Arm Power Kernel Team

Per-task I/O boost tracking

LPC 2021 Sched MC

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What is I/O boost?

- Reduce devices wait time when feeding it data
- Increase throughput by reducing the time the device stays active awaiting incoming requests
- Aide for I/O-bound tasks that usually have low utilization while performing I/O requests and as such will not trigger a frequency update on their own

I/O wait task

task utilization = 1/11

=> lower OPP

cycle increased from 1.1ms to 2ms

=> ~80% decrease in throughput

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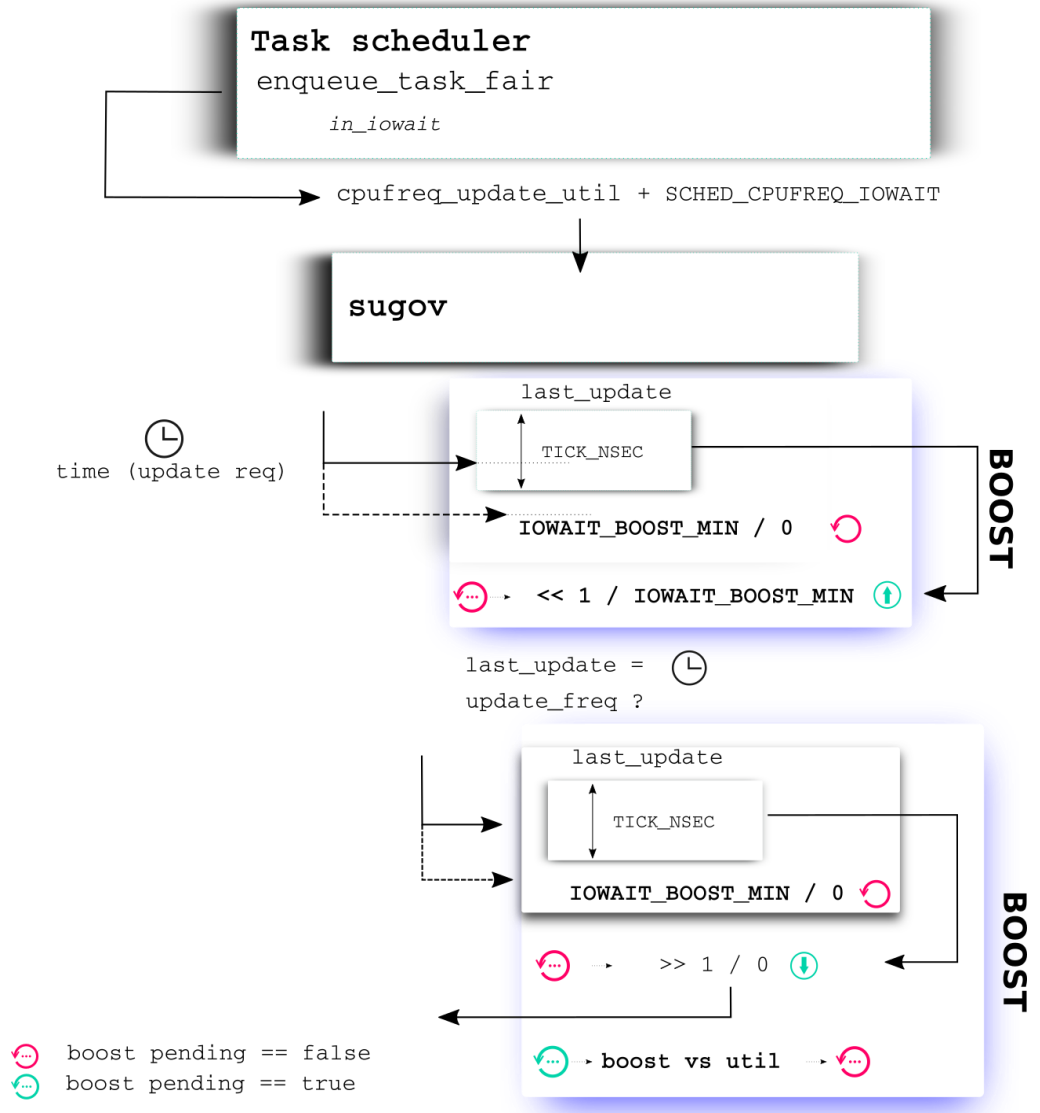
Current design

- Sugov: per-CPU boost driven by CFS tasks with iowait flag set
- Discrete boost values [128, 256, 512, 1024]

Boost value:

- Increase at each consecutive wake-up from I/0 (< TICK_NSEC and freq update in between)
- Maintain if non-I/O update and rate-limit applies or cross CPU request not possible
- Reduce if no pending boost request during freq update
- Reset if no update for > TICK_NSEC



