Red Hat
Enterprise Linux

DL Server

RT and Scheduling MC - LPC 2023

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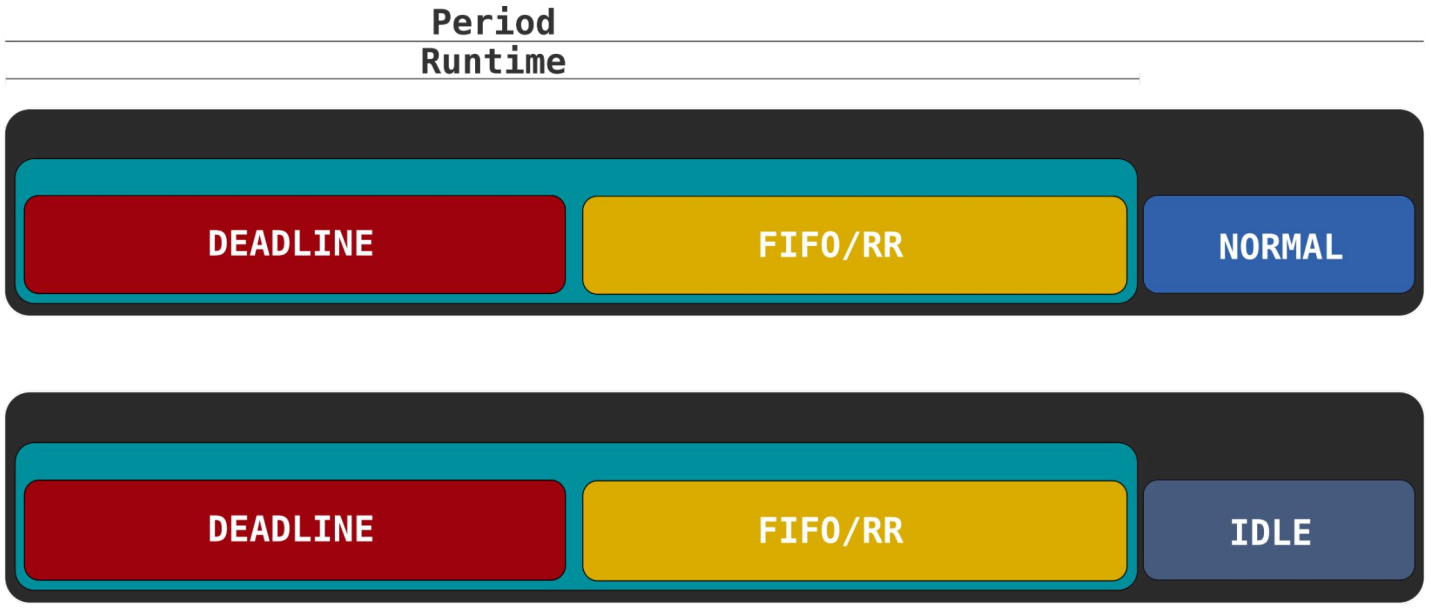
The RT Throttling problem

- The real-time throttling mechanism is a safeguard for misbehaving real-time tasks
  - kernel.sched_rt_runtime_us / kernel.sched_rt_period_us = 950000 / 1000000
  - It throttles the rt_rq
- It causes the system to go idle
- It does not work for fine-grained runtime
  - Many people deactivate it - though this is a workload problem
- It does not solve the starvation from SCHED_DEADLINE



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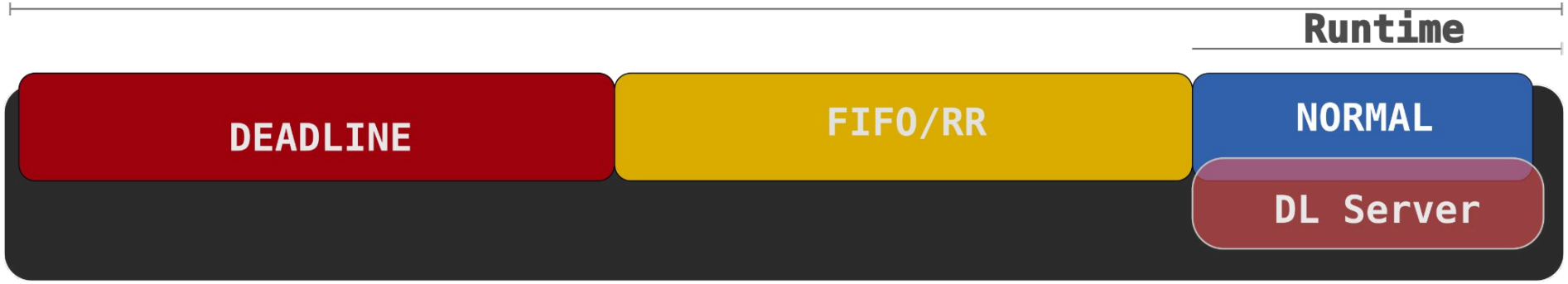
The RT Throttling problem

~~Failed attempts~~ Temp fixes and stalls

- The RT_RUNTIME_GREED options
  - If there are no starving tasks, ignore throttling and keep running
- stalld
  - User-space tool that monitors runqueue: If a task is not scheduled within a "timeout."
    - Boost with SCHED_DEADLINE
- SCHED_DEADLINE Servers
  - Back in 2017? The DL server was proposed by Peter
  - But back then, we stalled on the way not to break RT...



