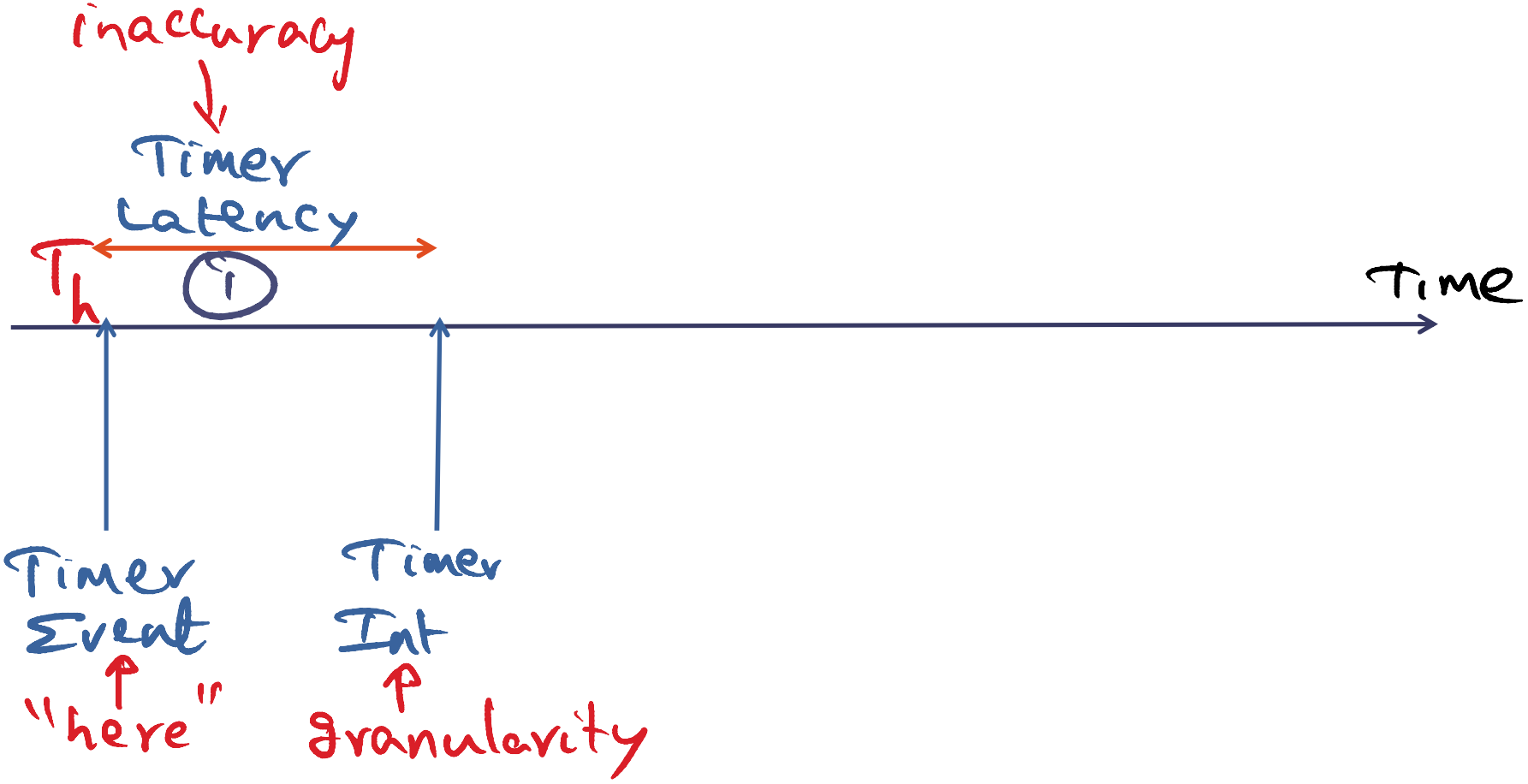
Lesson outline

→ TS- Linux

Persistent Temporal Streams

Sources of Latency



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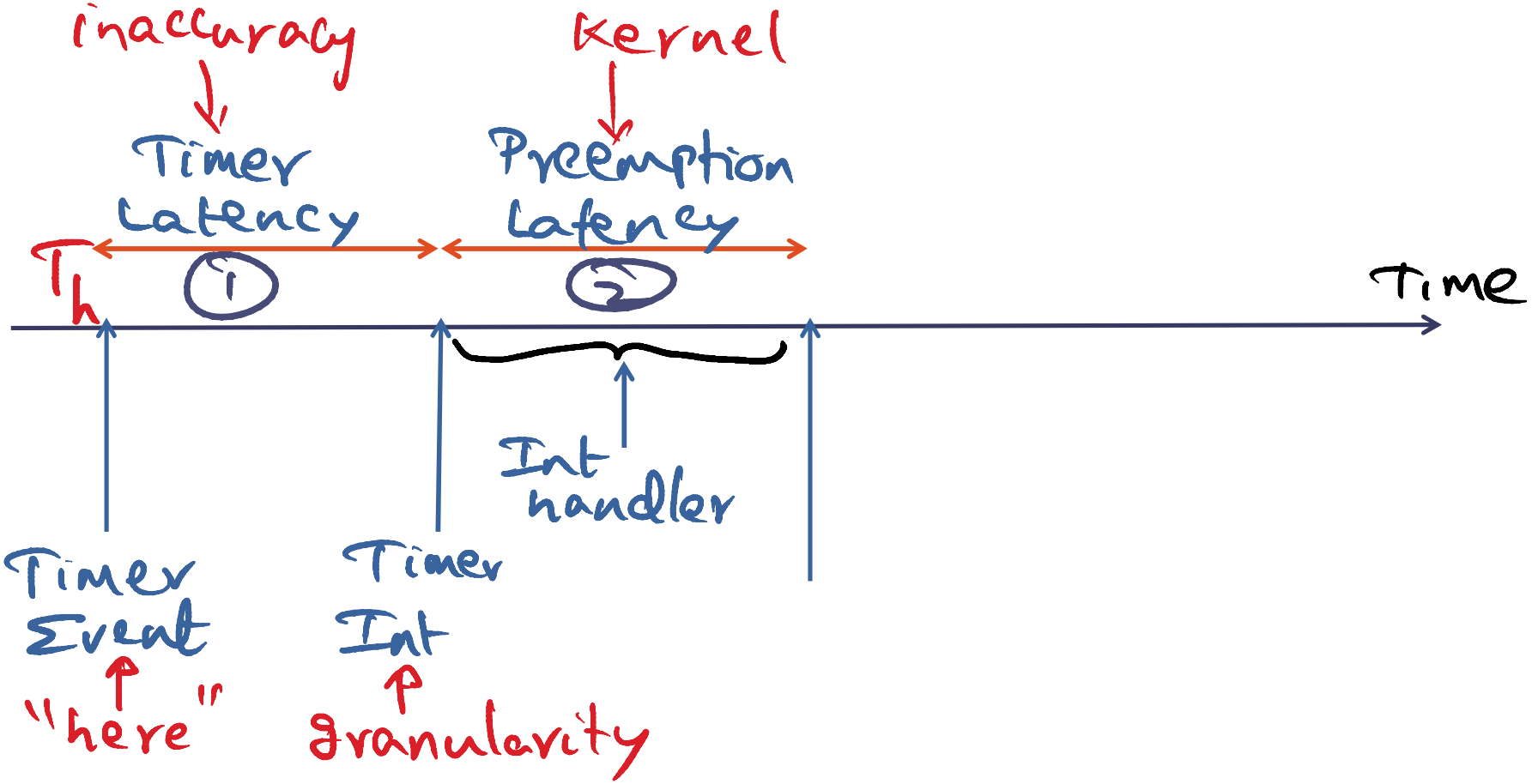

