ΟΙΚΟΝΟΜΙΚΟ
ΠΑΝΕΠΙΣΤΗΜΙΟ
ΑΘΗΝΩΝ

ATHENS UNIVERSITY
OF ECONOMICS
AND BUSINESS

Multimedia Technology

Section # 3: Multimedia systems

Instructor: George Xylomenos

Department: Informatics

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- Multimedia system hardware
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Requirements

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Application requirements (1 of 2)

- Management of large amounts of data
  - Storage, input-output, communication
  - Large loads on all buses (internal and external)
- Communication with the analog world
  - Conversion of media to digital files
    - Digitization of analog streams
  - Digital media processing
  - Conversion back to analog for playback

Application requirements (2 of 2)

- Compression and decompression
  - Hardware, software, or both
  - May be needed in real-time
    - Even inside a peripheral device
    - Example: webcams
- Real-time communication
  - Digitization and playback of audio
  - Digitization and playback of video

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Multimedia system hardware

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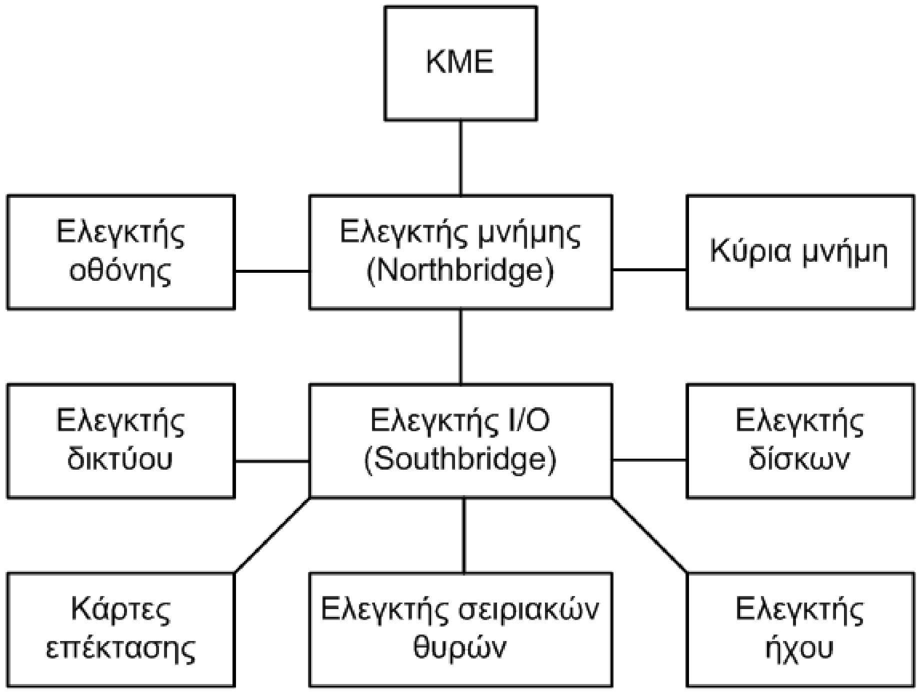
Hardware (1 of 4)



- Main system controllers
  - Memory and display: northbridge
  - Disks, network, I/O ports and audio: southbridge

Hardware (2 of 4)

- Central Processing Unit (CPU)
  - Media processing instructions
    - Usually with vector processing
- Co-processors
  - Floating Point Unit (FPU)
  - Graphics Processing Unit (GPU)
  - Digital Signal Processor (DSP)
  - Machine Learning (ML/AI)

Hardware (3 of 4)

- Data storage devices
  - High speed controllers
    - RAID arrays (for hard disks)
  - Cost – performance tradeoffs
    - HDD for media library
    - SSD for caching
- Input/Output devices
  - Directly on system bus (PCI)
  - On a separate controller (USB)

Hardware (4 of 4)

- Wide range of media devices
  - Analog devices
    - Microphones, headphones, speakers
  - Digital devices
    - Sound cards, frame grabbers
    - USB microphones, headphones and speakers
  - Devices that also compress data
    - Webcams, still/video cameras

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Multimedia system software

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Multimedia files (1 of 2)

- Composite media files
  - All media on the same file (e.g., AVI, VOB)
    - Ideally, in consecutive blocks
  - Separation of media segments
    - Video segment
    - Audio segments (multiple)
    - Subtitles (multiple)
  - Redundant reads (must read all languages)

Multimedia files (2 of 2)

- Independent media files
  - More flexible management
    - Only read the right audio and subtitle tracks
  - But, it requires moving the disc head
    - Or investing in SSDs
- Multiple files per title
  - The basis for adaptive streaming
  - Thousands of files per title

File storage (1 of 5)

- Basic distinction: logical vs physical block
- Logical block
  - Example: 1 sec of video
  - Useful for access to the media
- Physical block
  - Example: 16 Kbytes of data
  - Useful for access to the disc