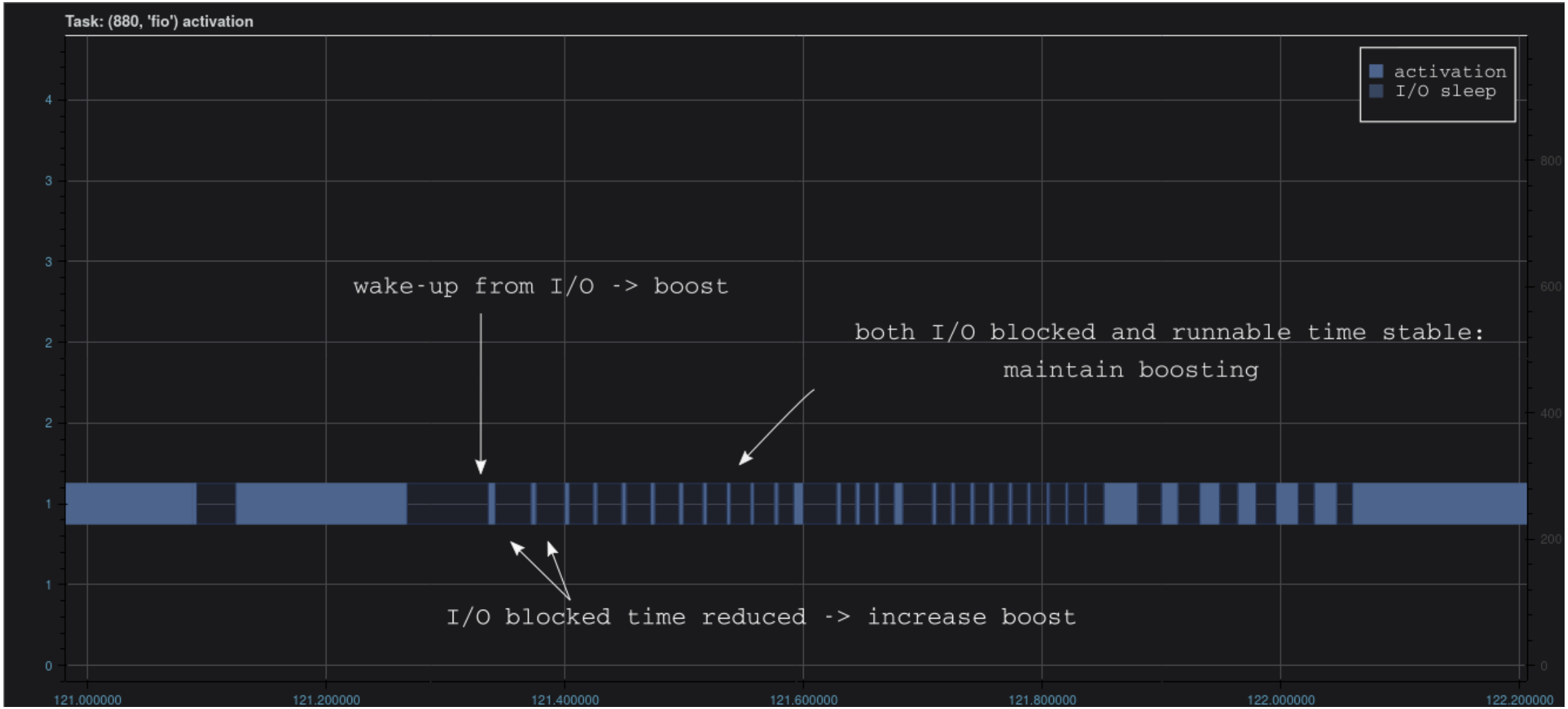
Issues with the current design

- Frequency spikes for sporadic I/O - increasing boost by unrelated I/O tasks
- I/O Devices with long response time - timing constraints (TICK_NSEC)
- Boost on CPU A can be affected by frequency updates on CPU B within same shared policy
- Task migration/termination - not covered since tracking per-CPU
- No real control over boosting – per-task uclamp vs boost value
- No per-task boost for task placement on asymmetric CPU capacity systems

New design proposal

- Concept: decision on I/O boosting moved from sugov to be performed on a per-task basis
- For each task that performs I/O requests track its time:
  - being blocked on I/O (sleep time)
  - between wake-ups from I/O (sleep + runnable time)
- Tracking 2 separate yet overlapping signals allows deriving conclusion on the I/O waiting pattern
- Used to decide whether further boosting is sensible (from performance and energy consumption perspective)
- With pre-defined margins and bit of coin tossing

New design proposal



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Continued .....

- Boost value is being represented in a form of 'boost levels' with max level of 4
  → this resembles sugov’s boosting with doubling boost value
- Boost levels are being max-aggregated on a rq level upon enqueueing the task
- Additional signal to retain boost between wakeups (rq level)

Discussion ...

- Boost decision points: increase / maintain / reduce ...
- Boost level max-aggregation for enqueued I/O bound task on CPU rq level
- Countermeasures for irregular patterns for I/O-bound workloads
  - Kernel worker threads that might cause disruption
- Decision making placed on the wake-up path -> additional overhead !
  - Sched vs CPUFreq gov realm