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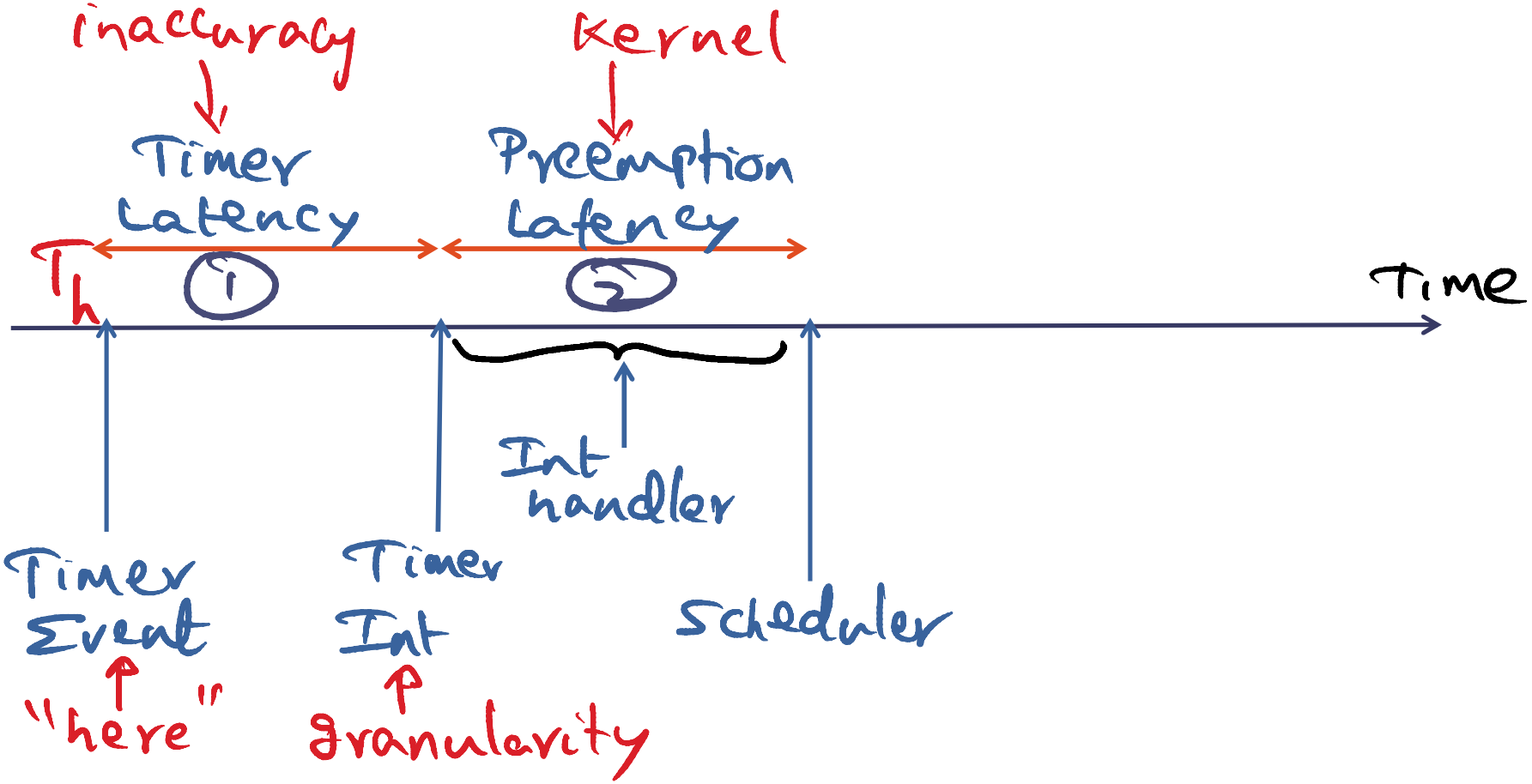

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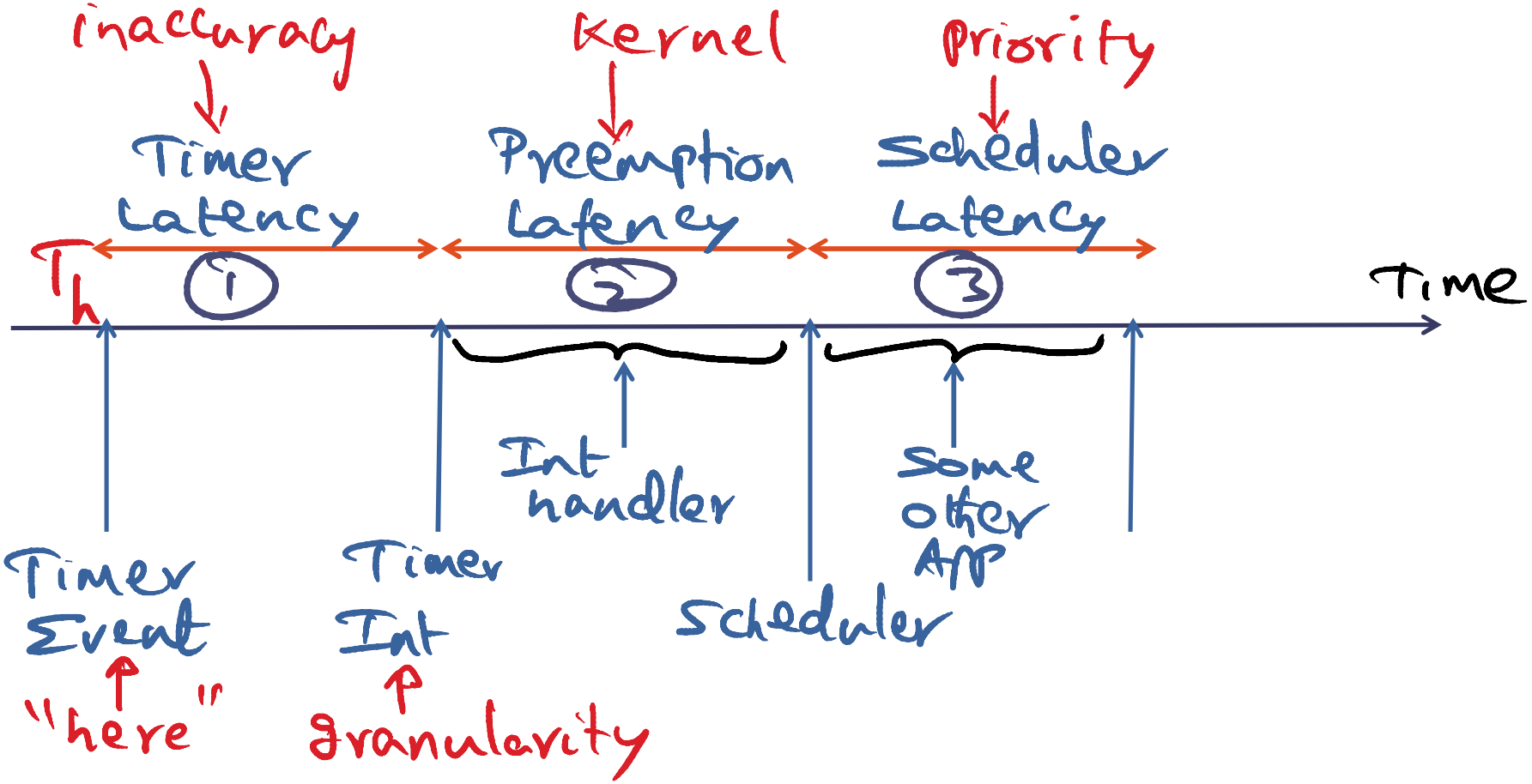

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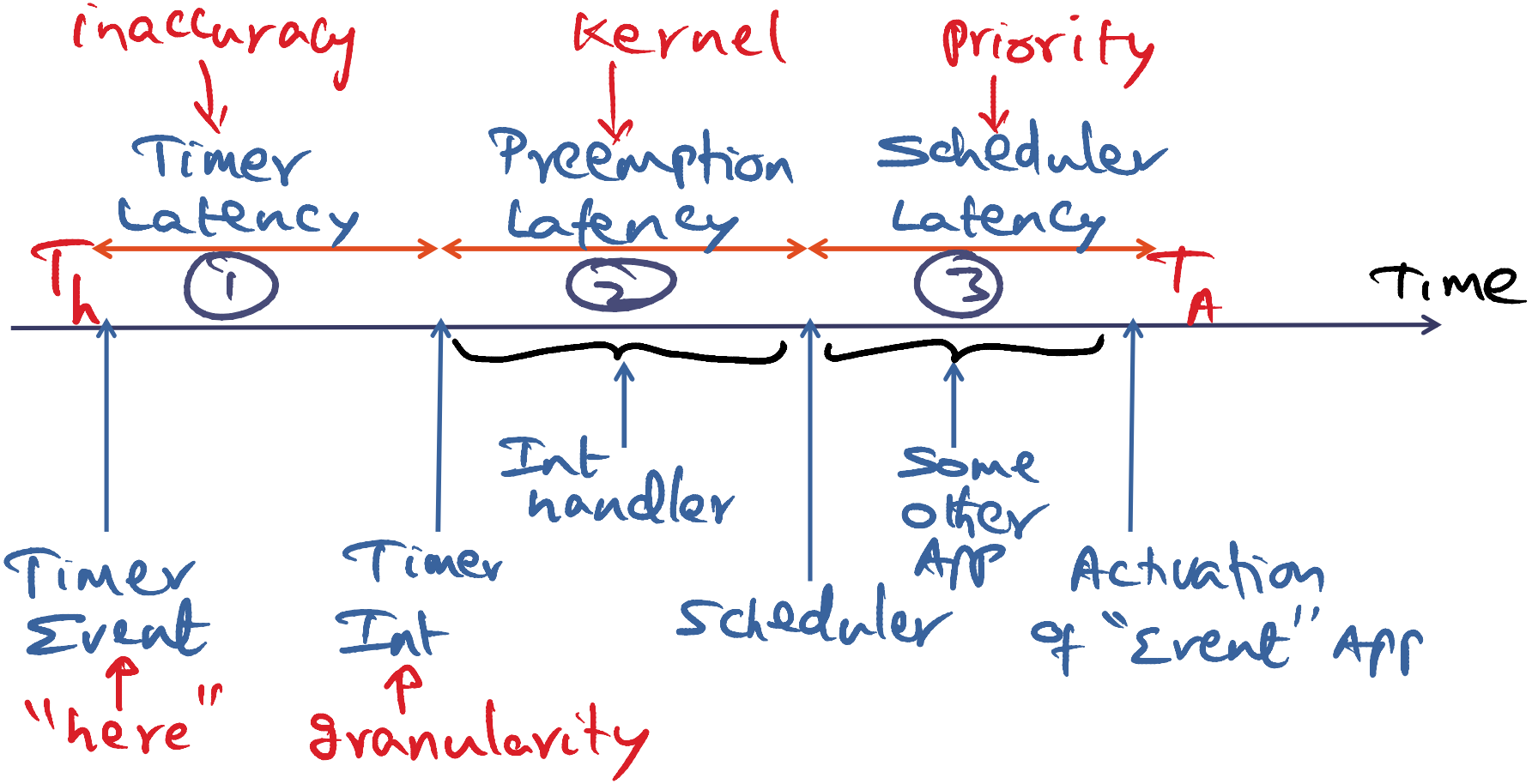

