

Five problems in compositionality of real-time systems

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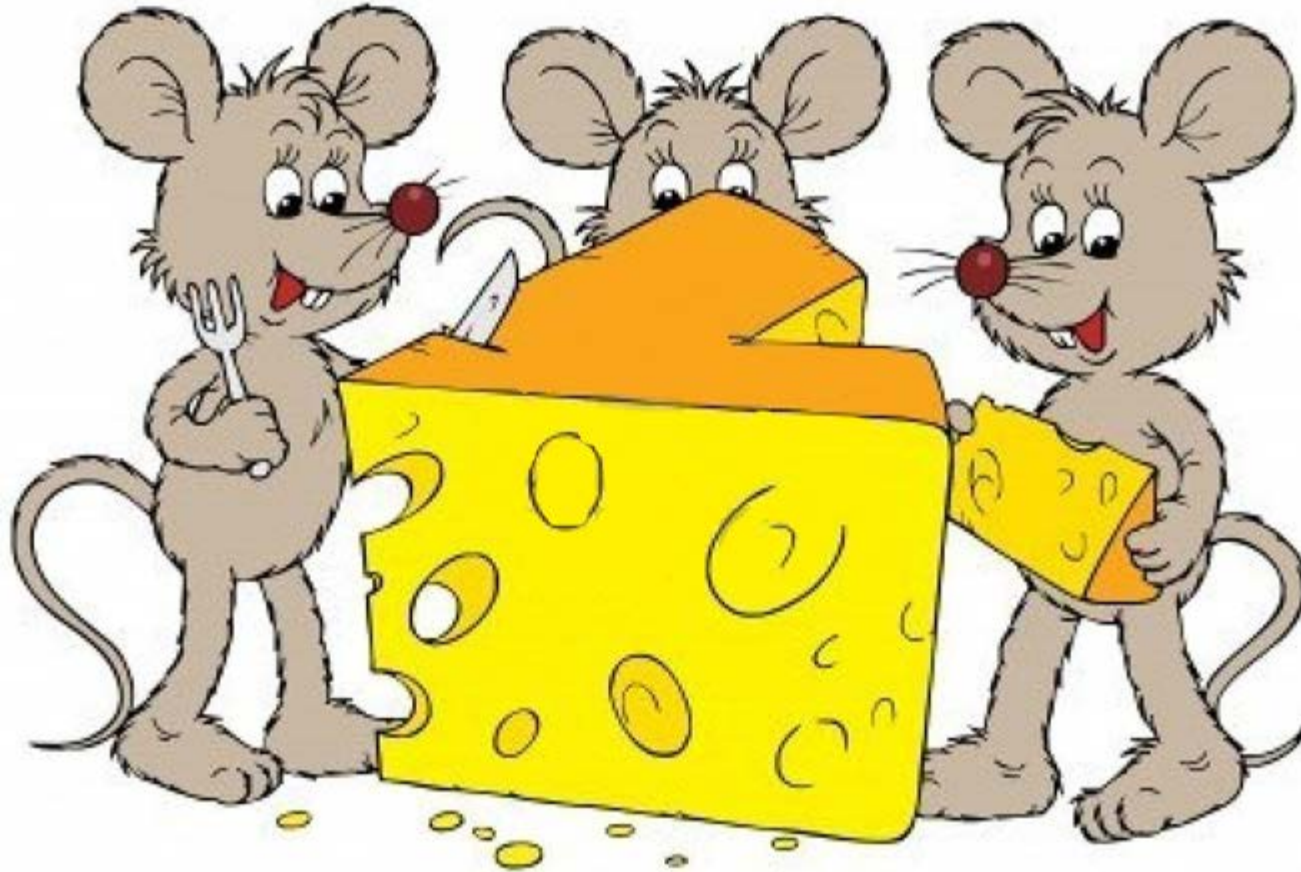
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DM-0001868



Resource Sharing



I need x units.

