Real-Time Systems

• Hard real-time system
  – Stringent requirements on deadlines for task completion
• Soft real-time system
  – Real-time task will receive priority but no absolute guarantee of completion is provided

Common Characteristics

• Single purpose – e.g., controlling anti-lock brakes, airline navigation, delivering music on an MP3 player, …
• Small size – space- or power-constrained environments
• Specific timing requirements

Implementing Real-Time Operating Systems

• In general, real-time operating systems must provide:
  (1) Preemptive, priority-based scheduling
  (2) Preemptive kernels
  (3) Latency must be minimized
    - interrupt latency
    - dispatch latency
**Real-Time CPU Scheduling**

- Periodic processes require the CPU at specified intervals (periods)
- \( p \) is the duration of the period
- \( d \) is the deadline by when the process must be serviced
- \( t \) is the processing time

![Diagram showing periodic processes and deadlines](image1)

**Rate Monotonic Scheduling**

- A priority is assigned based on the inverse of its period
- Shorter periods = higher priority;
- Longer periods = lower priority

![Diagram showing rate monotonic scheduling](image2)

**Scheduling of tasks when \( P_2 \) has a higher priority than \( P_1 \)**

- \( P_1 \): period=50, processing time = 20, deadline = period
- \( P_2 \): period=100, processing time = 35, deadline = period

![Diagram showing scheduling](image3)

**Missed Deadlines with Rate Monotonic Scheduling**

- \( P_1 \), \( P_2 \), \( P_3 \)
- Deadlines: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120

![Diagram showing missed deadlines](image4)
Earliest Deadline First Scheduling

- Priorities are assigned according to deadlines:
  
  the earlier the deadline, the higher the priority;

- Deadlines: $P_1$, $P_2$, $P_1$, $P_2$, $P_1$, $P_2$

Disclaimer

- Parts of the lecture slides were derived from those by Kai Shen, Willy Zwaenepoel, Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Andrew S. Tanenbaum, and Gary Nutt. The slides are intended for the sole purpose of instruction of operating systems at the University of Rochester. All copyrighted materials belong to their original owner(s).