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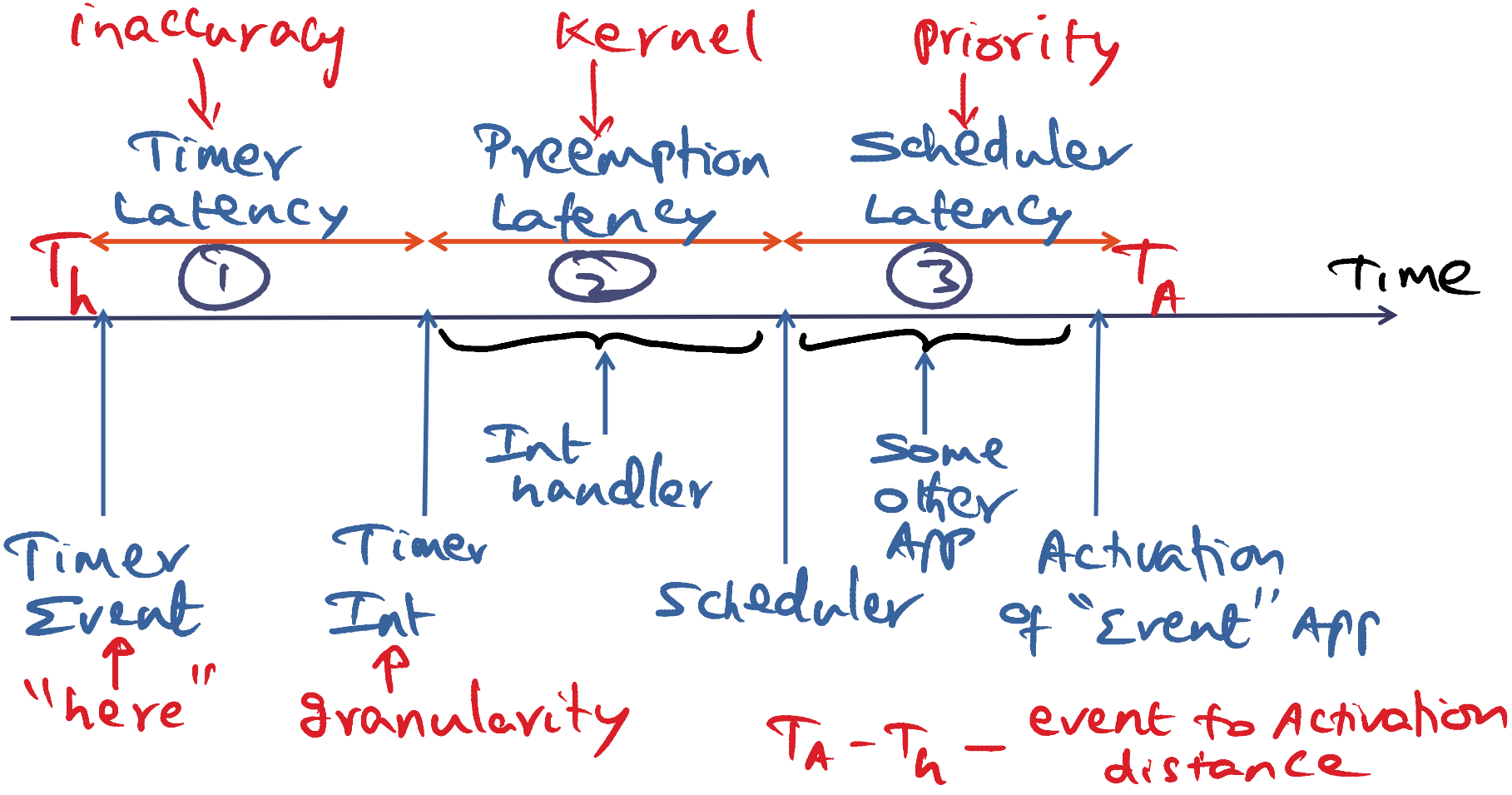

Choice of Timer	Pro	Con
Periodic	periodicity	event recognition latency

Choice of Timer	Pro	Con
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One-shot	timely	overhead

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Soft	reduced overhead	Polling overhead, latency

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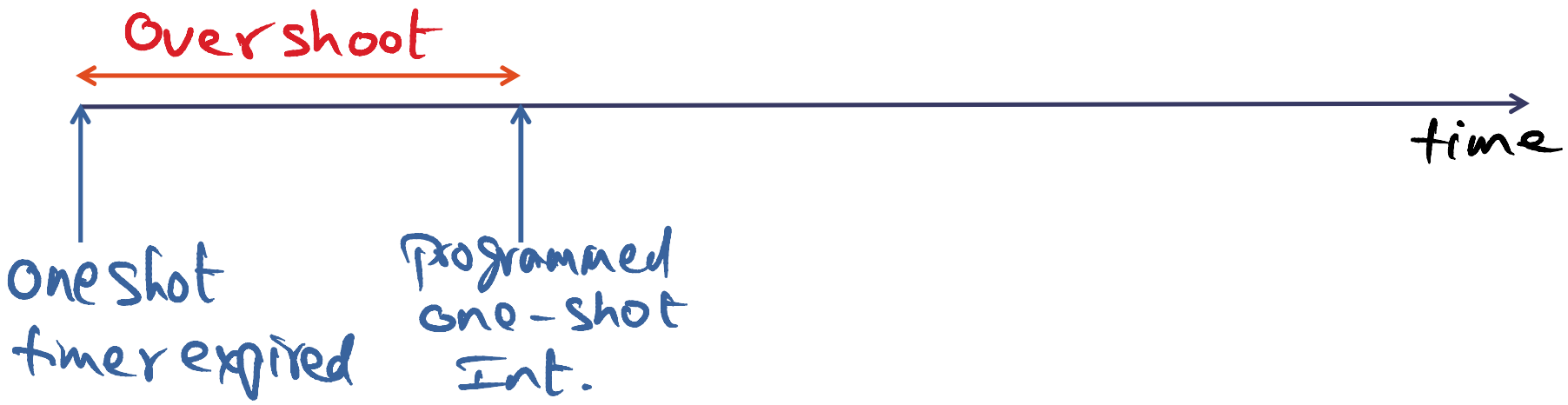
Periodic	periodicity	event recognition latency
One-shot	timely	overhead
Soft	reduced overhead	Polling overhead, latency
Firm	Combines all of the above	

Firm Timer Design

Accurate timing with low overhead

- Combine one-shot and soft timers
- Overshoot: Knob between hard and soft timers



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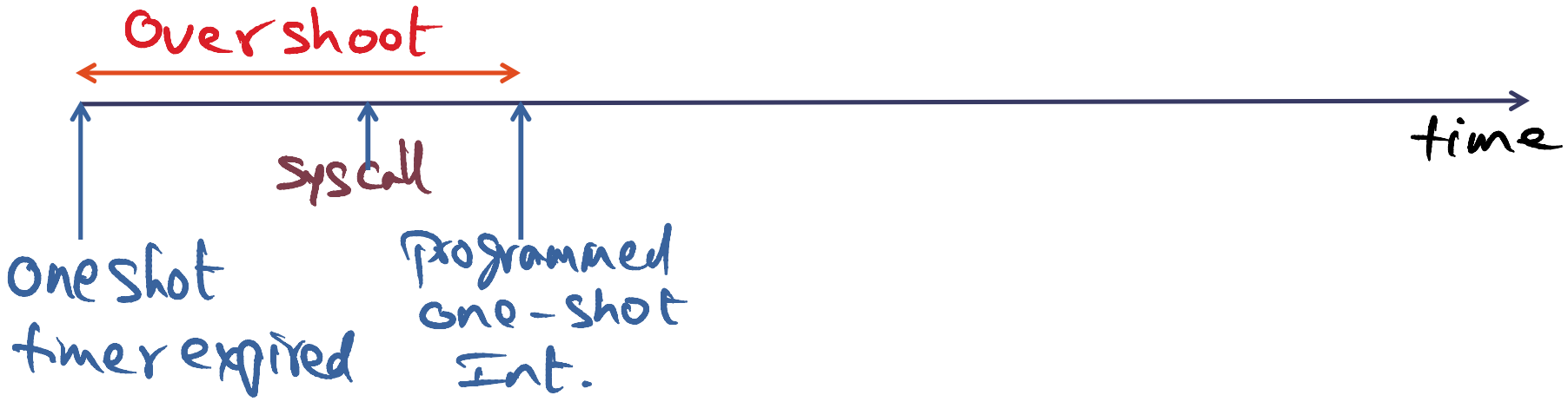