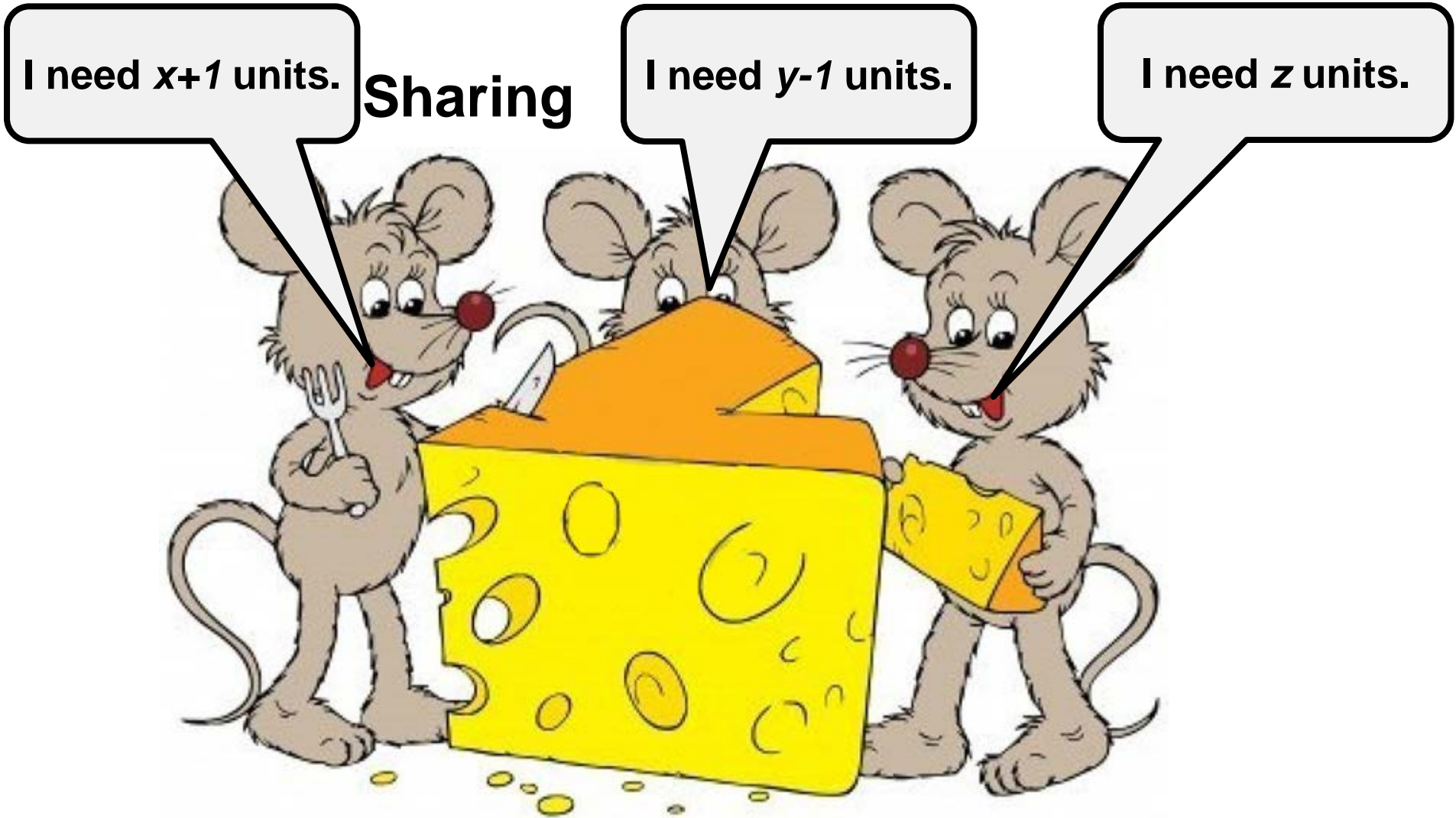
Sharing

I need y units.

I need z units.



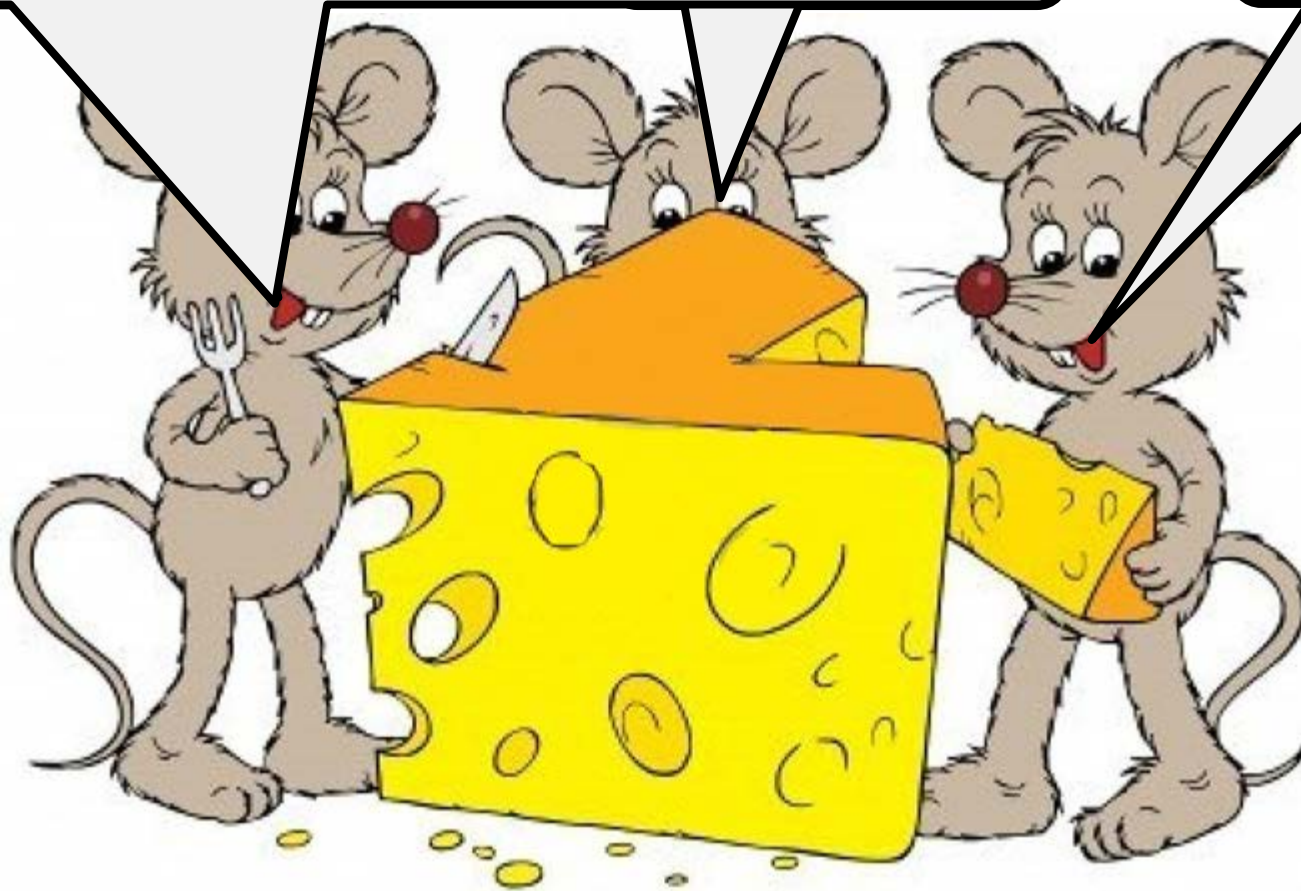
Is there enough resource capacity so that each request can be fulfilled?



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We need $x+y$ units together.

