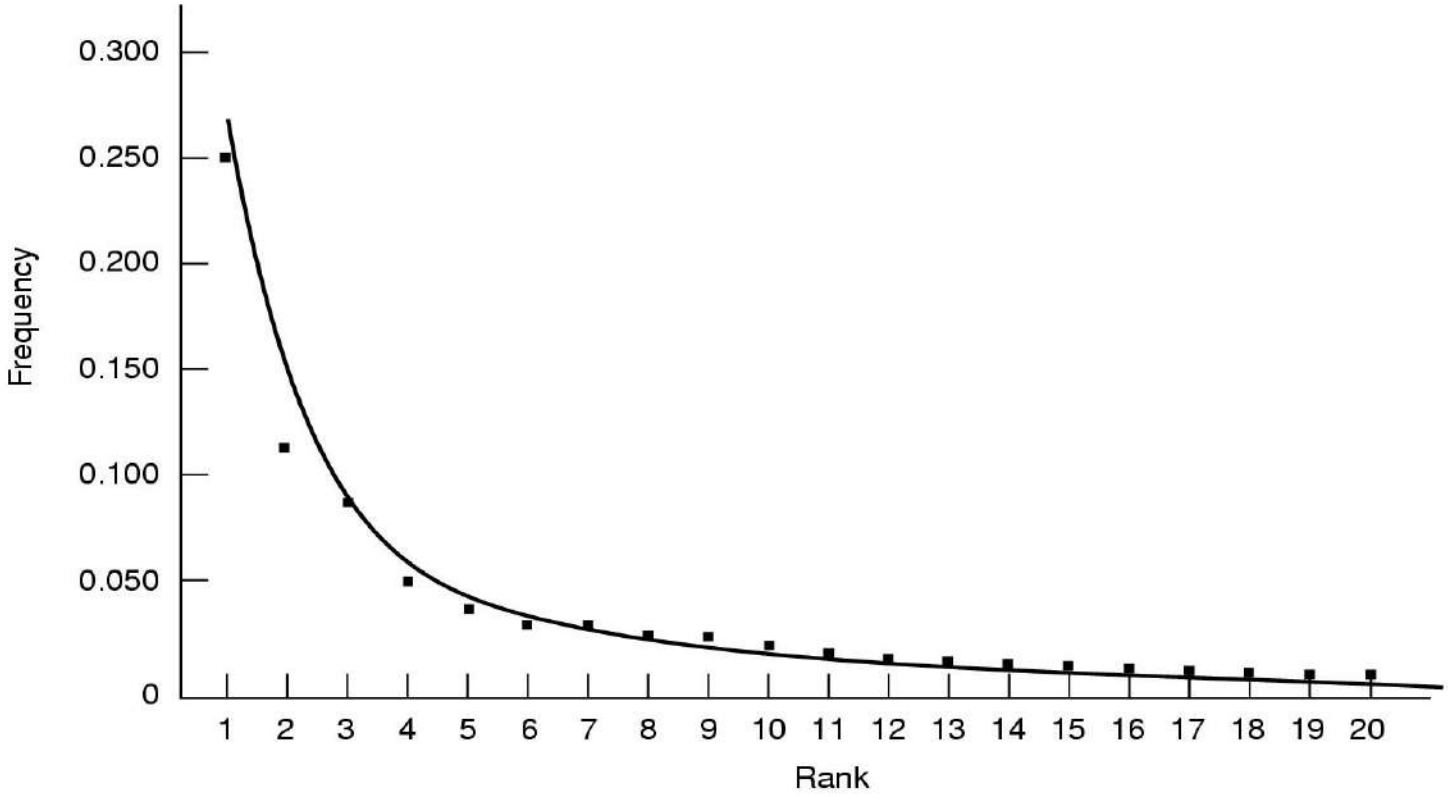
1. Frame index
   - heavier RAM usage during movie play
   - little disk wastage
- Block index (no splitting frames over blocks)
   - low RAM usage
   - major disk wastage
- Block index (splitting frames over blocks allowed)
   - low RAM usage
   - no disk wastage
   - extra seeks