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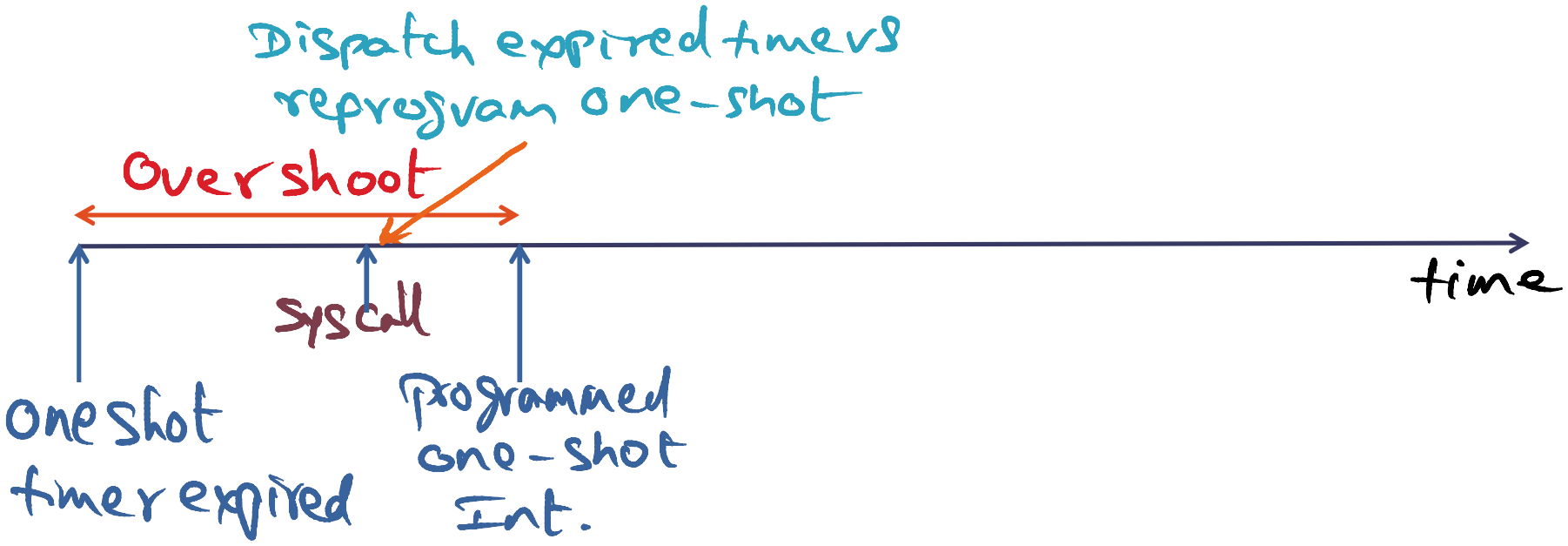

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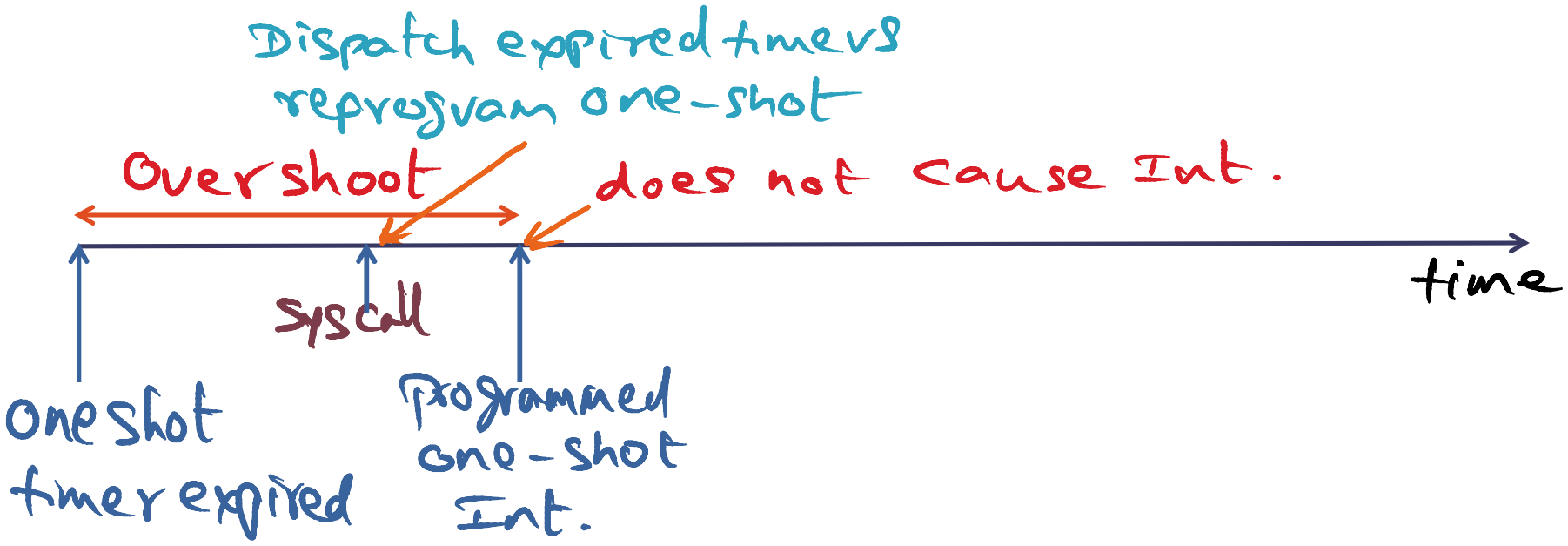
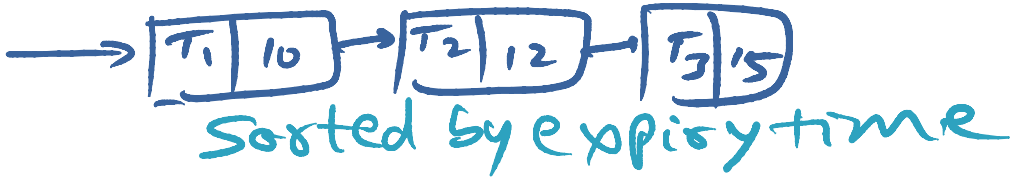


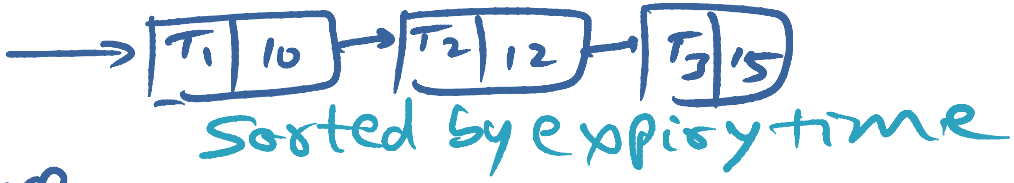
Firm Timer Implementation

Timer-Q data structure



Firm Timer Implementation

Timer-Q data structure



Apic timer hardware

- reprogramming: few cycles

Firm Timer Implementation

Timer-Q data structure

Sorted by expiry time

Apic timer hardware

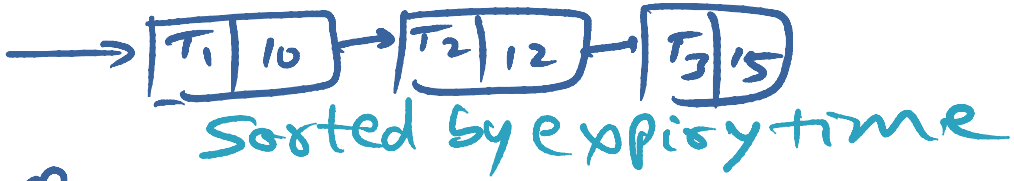
- reprogramming: few cycles

Soft timers

- eliminates need for fielding oneshot int

Firm Timer Implementation

Timer-Q data structure



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Firm Timer Implementation

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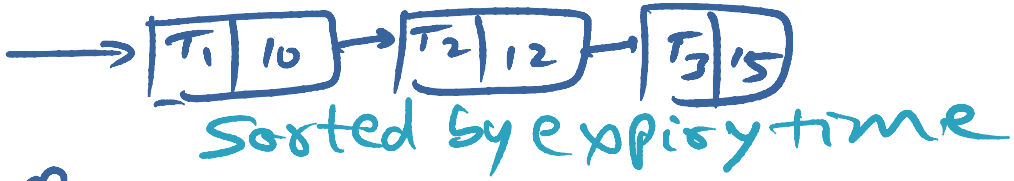

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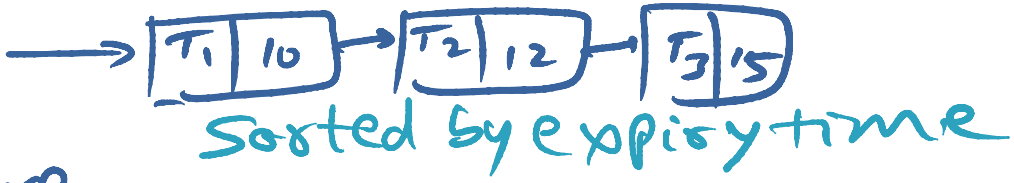
Long one shot distance

