Real Time Operating Systems

The Sporadic Server

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Sporadic and Aperiodic Tasks

- Arrival times are not known
- Execution times might be unknown too...
- $\Rightarrow$ Performing an admission test might be difficult...
- How to schedule aperiodic and sporadic tasks?
  - Risk to cause deadline misses in other tasks
  - Sporadic tasks can be scheduled as periodic tasks with period equal to the Minimum Interarrival Time $\Rightarrow$ system underutilisation

Serving Tasks with Unkwnown Utilisation

- Idea: “reshape” aperiodic and sporadic tasks to force their utilisation so that they do disturb other tasks
- Traditional solution: a periodic real-time task (called server) serves aperiodic and sporadic requests
  - Emulated by some scheduling algorithms
  - For this reason, the name of such algorithms often contains the word “Server”
- Server algorithms for aperiodic tasks are often based on static priorities
  - They can coexist with RM or DM
  - Examples: Polling Server, Deferrable Server, Sporadic Server, ...
- Can be modified to work with EDF

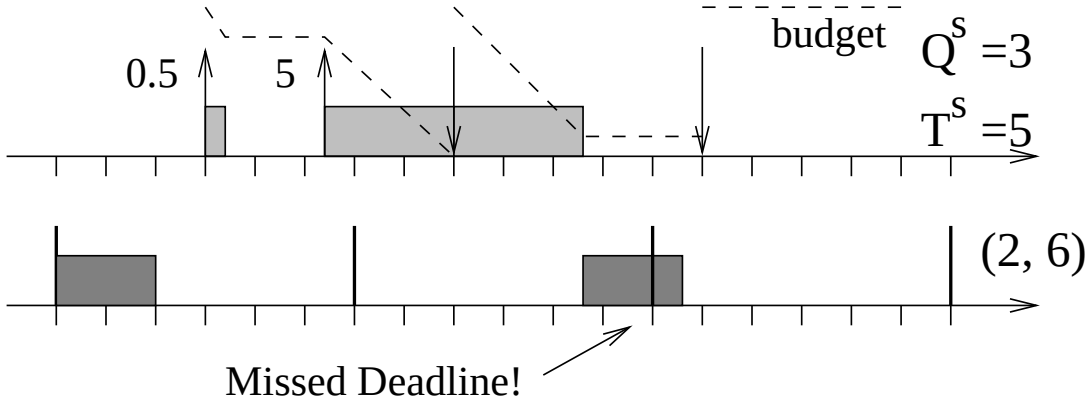
The Sporadic Server

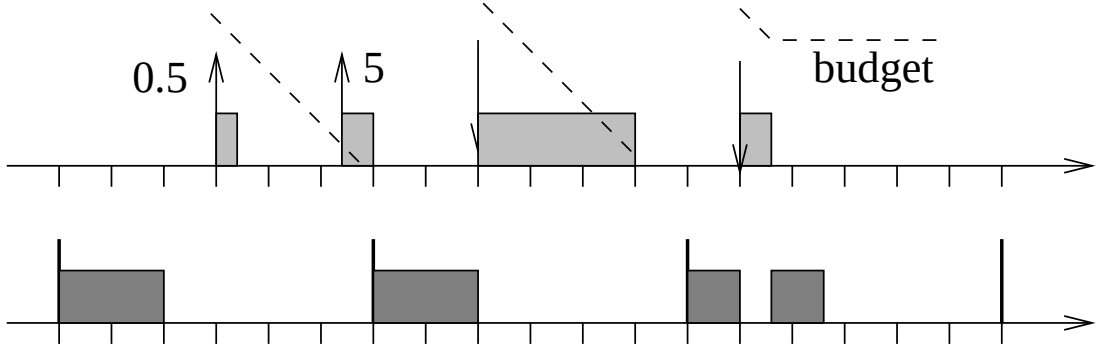
- Class of algorithms to serve aperiodic/sporadic tasks
  - Many different implementations have been proposed
  - A sporadic server *tries* (if possible) to serve requests as soon as they arrive (this is why it is called sporadic)
  - Has the worst-case behaviour of a periodic task
- A server is described by two parameters Q^s and T^s
  - Like other algorithms, is based on a *budget* q^s
  - The budget is decreased when the served task executes
  - The budget is *recharged* after T^s from its usage
- The various implementations differ in these accounting and replenishment rules