Placing Files for Near Video on Demand



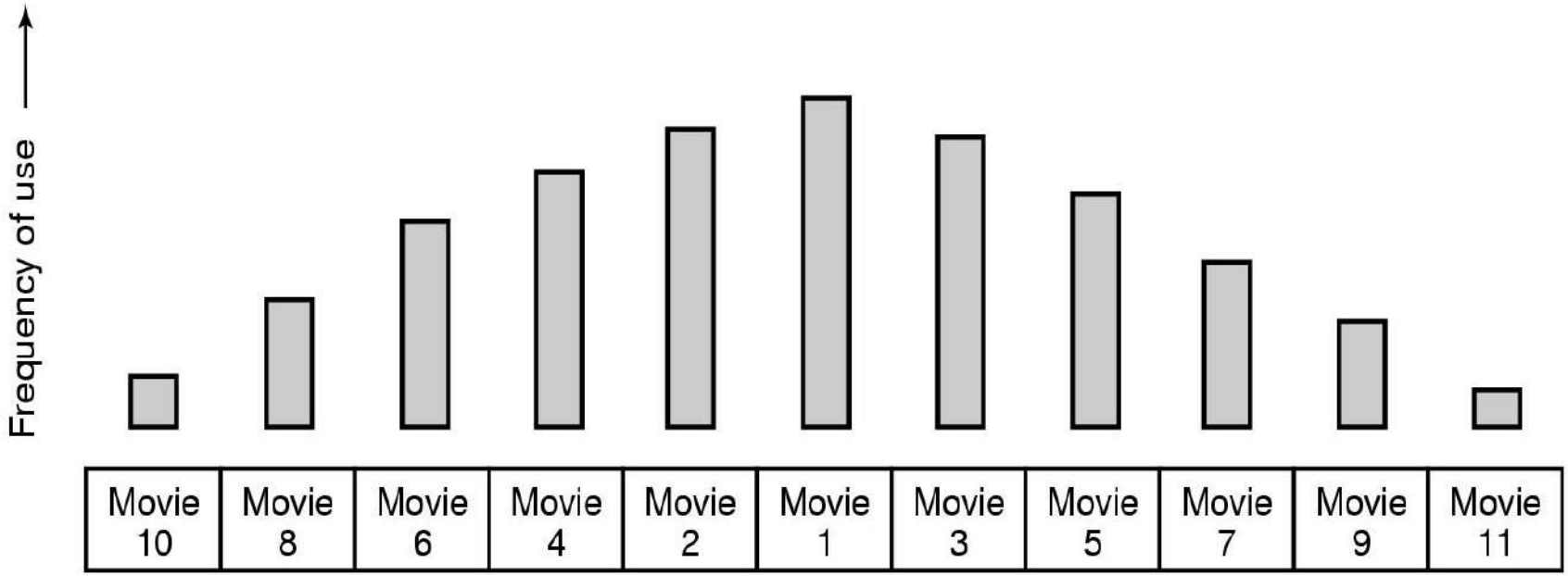
Optimal frame placement for near video on demand

Placing Multiple files on a Single Disk (1)