Firm Timer Implementation

Timer-Q data structure



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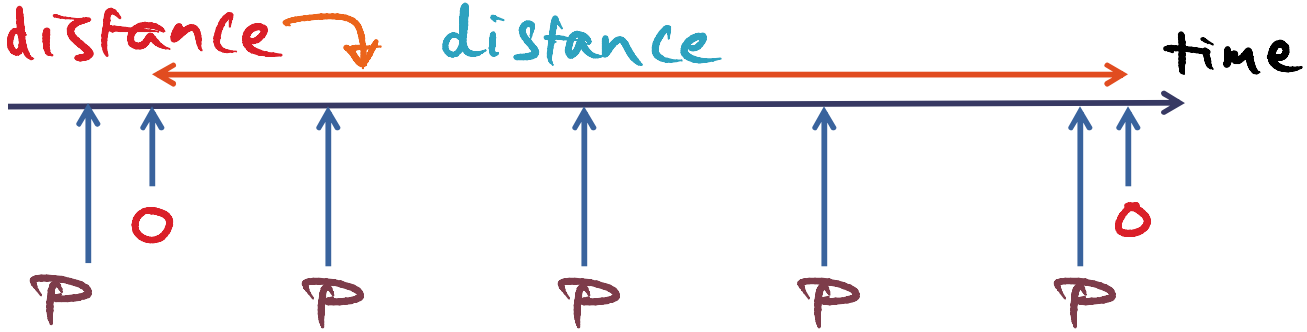
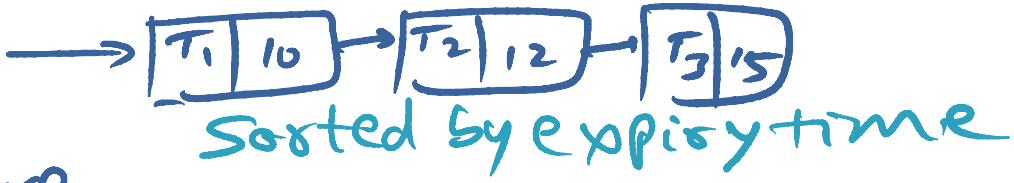


Firm Timer Implementation

Timer-Q data structure



Apic timer hardware

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Soft timers

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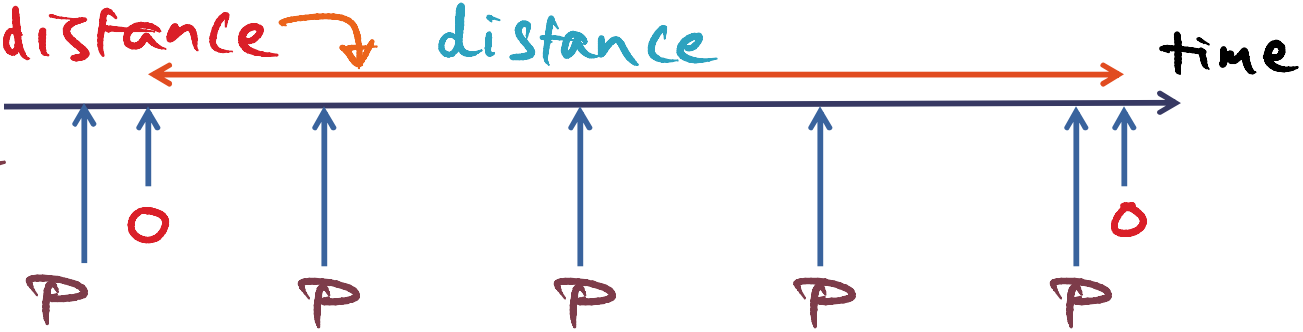
Long one shot distance ⇒ use periodic



Today

- RT + mm (Lesson 10 review)
  - * TS-Linux
  - * PTS

Final week

- Security (Lesson 11)
  - * Terminologies
  - * Security in AFS

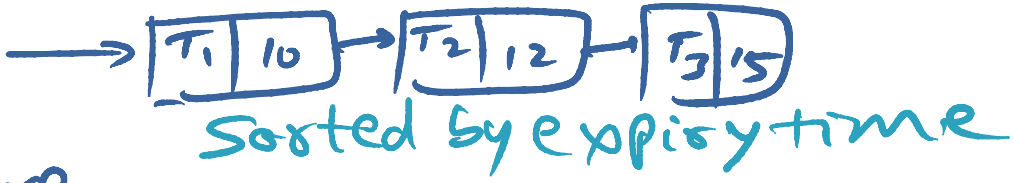
Group Activity

* Sources of latency in timer events?

* Solution approach for each Source?

Firm Timer Implementation

Timer-Q data structure



Apic timer hardware

- reprogramming: few cycles

Soft timers

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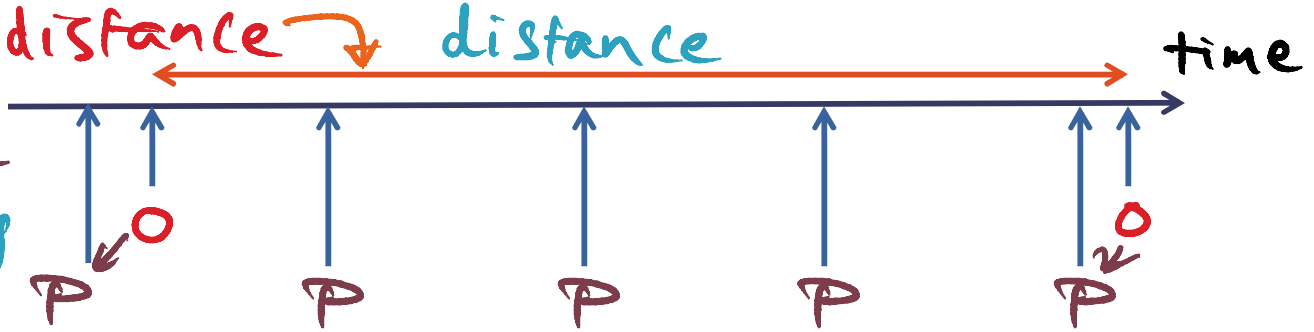
Long one shot distance ⇒ use periodic dispatch @ preceding Periodic



Reducing Kernel Preemption Latency

Approaches

- Explicit insertion of preemption points in kernel

Reducing Kernel Preemption Latency

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- Allow preemption anytime kernel not manipulating shared data structures

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Lock-Breaking Preemptible Kernel

- Combines the above two ideas

Reducing Kernel Preemption Latency

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```
acq(C)
  :
rel(C)
```

Reducing Kernel Preemption Latency

Approaches

- Explicit insertion of preemption points in kernel
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Lock-Breaking Preemptible Kernel

- Combines the above two ideas

```
acq()                    acq()
  :                        manipulate shared data
rel()        change      rel()
             to          reacq()
                           :
                         rel()
```

Reducing Kernel Preemption Latency

Approaches

- Explicit insertion of preemption points in kernel
- Allow preemption anytime kernel not manipulating shared data structures

Lock-Breaking Preemptible Kernel

- Combines the above two ideas