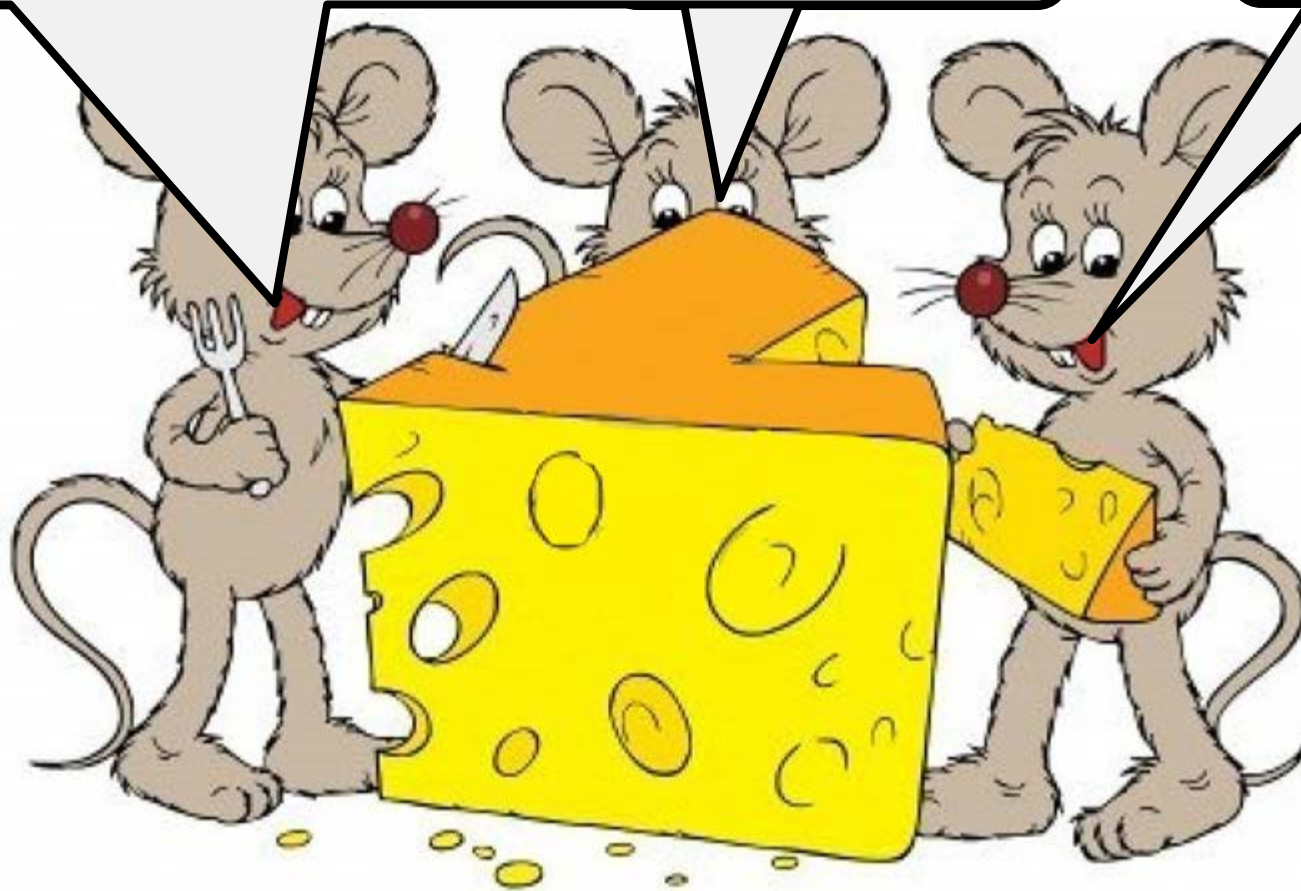
I need z units.



Is there enough resource capacity so that each request can be fulfilled?

We need $x+y$ units together.

I need z units.



Problem 1: Create an interface (describing how much resources a subset of requestors need).

Problem 2: Design analysis techniques that take interfaces as inputs.