File storage (2 of 5)

- Fixed duration organization
  - Uses small disc blocks
    - Example: 1 KB, 4 KB, 8 KB
  - Each logical block consists of many disc blocks
    - The final one may be partially empty
  - Media index
    - Every logical block has a fixed duration
    - Shows the starting disc block for each logical block

File storage (3 of 5)

- Fixed size organization
  - Uses large disc blocks
    - Example: 256 KB, 512 KB, 1 MB
  - Each disc blocks holds multiple logical blocks
    - May have some empty space in the end
  - Disc index
    - Each disc block has many logical blocks
    - Time code for first logical block in disc block

File storage (4 of 5)

- Fixed duration or fixed size?
- Advantages of fixed duration
  - May required less space
  - Faster location of desired time
  - Each change of quality (for adaptive streaming)
- Advantages of fixed size
  - Fewer disc seeks and transfers
  - Smaller index

File storage (5 of 5)

- Organization for near video on demand
  - Say that we have a 120 min title
  - It starts every 10 min
  - Need to read at 12 different points at once
  - Interleave blocks for every 10 minutes
    - Assume 1 block per minute
    - First group : block 0, block 10, block 20, ...
    - Second group: block 1, block 11, block 21

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Real-time systems

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Real-time

- What is a real-time system
  - Executes processes within a specific deadline
    - Regardless of what else is going on
    - The deadline is the latest execution time
    - Usually calculated from when an event occurs
  - Periodic or aperiodic processes
  - Requires complex scheduling
  - Hard and soft real-time systems

Hard and soft systems

- Hard real-time systems
  - Deadlines must always be achieved
  - Otherwise, catastrophic event
  - Example: industrial control
- Soft-real time systems
  - Deadlines statistically achieved
  - Otherwise, user is annoyed
  - Example: set-top box

Multimedia systems

- Soft-real time systems
  - Reliability: there are no catastrophic events
    - In the worst case, the system is useless
  - Redundancy: error hiding
  - Adaptivity: quality reduction
    - Based on understanding human perception
  - Periodicity: usually periodic events
    - Example: display 30 frames per second

Resource Management

- Resources in real-time systems
  - Need to check in advance if resources exist
  - Commit resources to a process
  - Manage resources at any point in time
  - What if resource needs are not constant?
- Resource commitment policies
  - Pessimistic: assume maximum requirements
  - Optimistic: assume average requirements

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Real-time scheduling

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Scheduling (1 of 2)

- General purpose systems
  - Priority mechanism
  - Does not provide any guarantees
  - Can just use higher priorities and hope!
- Real-time systems
  - Provide guarantees
  - Pessimistic (worst case) resource commitment

Scheduling (2 of 2)

$$\sum_{i=1}^{m} \frac{C_i}{P_i} \leq 1$$

- Process scheduling condition
  - Assume m periodic processes
  - C_i: CPU time, P_i: execution period
  - Total CPU utilization <= 1
  - Not every algorithm can actually achieve this
    - Many fail before they reach 1!