```
acq()
  :
rel()
```

change to

```
acq()
  manipulate shared data
rel() → preempt kernel
acq()
  :
rel()
```

Reducing Kernel Preemption Latency

Approaches

- Explicit insertion of preemption points in kernel
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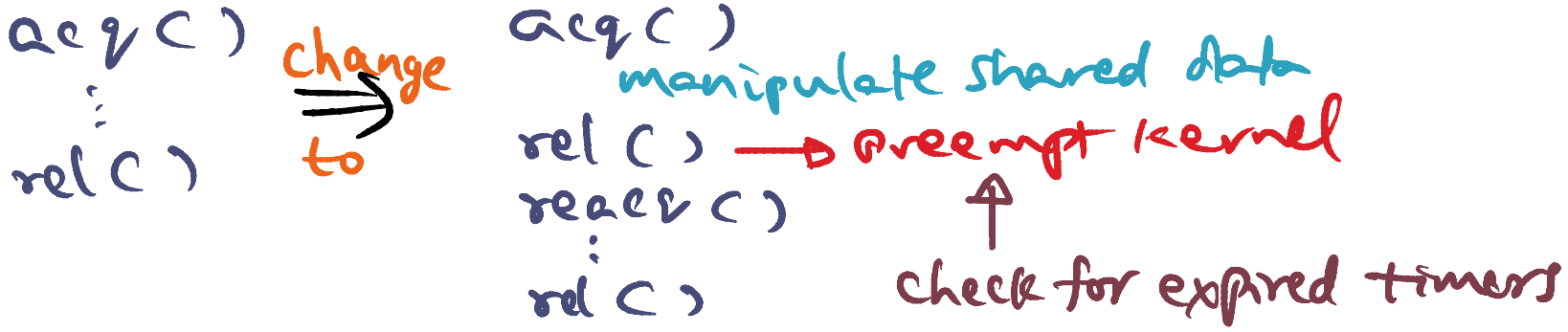
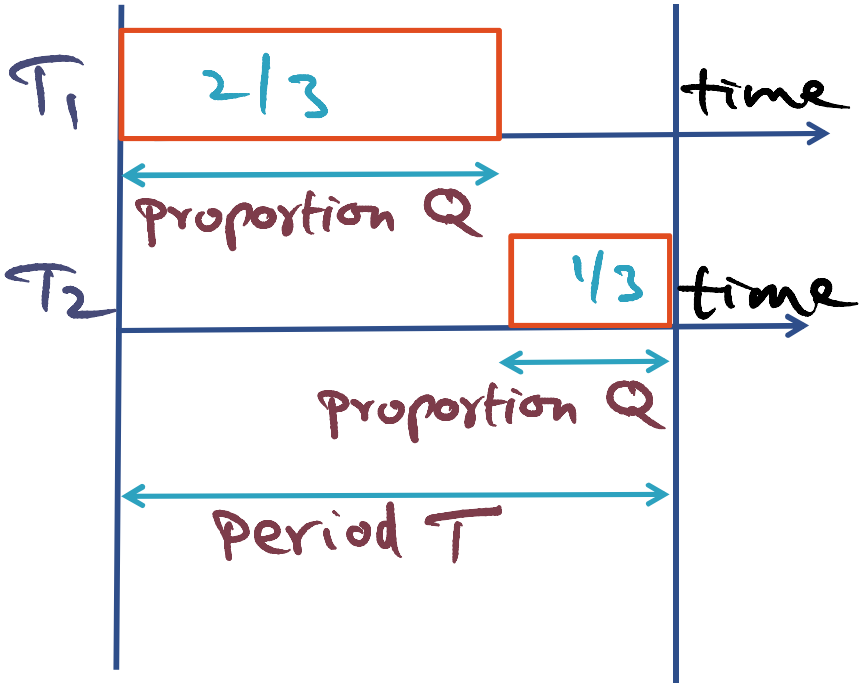
Lock-Breaking Preemptible Kernel

- Combines the above two ideas



Reducing scheduling latency

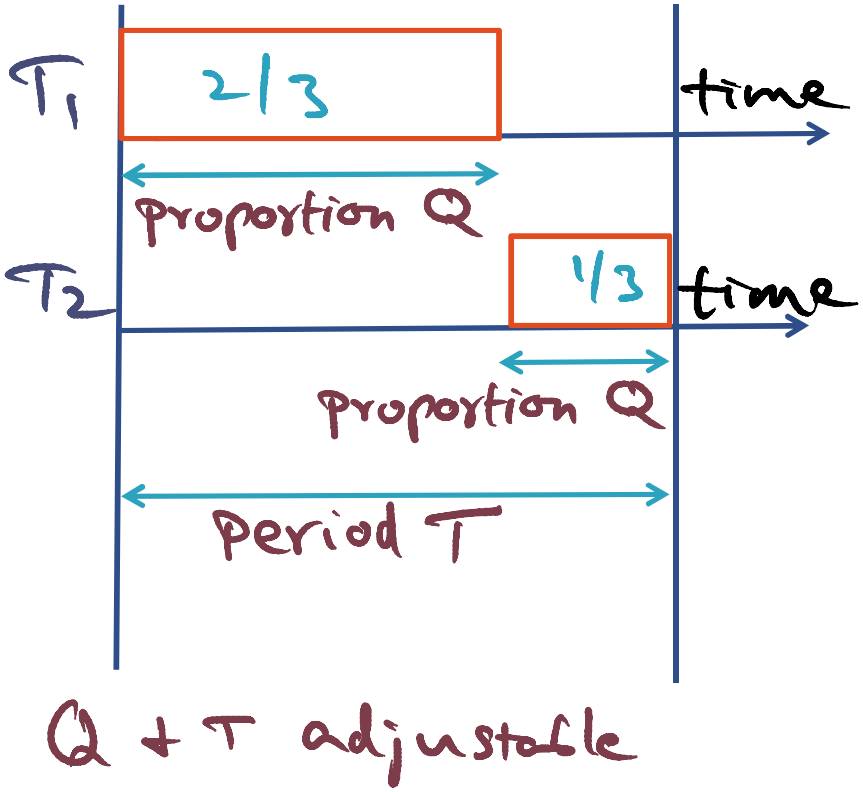
Proportional Period sched



Q + T adjustable

Reducing scheduling latency

Proportional Period sched



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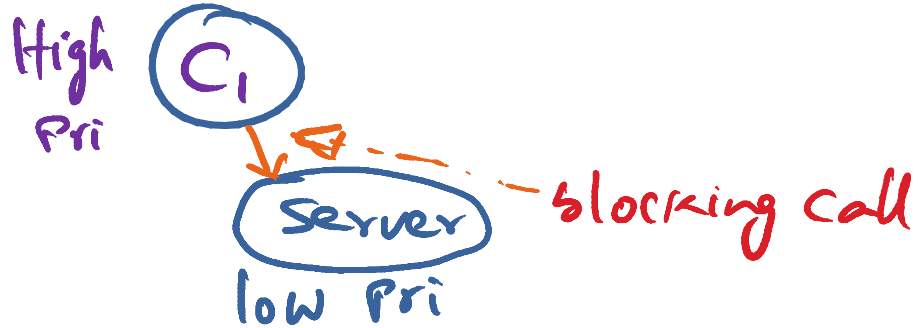

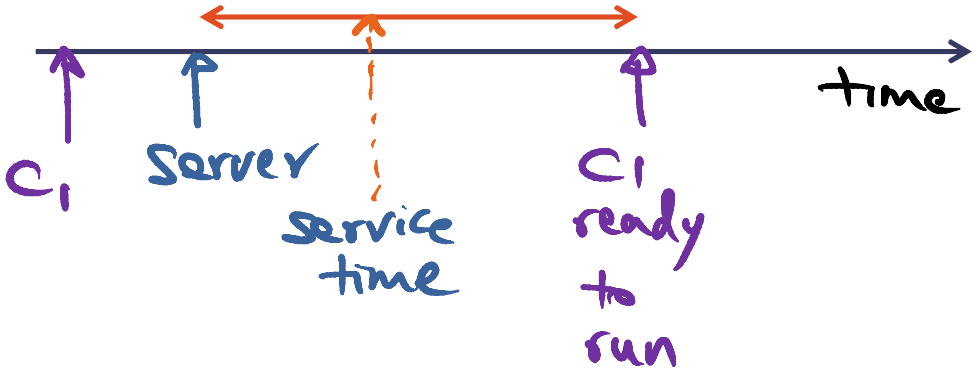

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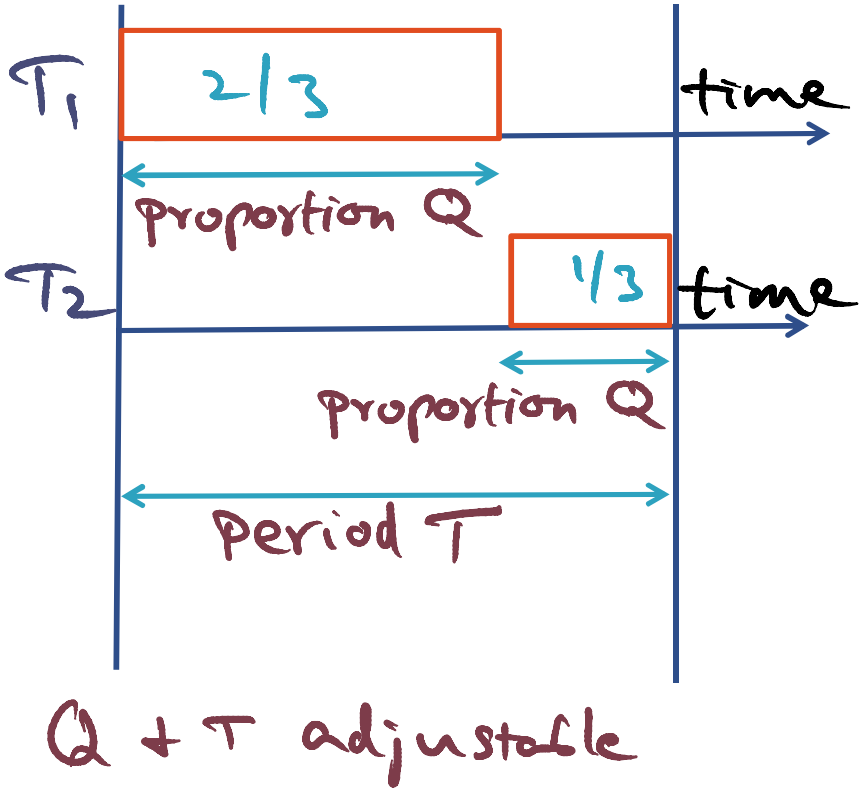