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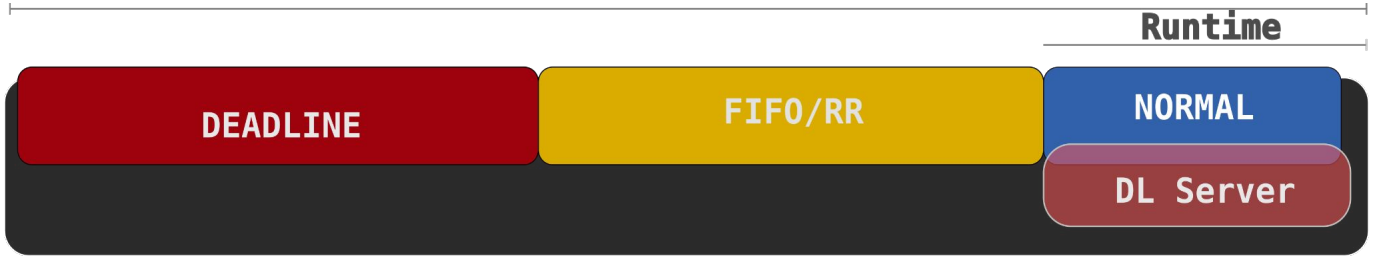
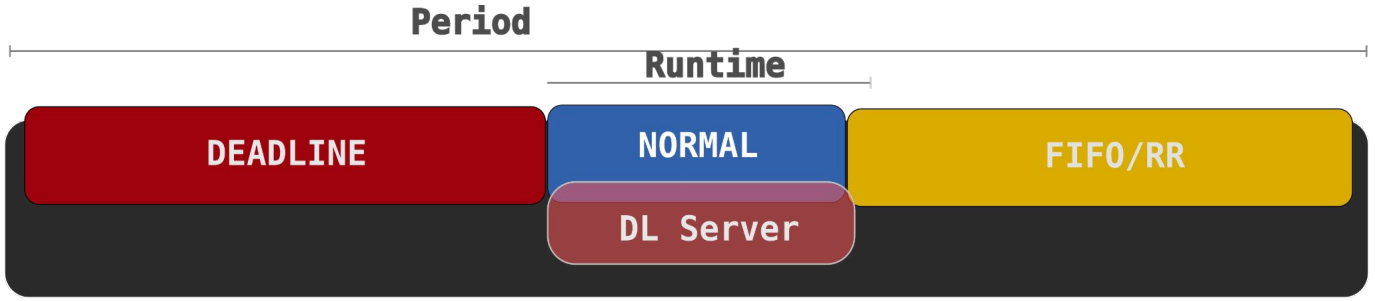
The RT Throttling problem

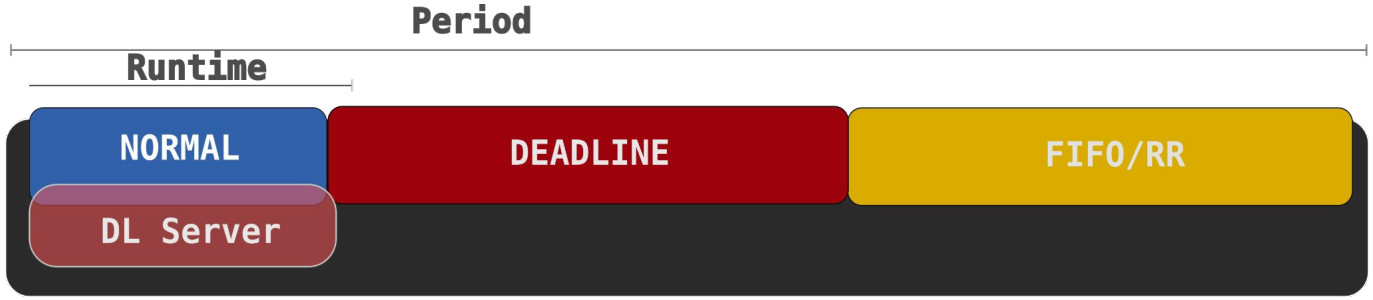
- What we wanted:



- What we had:



- What we thought it would be the best solution:



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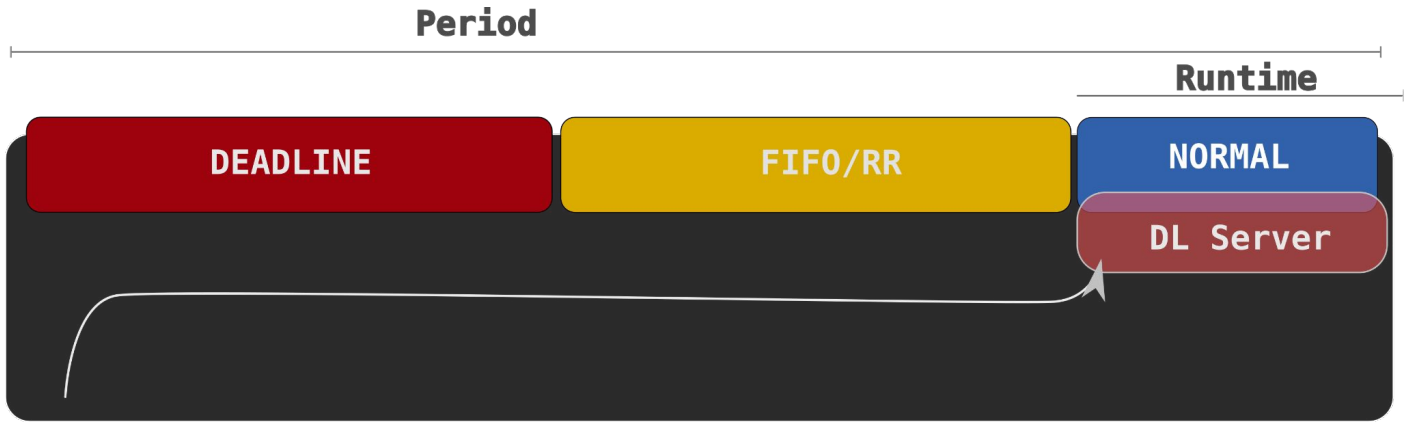
DL Server with deferred activation

- The fixed priority scheduler has properties that many people rely on:
  - The highest priority task runs with minimum latency
  - The EDF does not have this priority because the highest priority task changes as time goes
- Using the DL server is the best way to get out of sched fair starvation
  - It boosts the entire rq
  - It fixes all the other problems we had
- But activating it when not needed caused us the problem on the first bullet
  - We need the DL server only if the fair scheduler is starving
- We've learned from stalld that waiting for starvation to be imminent was a good thing!



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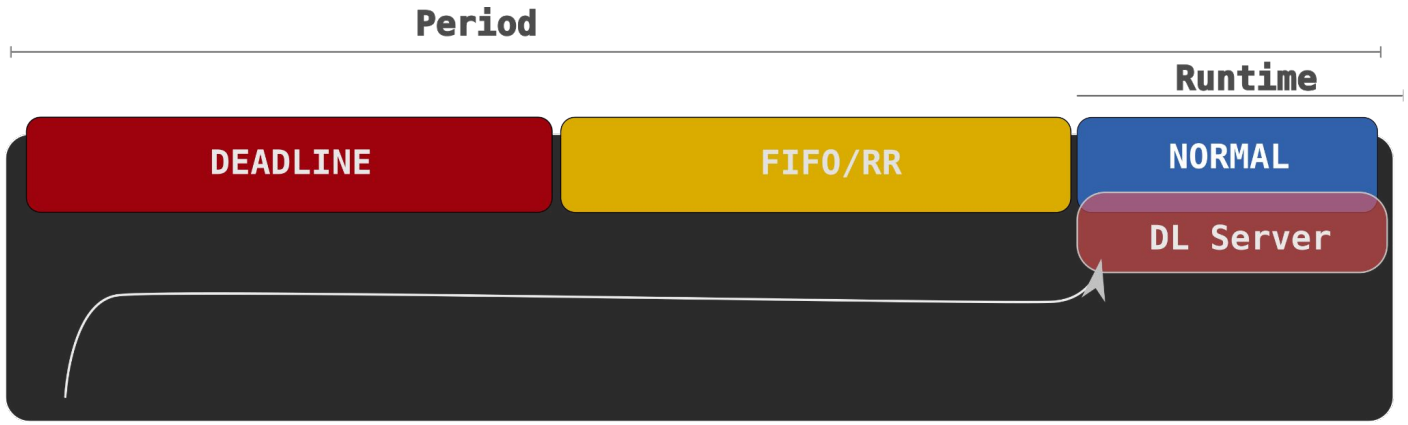
DL Server with deferred activation

- Anytime a fair task is active the DL Server is started:
  - **period and runtime are set** if deadline already not set in the future
  - The server **starts throttled**
    - The **replenishment timer is set to deadline - runtime** (zero laxity time of the task alone at starting time)
  - Anytime the **fair scheduler runs**, the **dl_server has its runtime consumed**
    - Even if the dl_server is not actually running
  - **If the server had enough runtime before the replenishment time**:
    - **Reset runtime & period, reschedule the replenishment timer**
  - **Otherwise: replenish the dl server accordingly to the CBS rule and run as a DL task**



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DL Server with deferred activation

- In other words:
  - The fair dl_server is always armed
  - If fair dl_server had enough runtime, it is postponed
  - otherwise, the fair scheduler becomes a SCHED_DEADLINE task
  - In a properly loaded RT system, the DL server should not be activated!
- Interface:
  - /debug/sched/fair_server/cpu{ID}:
    - runtime : 50ms
    - period : 1s
    - defer : 1
- The rt throttling is confined on RT_GROUP_SCHED
  - The sysctls (sched...rt_runtime_us...) are still there to limit sched deadline bandwidth
- It works! :D

Thank you

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