University of Glasgow | School of Computing Science

# Real-time Scheduling of Periodic Tasks

## Advanced Operating Systems
## Tutorial 1

# Tutorial Outline

- Review of lectured material
- Worked examples

# Review of Lectured Material

- Introduction and system model
  - Tasks, jobs, processors, resources
  - Timing constraints and scheduling algorithms
  - Periodic, aperiodic, and sporadic tasks
  - Hard and soft real-time systems
- Scheduling periodic tasks
  - Types of scheduler: clock-driven vs. priority-driven
  - Scheduling algorithms; approaches to proving correctness
  - Rate monotonic: non-optimality, time-demand analysis & critical instants, simply periodic systems, maximum utilisation tests
  - Earliest deadline first: optimality, maximum utilisation test, density test
  - Choice of rate monotonic vs. earliest deadline first
  - Other algorithms: deadline monotonic and least slack time

# Worked Examples

- Identifying tasks
- Rate monotonic scheduling
- Earliest deadline scheduling

# Identifying Tasks

- A hypothetical helicopter flight control system, with 1/180th second cycle:
  - Validate sensor data and select data source; on failure reconfigure system
  - Do 30Hz avionics tasks, each once every 6 cycles:
    - Flight control input; data normalisation & coordinate transformation; tracking reference update
  - Do 30Hz calculations, each once every 6 cycles:
    - Control laws of outer pitch-control loop; control laws of outer roll-control loop; control laws of outer yaw- and collective-control loop
  - Every 2 cycles, do 90Hz calculations, using outputs of 30Hz calculation
    - Control laws of inner pitch-control loop; control laws of inner roll- and collective-control loop
  - Calculate inner yaw-control loop, using outputs of the 90Hz calculations
  - Output commands to control surfaces
  - Carry out built-in-test
- What are the jobs and tasks in this example?

# Rate Monotonic Scheduling

- Can the system of five independent, preemptable, tasks $T_1$=(1.0, 0.25), $T_2$=(1.25, 0.1), $T_3$=(1.5, 0.3), $T_4$=(1.75, 0.07) and $T_5$=(2.0, 0.1) be scheduled using the rate monotonic algorithm?

# Earliest Deadline Scheduling

- Can the system of three independent preemptable periodic tasks $T_1$=(8, 4), $T_2$=(12, 4) and $T_3$=(20, 4) be scheduled using earliest deadline first?

# Discussion

- Maximum utilisation tests are powerful
  - Don’t perform exhaustive simulation or time-demand analysis unless you have to