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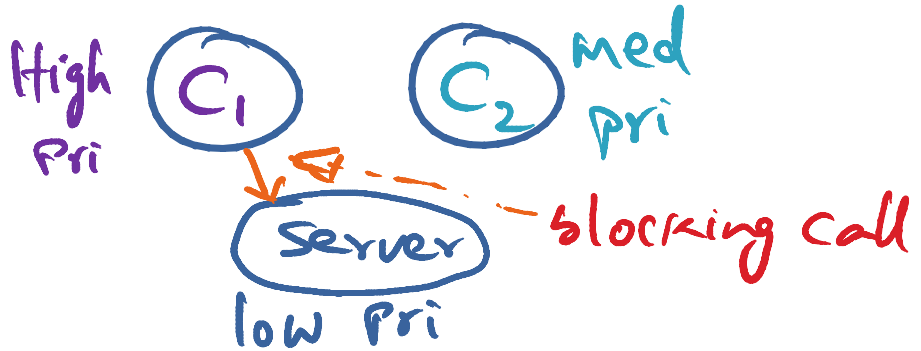

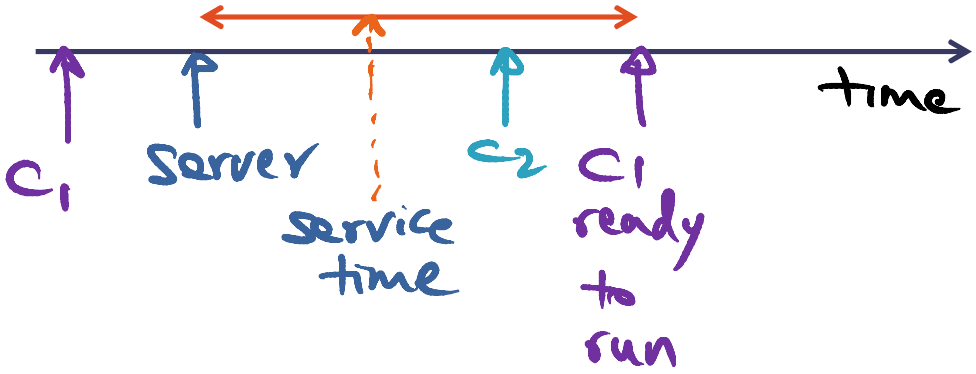

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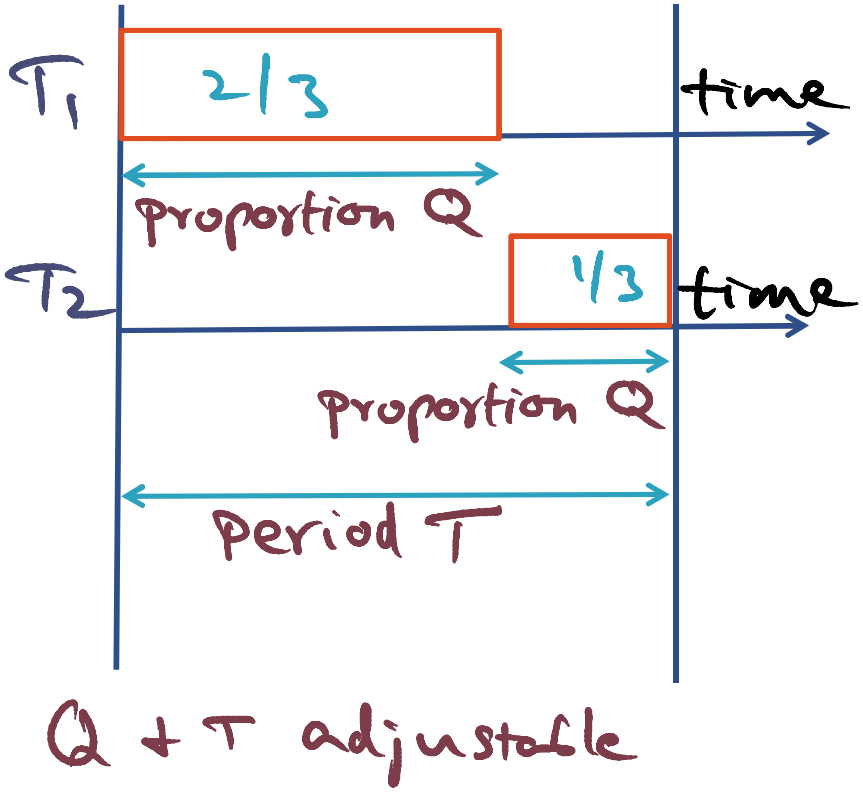

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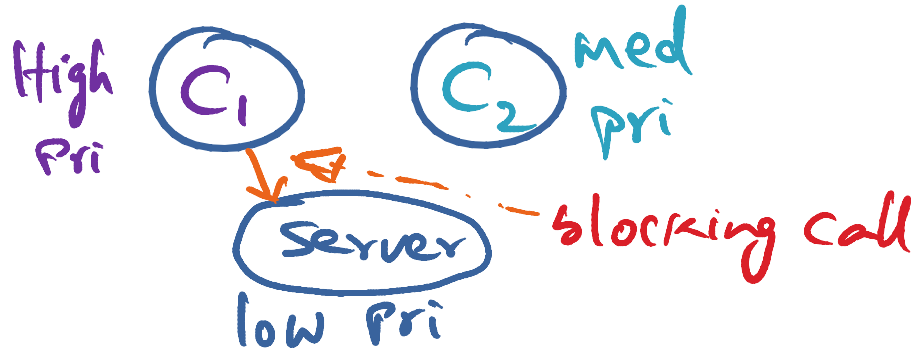
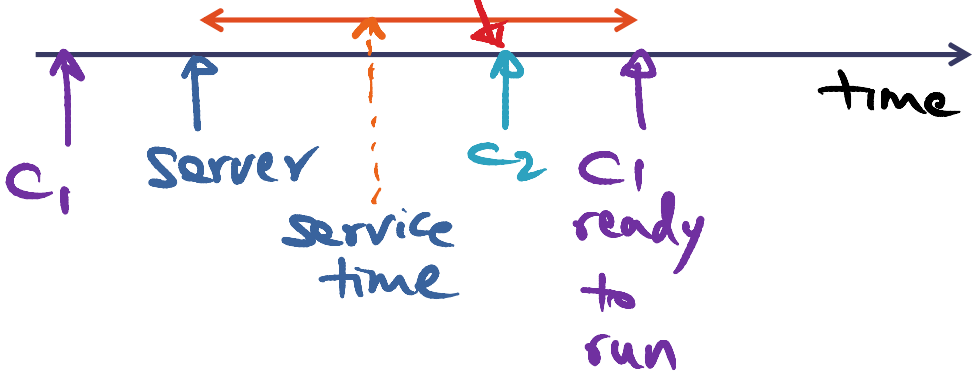


C2 preempts server
⇒ priority inversion for C1



Reducing scheduling latency

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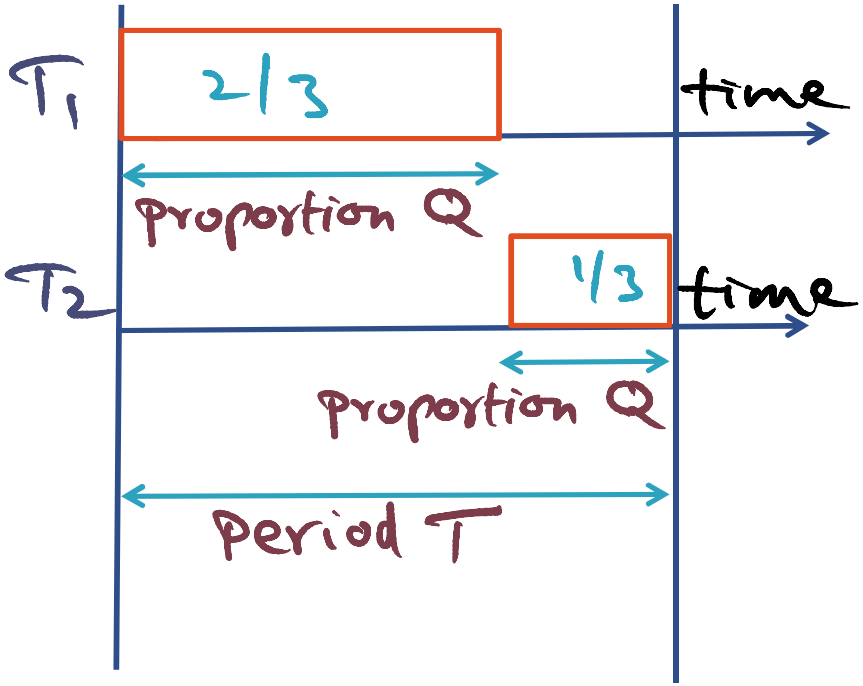
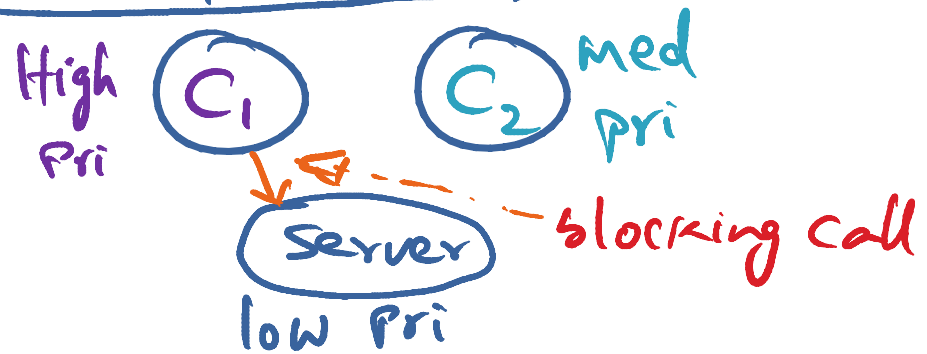


Q + T adjustable

Priority-based sched



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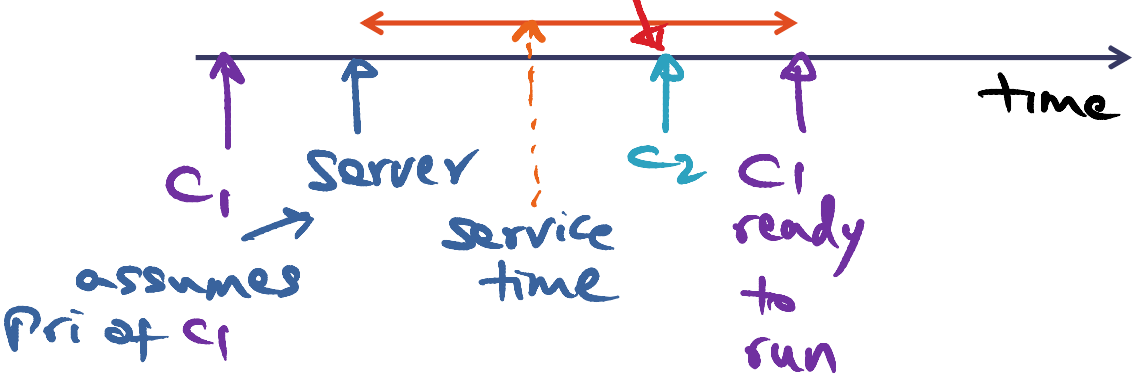

Reducing scheduling latency