Outline

Interface for constrained-deadline sporadic tasks on a single processor

Interface for memory accesses

Interface for complex protocols

Interface for wireless traffic

Interface for autonomous cars



Interface for constrained-deadline sporadic tasks on a single processor

Problem context/statement

τ_1

$$T_1 = \infty$$

$$D_1 = 1$$

$$C_1 = 1$$

τ_2

$$T_2 = \infty$$

$$D_2 = 2$$

$$C_2 = 1$$

τ_3

$$T_3 = \infty$$

$$D_3 = 3$$

$$C_3 = 1$$

τ_4

$$T_4 = \infty$$

$$D_4 = 4$$

$$C_4 = 1$$

τ_5

$$T_5 = \infty$$

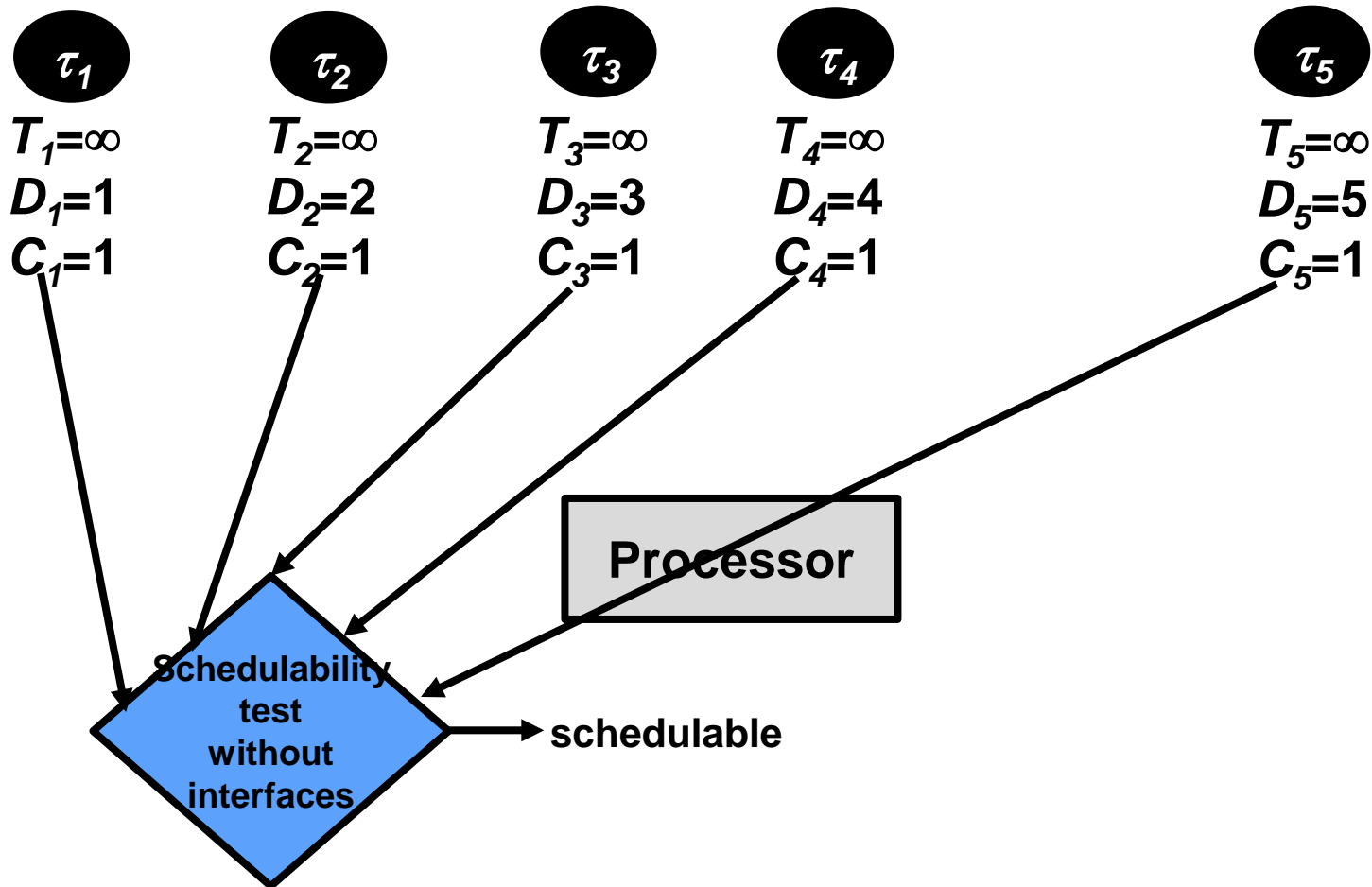
$$D_5 = 5$$

$$C_5 = 1$$

Processor

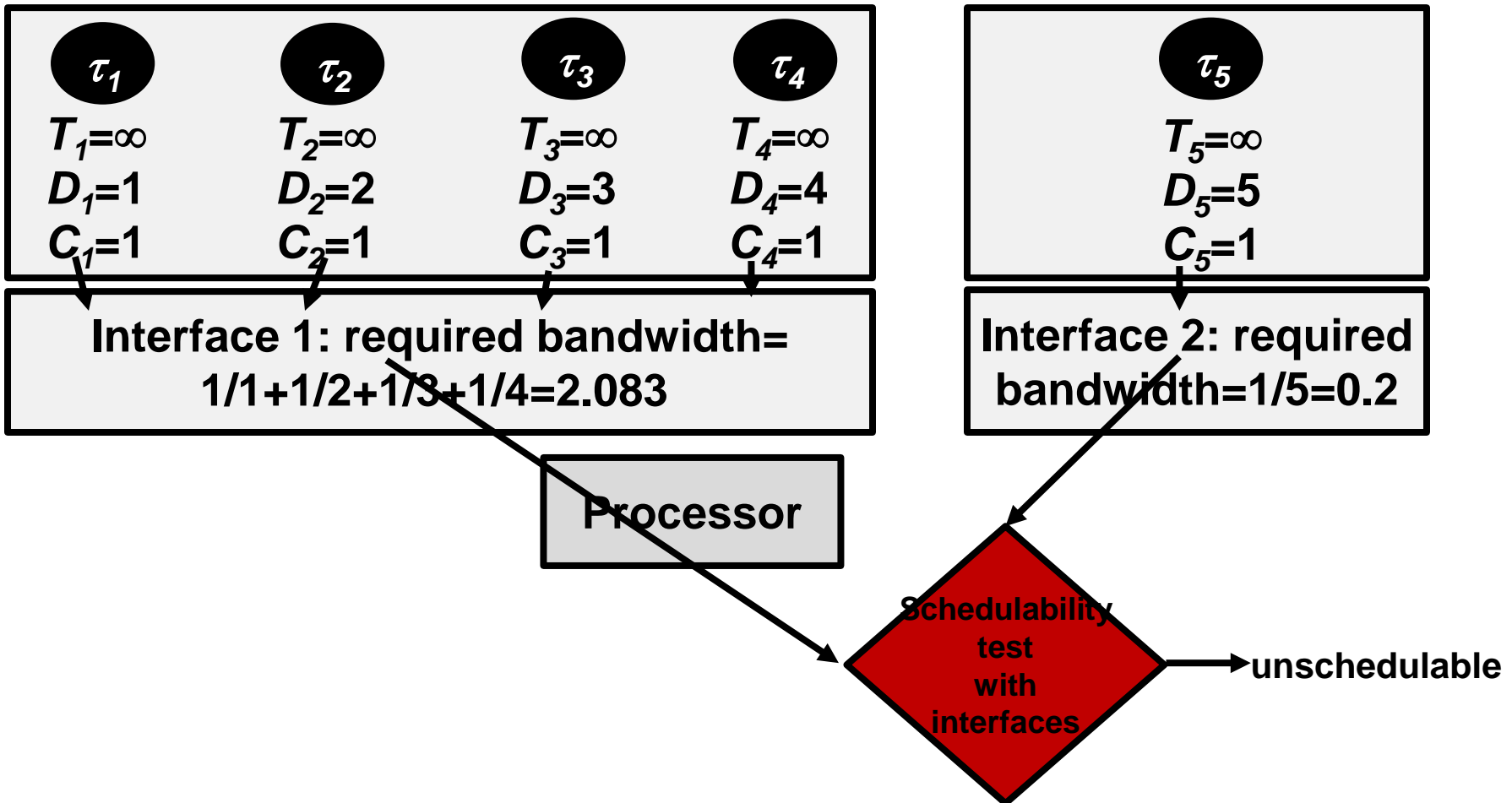
Interface for constrained-deadline sporadic tasks on a single processor

Problem context/statement



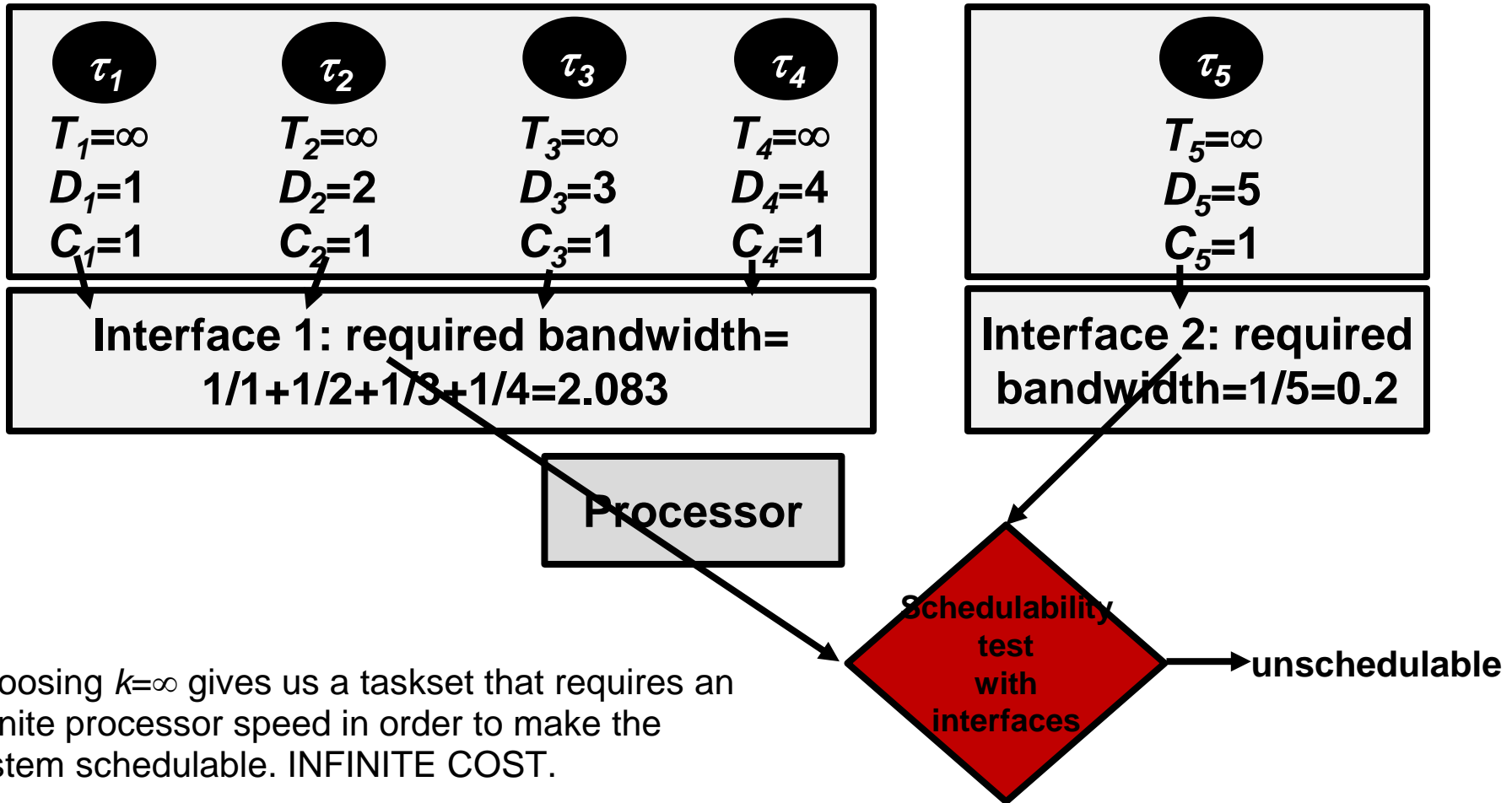
Interface for constrained-deadline sporadic tasks on a single processor

