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- Long jobs will eventually get a slice

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- But now critical shorter jobs might not finish in time as they could get scheduled after a long-waiting job
- This needs frequent re-evaluation of priorities to get good behaviour, which implies small timeslices, and so lots of scheduling overhead

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- If a process appears in a higher queue, we go back to that higher queue

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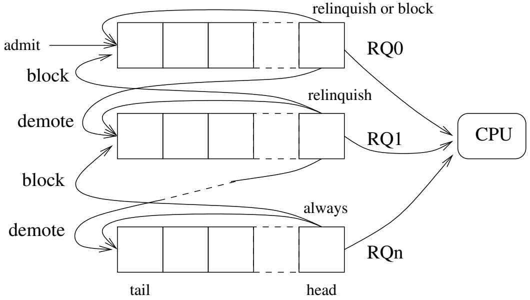
- Similarly blocking processes in RQ_0 get placed back at the end of RQ_0

Multilevel Feedback Queueing



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Old processes tend to starve with this, so a variant doubles the quantum for each level: RQ_0 gets 1, RQ_1 gets 2, RQ_2 gets 4, and so on

So compute intensive processes get a big bite, whenever they get a chance, at the potential cost of responsiveness to a new process

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Algorithms

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This scheme was used by Windows NT and Unix derivatives, as we shall see next

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Algorithms

Traditional Unix scheduling

As used in older Unix derivatives — modern scheduling is much more sophisticated

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The 1/2 was a quirk of implementation and is not important

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Note that this is actually very similar in effect to Multilevel Feedback Queueing where a priority of n corresponds to RQ_n

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But nice also enables a *purchased* priority

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So this is not used in modern systems, where many 100s of processes is common

Fair Share Scheduling

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Fair share scheduling is where each *user* (or group or other collective entity) gets a fair share, rather than each *process*

Fair share Scheduling in Unix

Recall Unix processes are collected in groups in a tree: a *process group*

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$$\begin{aligned}\text{Priority} &= \text{base priority} + \frac{\text{CPU time used by process}}{2} \\ &+ \frac{\text{CPU time used by process group}}{2} + \text{nice}\end{aligned}$$

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Exercise. Read up on $O(1)$ scheduling and *The Completely Fair Scheduler*

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Exercise. Read up on $O(1)$ scheduling and *The Completely Fair Scheduler*

Also have a look at scheduling for real-time systems: for when a process must *absolutely* get scheduled within a given time

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We now look at a new problem that arises when we want to schedule *multiple* resources

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There is no “waiting” happening: the process does not run when blocked

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Sometimes the wait is infinite!

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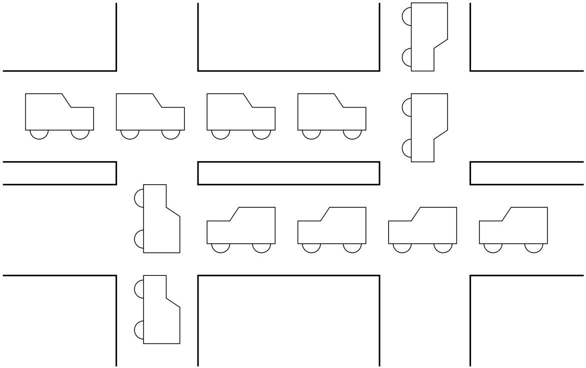

Gridlock/Deadlock

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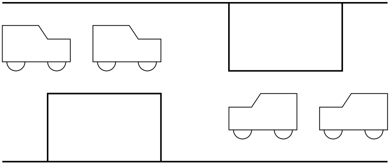

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- Now both P_1 and P_2 are blocked and the OS can't run either process!

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And with more than two processes: think of three or more processes in a circle

Deadlock

A formal definition of deadlock:

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A set of processes D is *deadlocked* if

1. each process P_i in D is blocked on some event e_i
2. event e_i can only be caused by some process in D

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[2] I've seen it happen