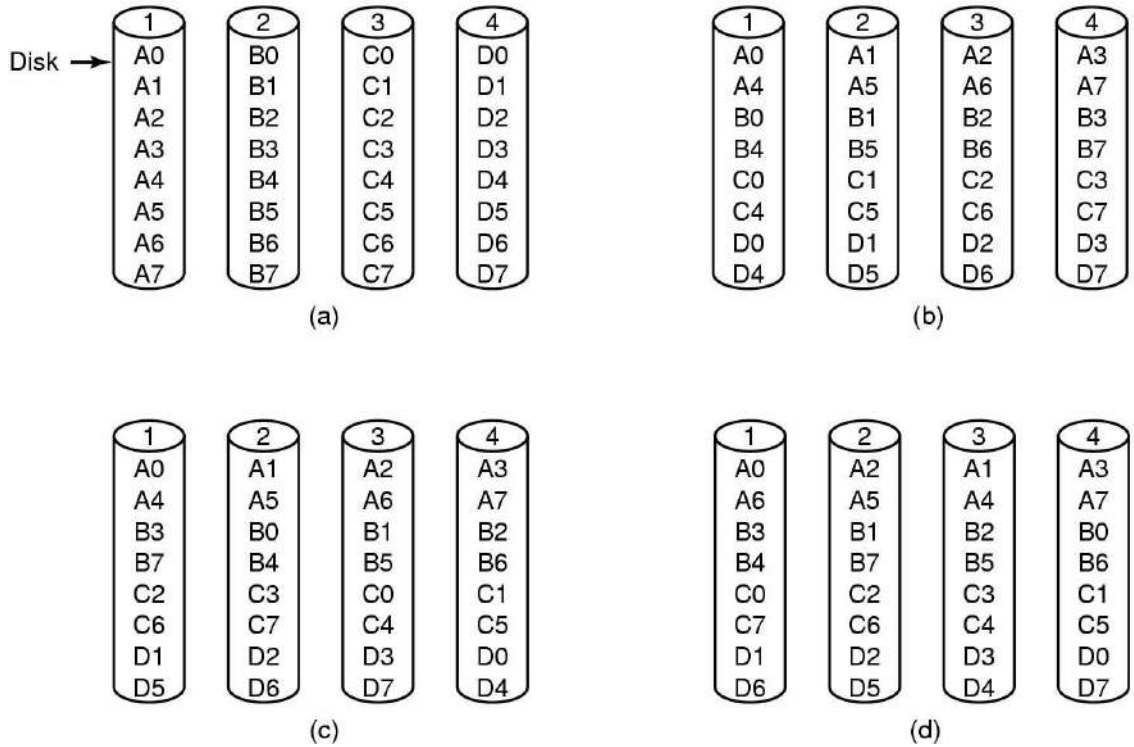
- Zipf's law for N=20
- Squares for 20 largest cities in US
  - sorted on rank order

Placing Multiple files on a Single Disk (2)



- Organ-pipe distribution of files on server
  - most popular movie in middle of disk
  - next most popular either on either side, etc.