Problem context/statement



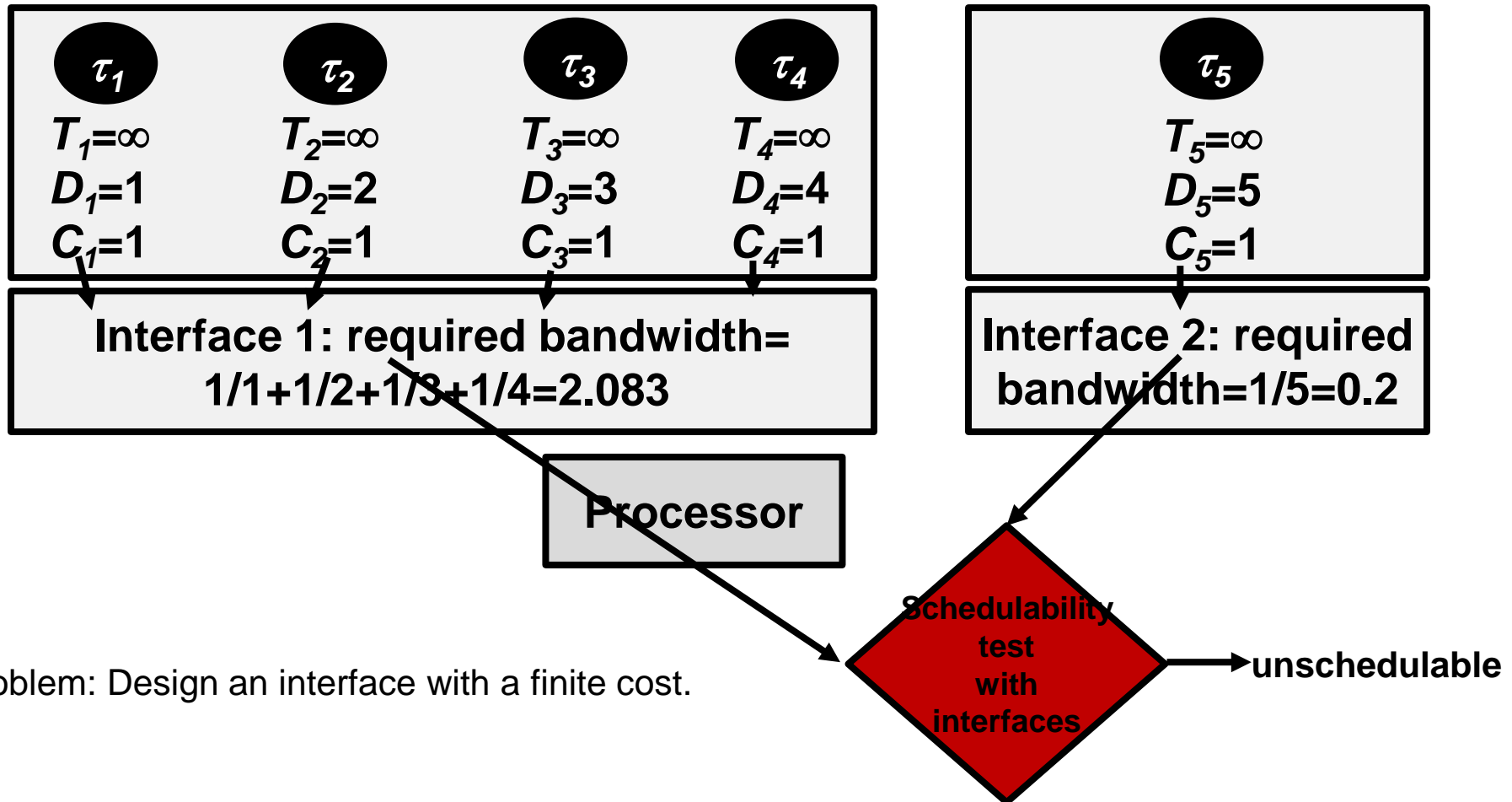
Interface for constrained-deadline sporadic tasks on a single processor

Why is it challenging?



