REALTIME SCHEDULING ALGORITHMS

Module 2.7
COP4600 – Operating Systems
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SCHEDULING IN REAL-TIME SYSTEMS

- Timing is everything!
  - Deadlines for tasks
  - Consequences if deadline missed!
- Tasks may be periodic
  - Same task done repeatedly
  - E.g., check altitude of plane, adjust elevators
- Tasks may be aperiodic
  - Tasks arrive based on external events
  - E.g., Temperature in reactor core is too high!

REAL-TIME SYSTEM CATEGORIES

- Hard real time
  - Disaster if deadline missed (fly-by-wire, chemical plant, etc.)
- Soft real time
  - Annoying if deadline missed (audio, video, etc.)

SCHEDULING IN REAL-TIME SYSTEMS

- Periodic task set = $\{(C_i,P_i)|i=1,2,\ldots,m\}$
  - C_i = i^{th} task's maximum compute time
  - P_i = i^{th} task's period
  - May also include deadlines, priorities
  - Normally assume deadline same as period

SCHEDULING IN REAL-TIME SYSTEMS

- Schedule
  - Which task is running at each instant
- Requirements
  - j^{th} instance of task i must complete before its deadline (i.e., $(j+1)^{st}$ instance arrival)
  - Highest priority unfinished task runs

SCHEDULING IN REAL-TIME SYSTEMS

- Static Priorities
  - Task i's priority never changes
  - Always run highest priority task (preemptive)
  - Rate Monotonic Scheduling is optimal
    - Shortest period = highest priority
- Dynamic Priorities
  - Earliest deadline first (EDF) is optimal
  - Can schedule iff

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

  - Also works for aperiodic tasks

PRIORITY INHERITANCE

- Locking and Blocking
  - Low priority task may hold lock
  - Block high priority task
- Priority Inversion
  - Medium priority task may preempt low priority task blocking high priority task!
- Priority Inheritance
  - Give low priority task with lock the priority of the highest priority task waiting on it (directly or indirectly)

SUMMARY

- Realtime System types
  - Hard vs. Soft
- Specifying realtime systems
- Static Priority
  - Rate Monotonic Scheduling
- Dynamic Priority
  - Earliest Deadline First
  - Condition for Schedulability
- Priority Inversion
  - Priority Inheritance