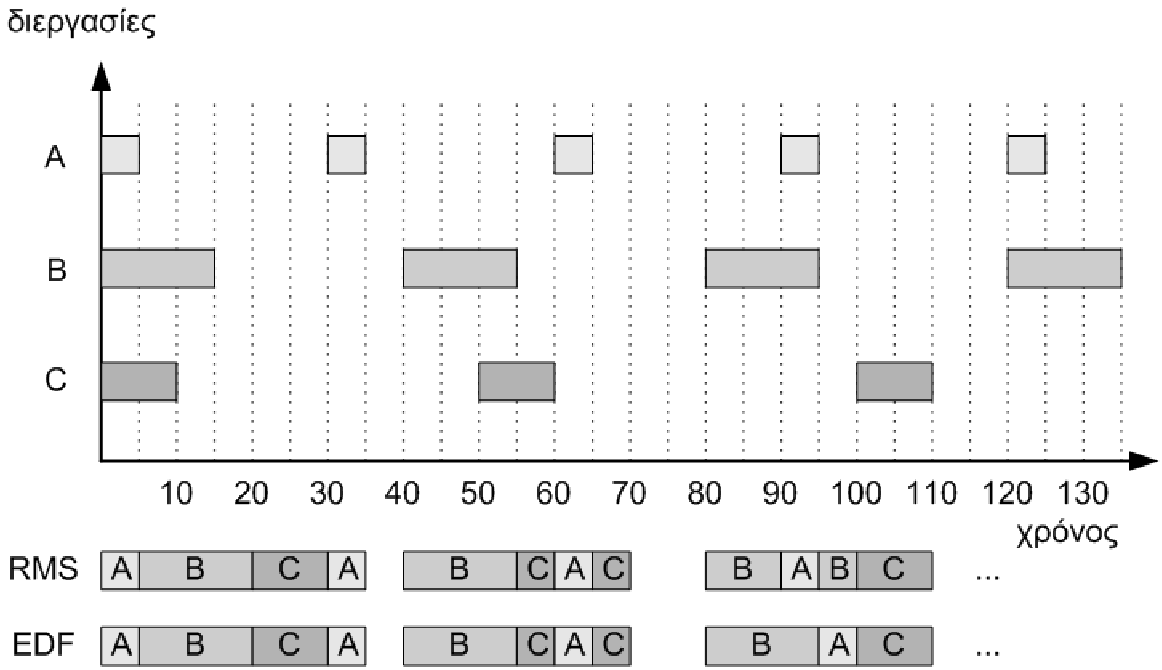
RMS algorithm

- Rate Monotonic Scheduling (RMS): static
  - All processes must be periodic
  - Priority proportional to frequency
    - Process priorities are static
    - Only frequency / period matters
  - Always executes higher priority process
    - As long as it is ready
  - Cannot achieve 100% utilization (in general)

EDF algorithm

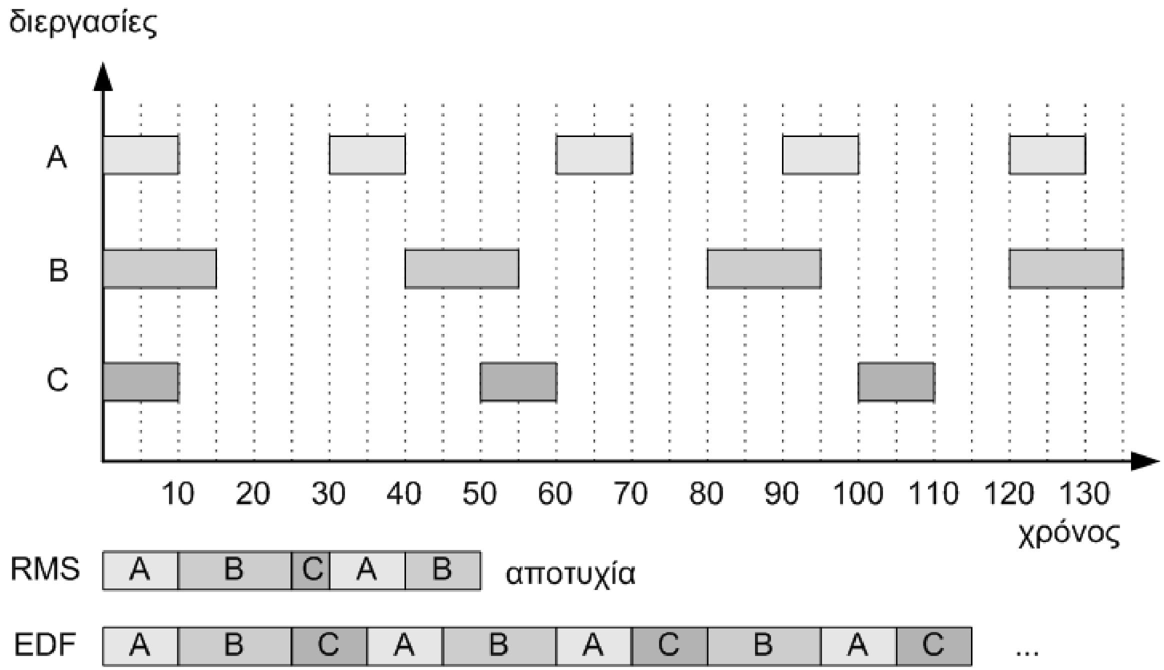
- Earliest Deadline First (EDF): dynamic
  - Can also handle aperiodic processes
  - Priority inverse to deadline
    - Could be the next time execution for periodic processes
  - Priorities are dynamic
  - Always executes higher priority process
    - As long as it is ready
  - No guarantees for aperiodic processes

Example: RMS succeeds



- A: every 30 ms, executes 5 ms
- B: every 40 ms, executes 15 ms
- C: every 50 ms, executes 10 ms
- CPU utilization = 0,74

Example: RMS fails



- A: every 30 ms, executes 10 ms
- B: every 40 ms, executes 15 ms
- C: every 50 ms, executes 10 ms
- CPU utilization = 0,91

RMS vs EDF

- RMS is simple and fast
  - RMS never changes priorities
  - EDF changes priorities
    - Need to sort the ready list
- EDF is more efficient
  - Can always work for utilization under 100%
  - RMS can fail even at 90%
    - Depends on number and details of processes

Processes vs packets

- Two types of scheduling (in general)
- Preemptive: used with processes
  - A process can be interrupted by a higher priority
  - It will continue later
- Non-preemptive: used with packets
  - Packets always complete transmission
  - Otherwise, the entire transmission is wasted

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End of Section #3

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