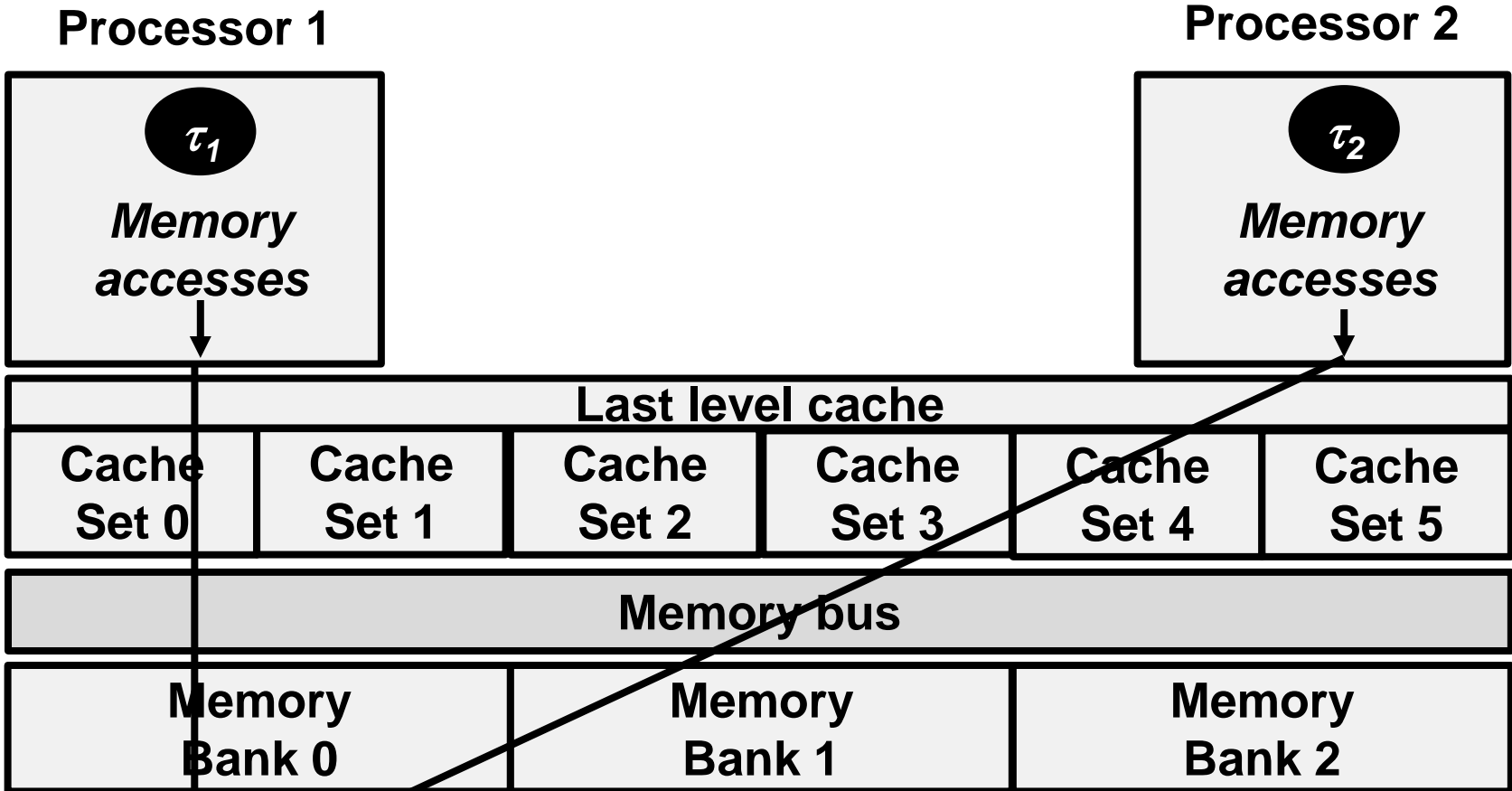
Interface for constrained-deadline sporadic tasks on a single processor

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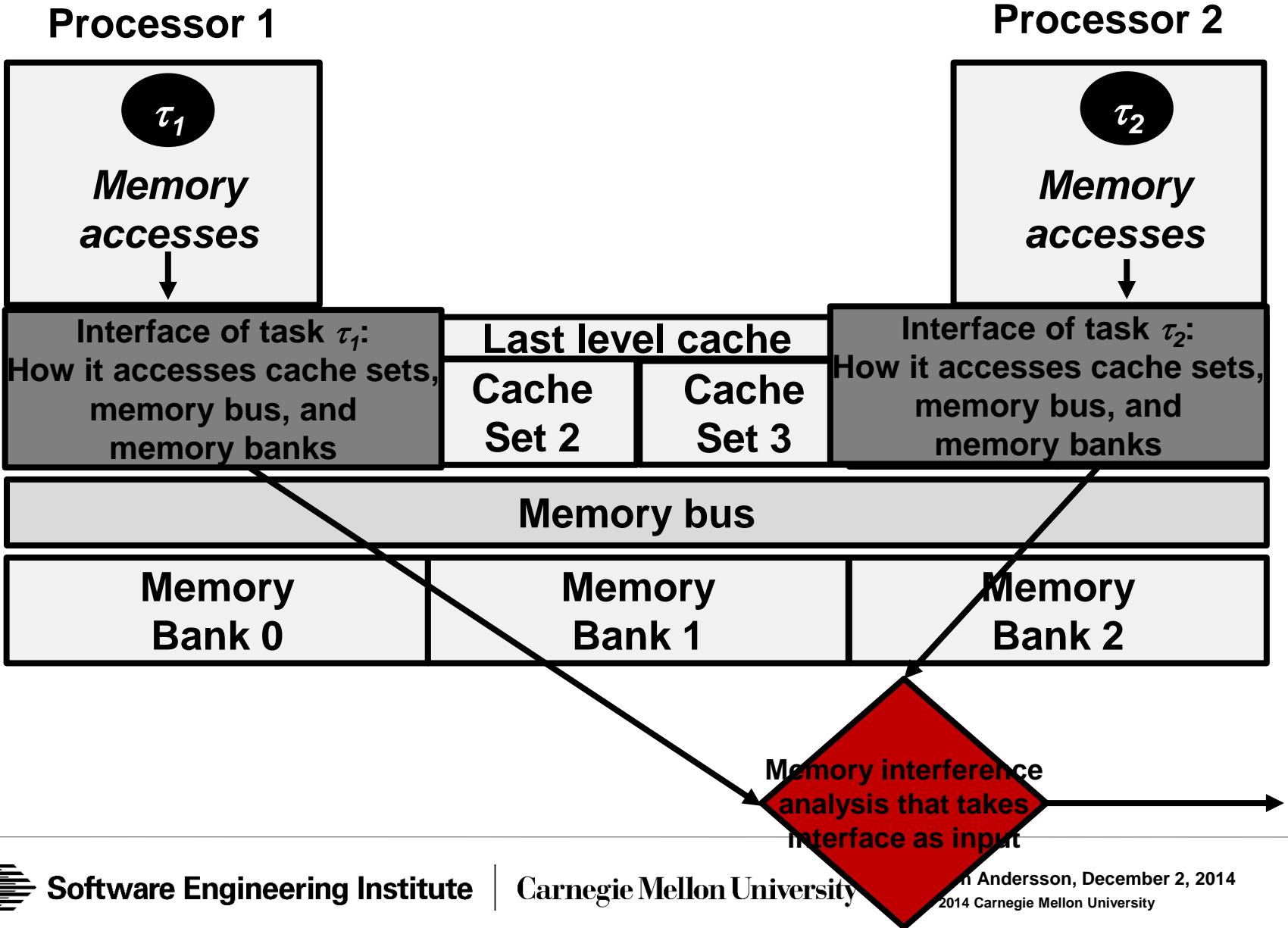
Problem: Design an interface with a finite cost.