Sporadic Servers: Possible Choices

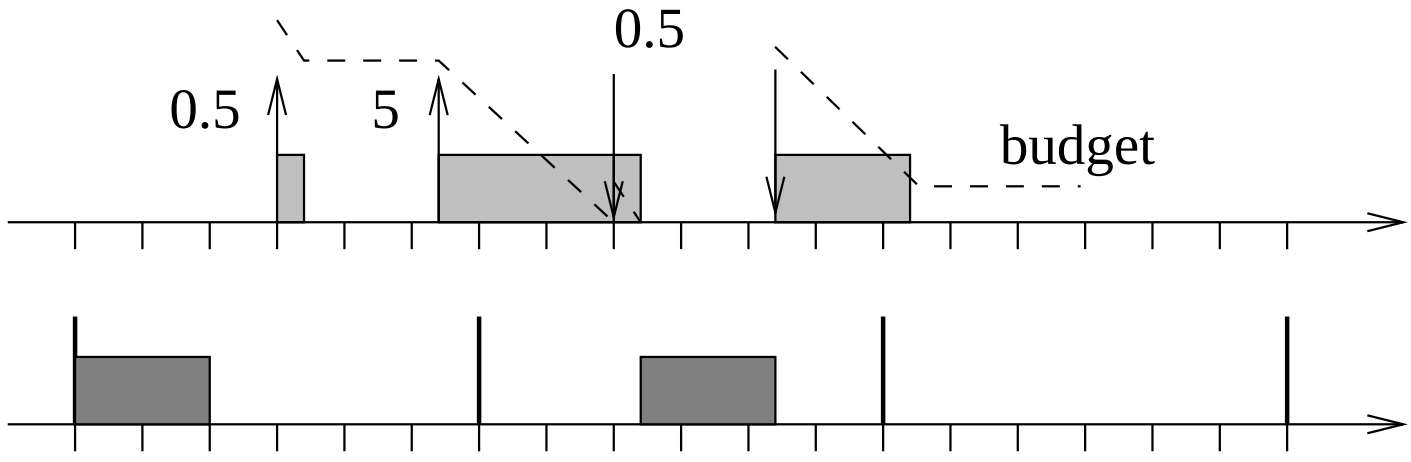
- When / How to replenish?
  - Replenishment can be performed by *always replenishing* q^s *to* Q^s. In this case, q^s is decreased when the highest priority tasks are idle and $q^s > 0$
  - If q^s is decreased only when the served task is executing, then the budget must be recharded "in chunks": if c time units are consumed from t_0 to $t_0 + c$, then the budget is recharged at time $t_0 + T^s$ as $q^s = q^s + c$
- Can background time be used?
- Can the server use the time unused by higher priority tasks?

Replenishing to q^s





Replenishing in Chunks



Sporadic Server in POSIX

- POSIX defines various scheduling policies:
  - `SCHED_FIFO`
  - `SCHED_RR`
  - `SCHED_SPORADIC`
  - `SCHED_OTHER`
- `SCHED_SPORADIC` is a *Sporadic Server*
  - Specific Sporadic Server definition by POSIX
  - The `sched_param` structure must be extended...
  - Difference respect to “traditional” sporadic servers: when the budget is exausted, the task is not blocked (but is scheduled at a lower priority)
  - Performs replenishments “in chunks”

Sporadic Server Interface

- `struct sched_param` has been extended:
  - `sched_ss_init_budget`: maximum budget Q^s
  - `sched_ss_repl_period`: replenishment period T^s
  - `sched_ss_low_priority`: background priority (at which the server is scheduled when the budget q^s is depleted)
  - `sched_ss_max_repl`: maximum number of pending replenishments
- The priority of the server is given by `sched_priority`
  - When $q^s > 0$, served tasks are scheduled at priority `sched_priority`

POSIX Algorithm

- The budget q^s is decreased when served tasks execute
- `activation_time`: job arrival time $r_{i,j}$, or replenishment time when q^s becomes > 0
- Replenishment times are set to `activation_time` $+T^s$
- Replenishment amounts are computed when a job finishes (task blocks), or when the budget is depleted ($q^s = 0$)
- When $q^s = 0$, the task is scheduled at `sched_ss_low_priority`
- The budget q^s is always $\leq Q^s$
- Limit the maximum number of pending replenishments: if `sched_ss_max_repl` replenishments are pending, schedule at `sched_ss_low_priority`