Placing Files on Multiple Disks



Organize multimedia files on multiple disks

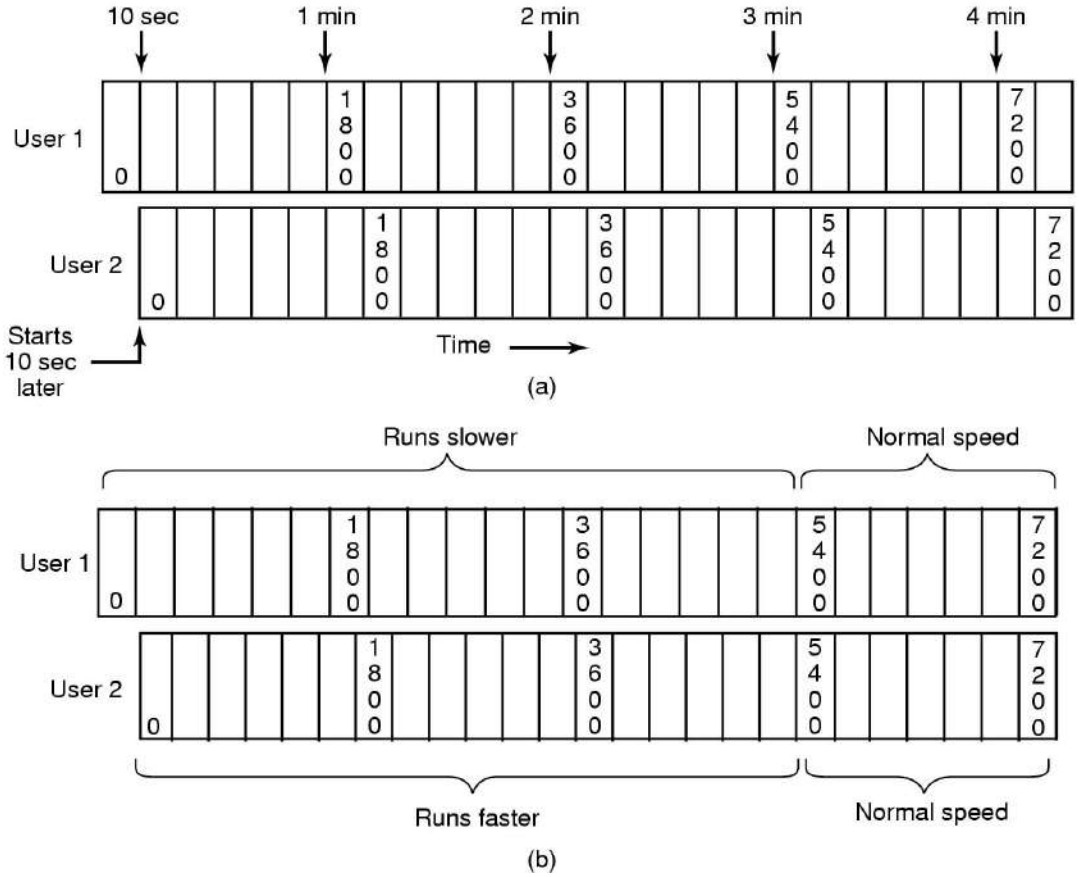
(a) No striping

(b) Same striping pattern for all files

(c) Staggered striping

(d) Random striping

Caching



Block Caching

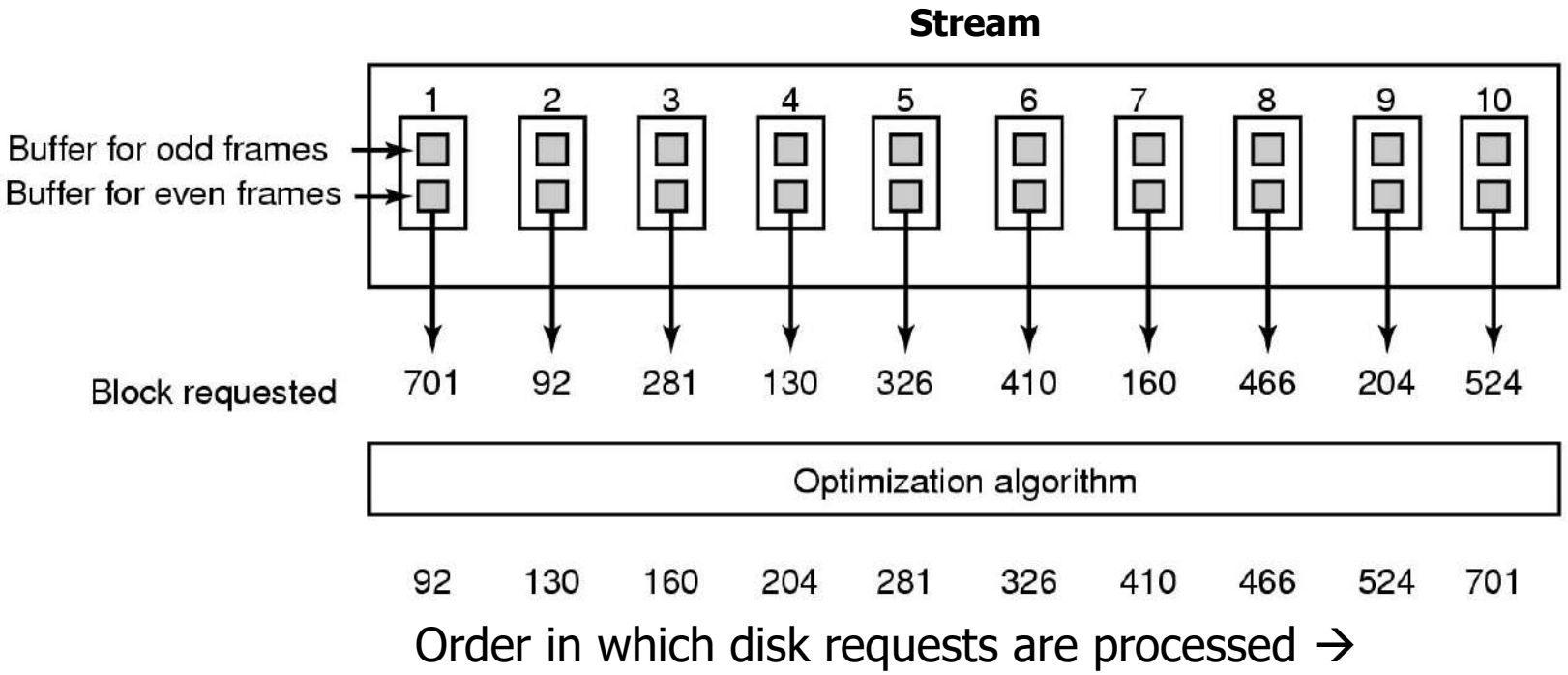
(a) Two users, same movie 10 sec out of sync