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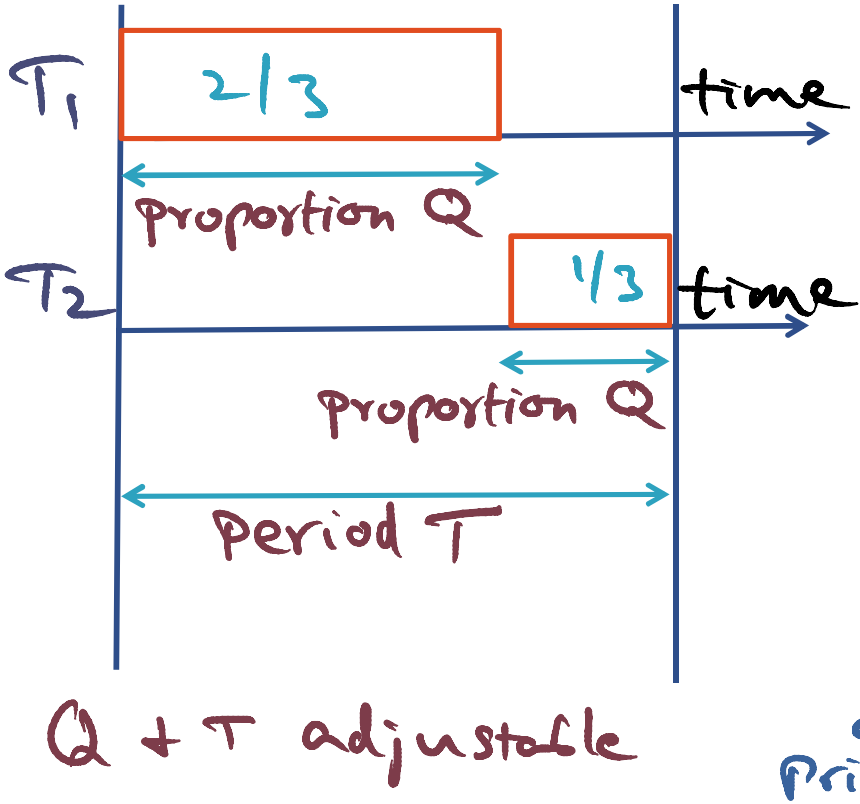

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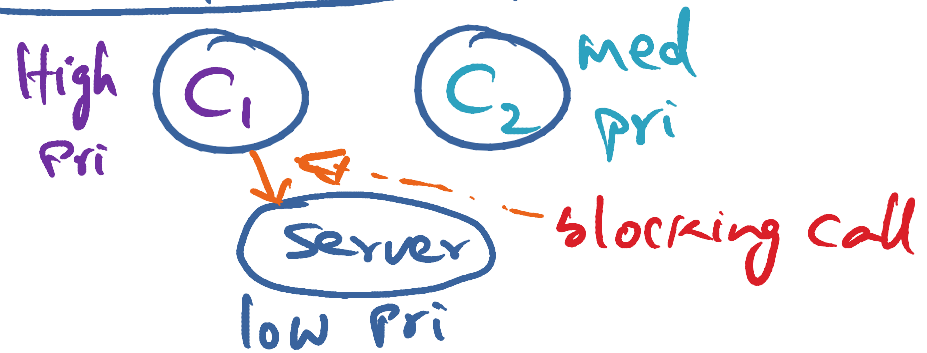

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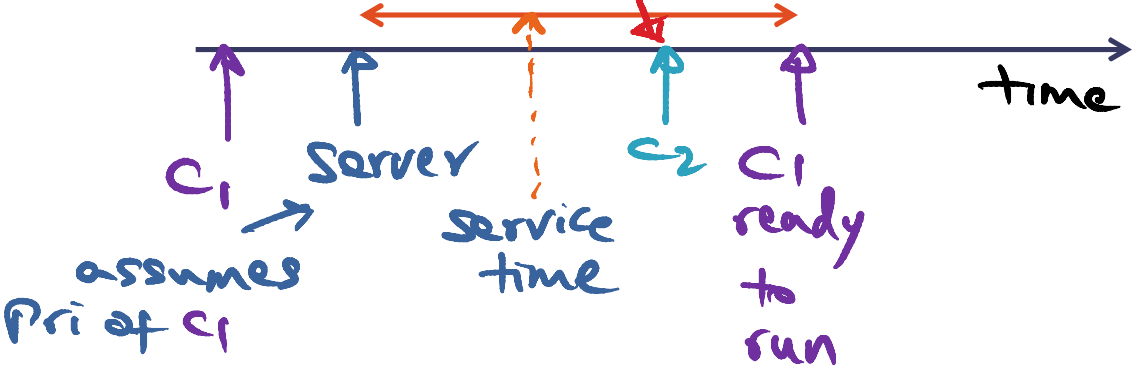

Reducing scheduling latency

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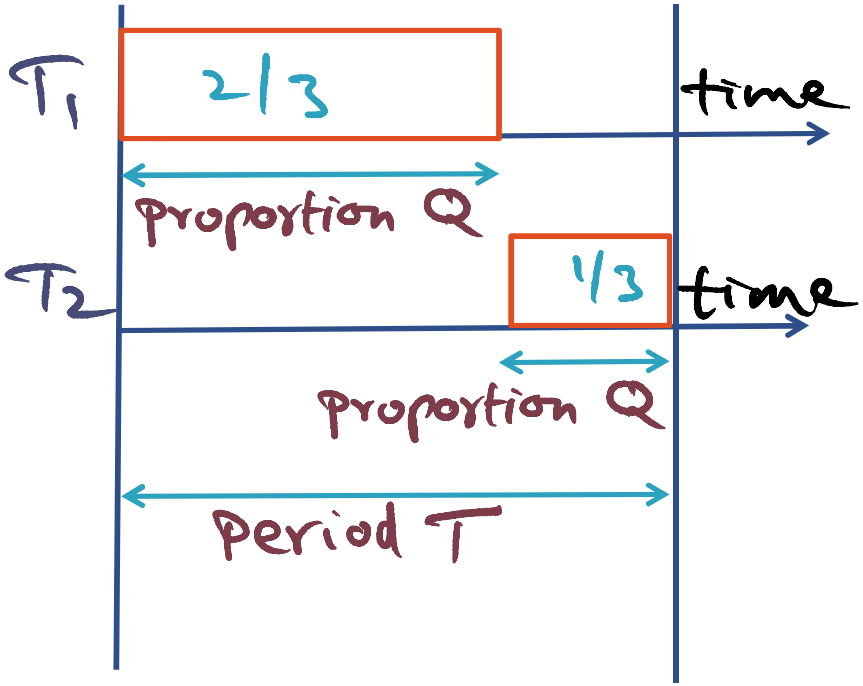

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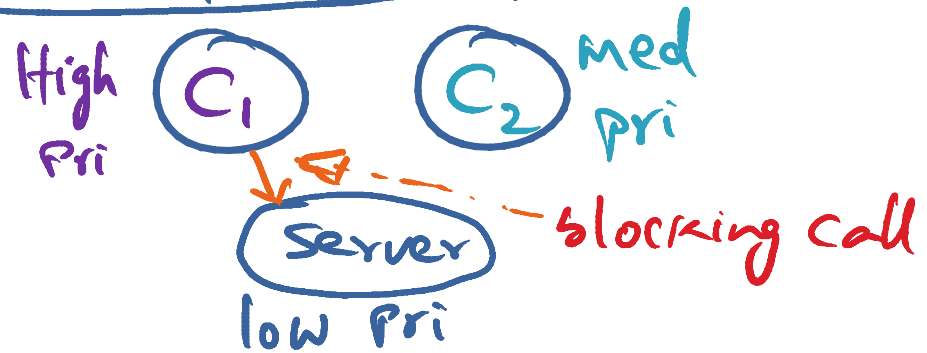

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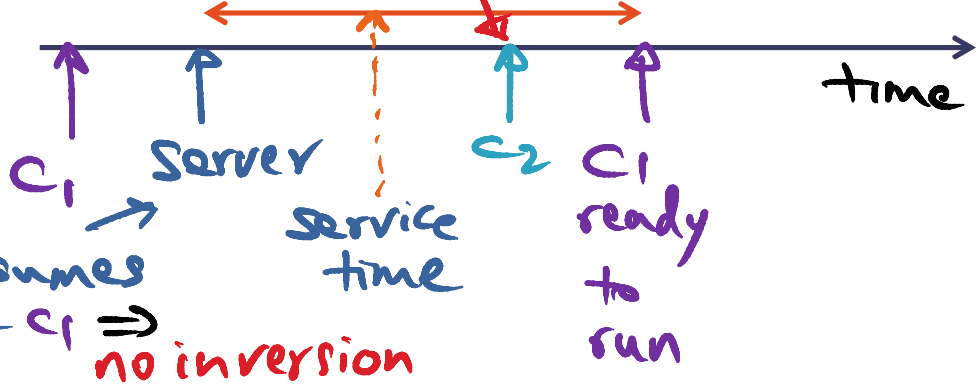

Key takeaways

- TS-Linux provides QoS guarantees for real-time apps running on commodity OS like Linux.
- Admission control using the proportional-period scheduling TS-Linux ensures that throughput-oriented tasks are not shut out from getting CPU time.