(b) Merging two streams into one

File Caching

- Most movies stored on DVD or tape
  - copy to disk when needed
  - results in large startup time
  - keep most popular movies on disk
- Can keep first few min. of all movies on disk
  - start movie from this while remainder is fetched

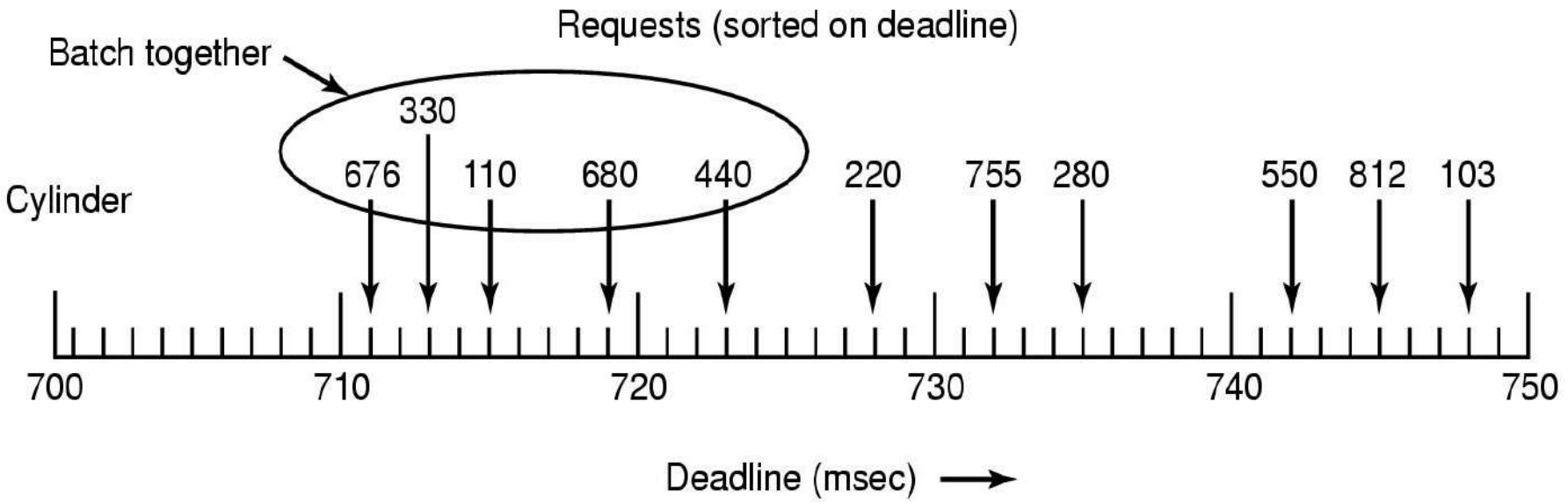
Disk Scheduling for Multimedia



Static Disk Scheduling

- In one round, each movie asks for one frame

Dynamic Disk Scheduling



- Scan-EDF algorithm
  - uses deadlines & cylinder numbers for scheduling