Interface for memory accesses



Memory interference analysis that complete description of memory accesses

Interface for memory accesses



Interface for complex protocols



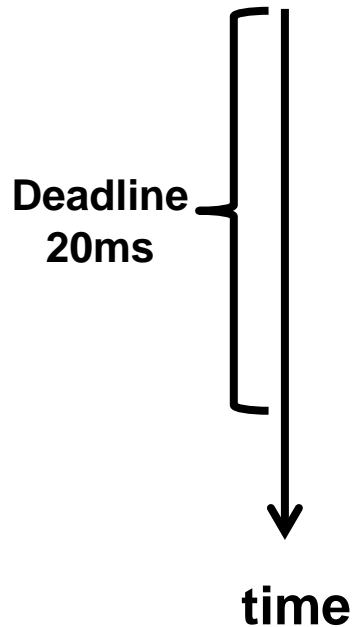
Interface for complex protocols



Computer node 1 requests the temperature of computer node 2. It does so by sending http get request. Timing requirement: Computer node 1 must receive temperature within 20ms



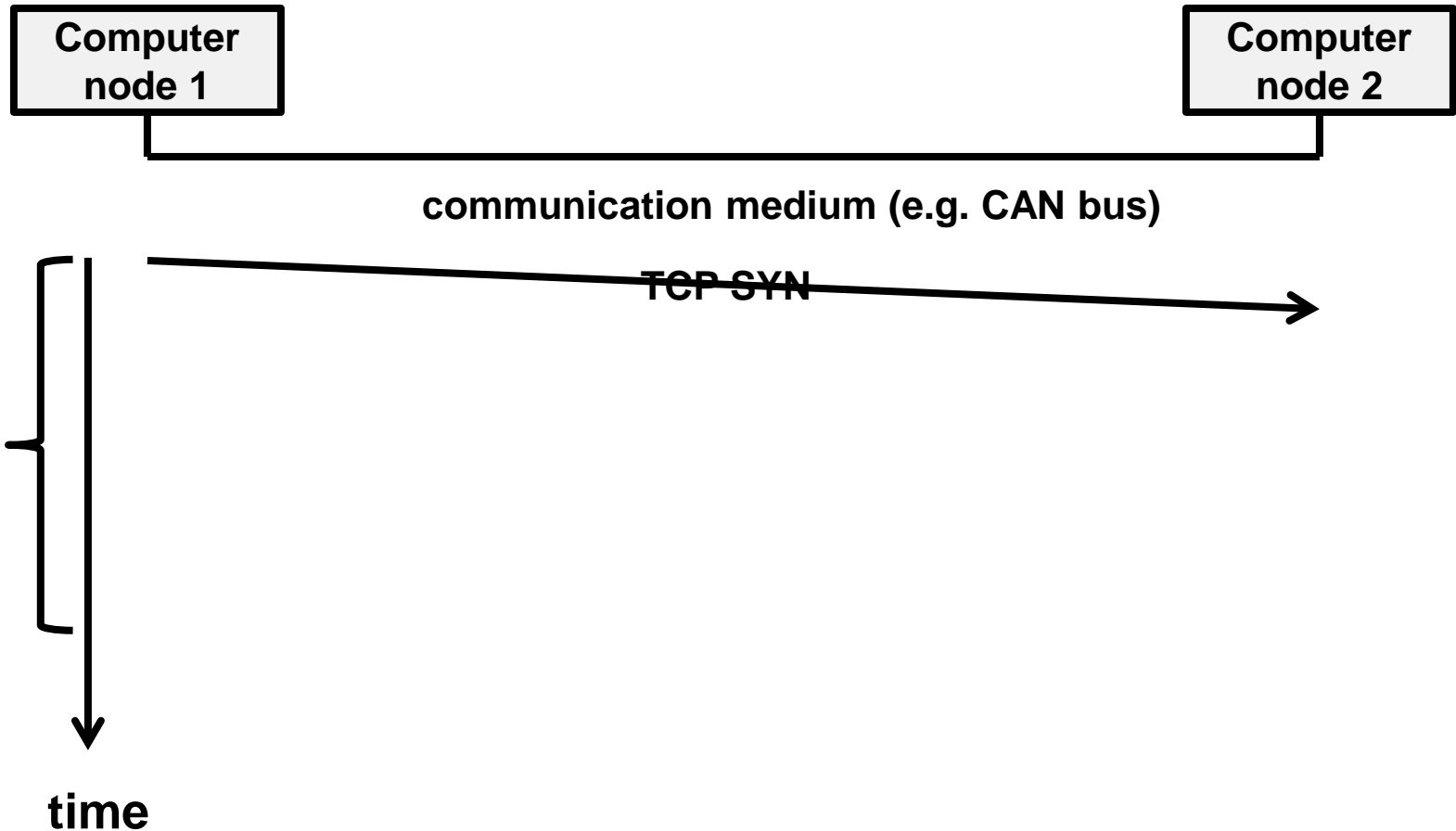
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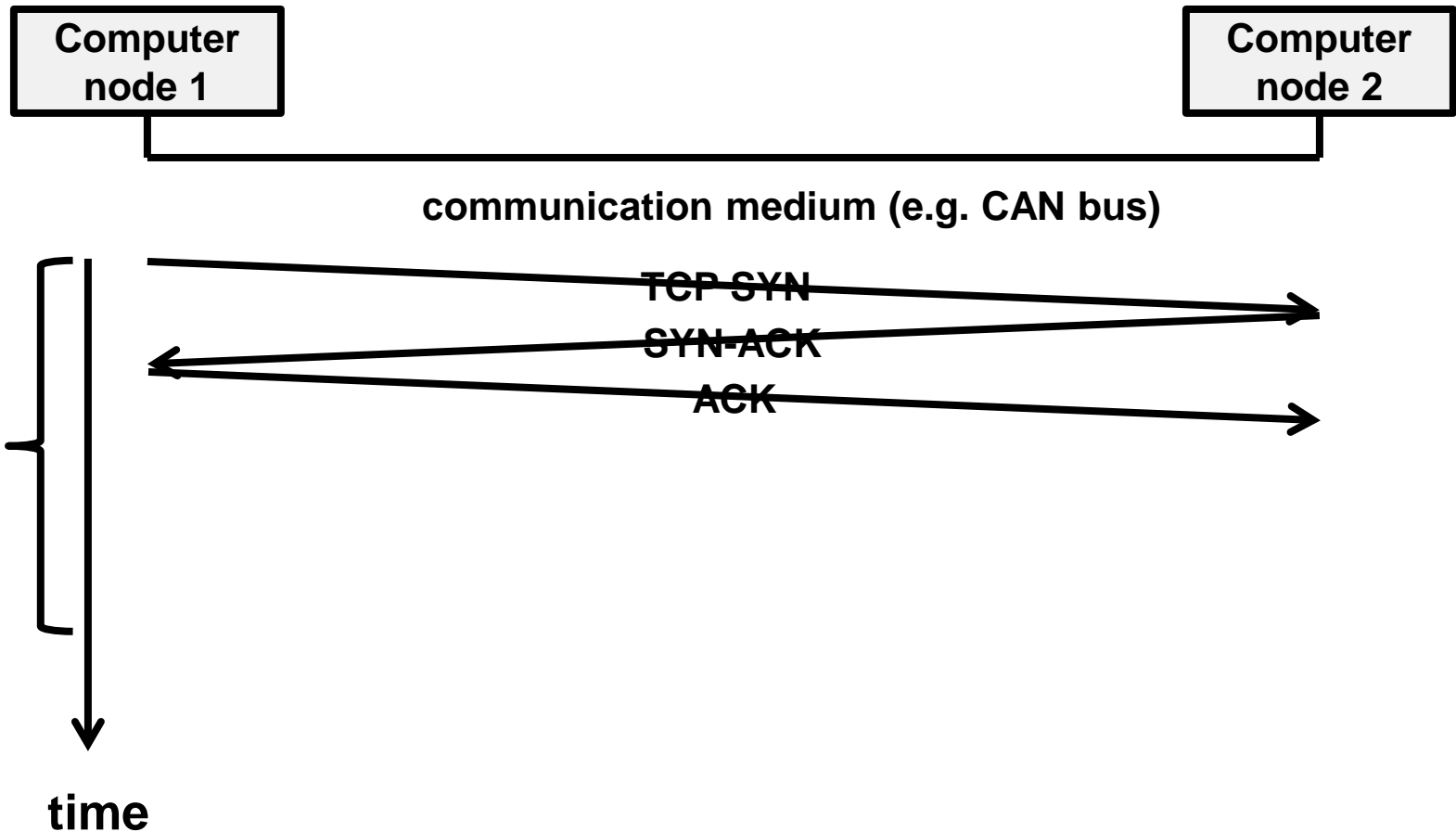
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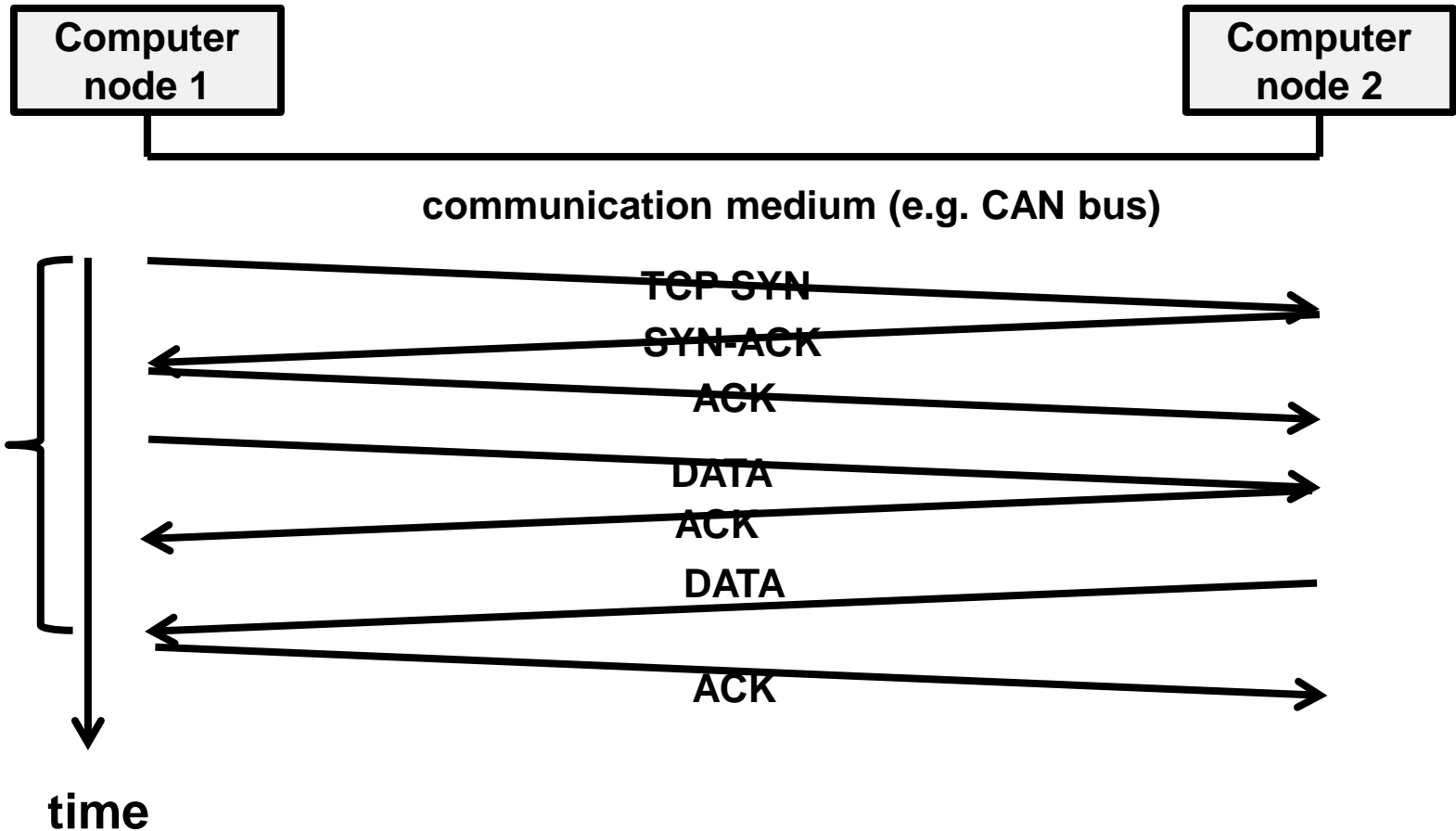


Interface for complex protocols



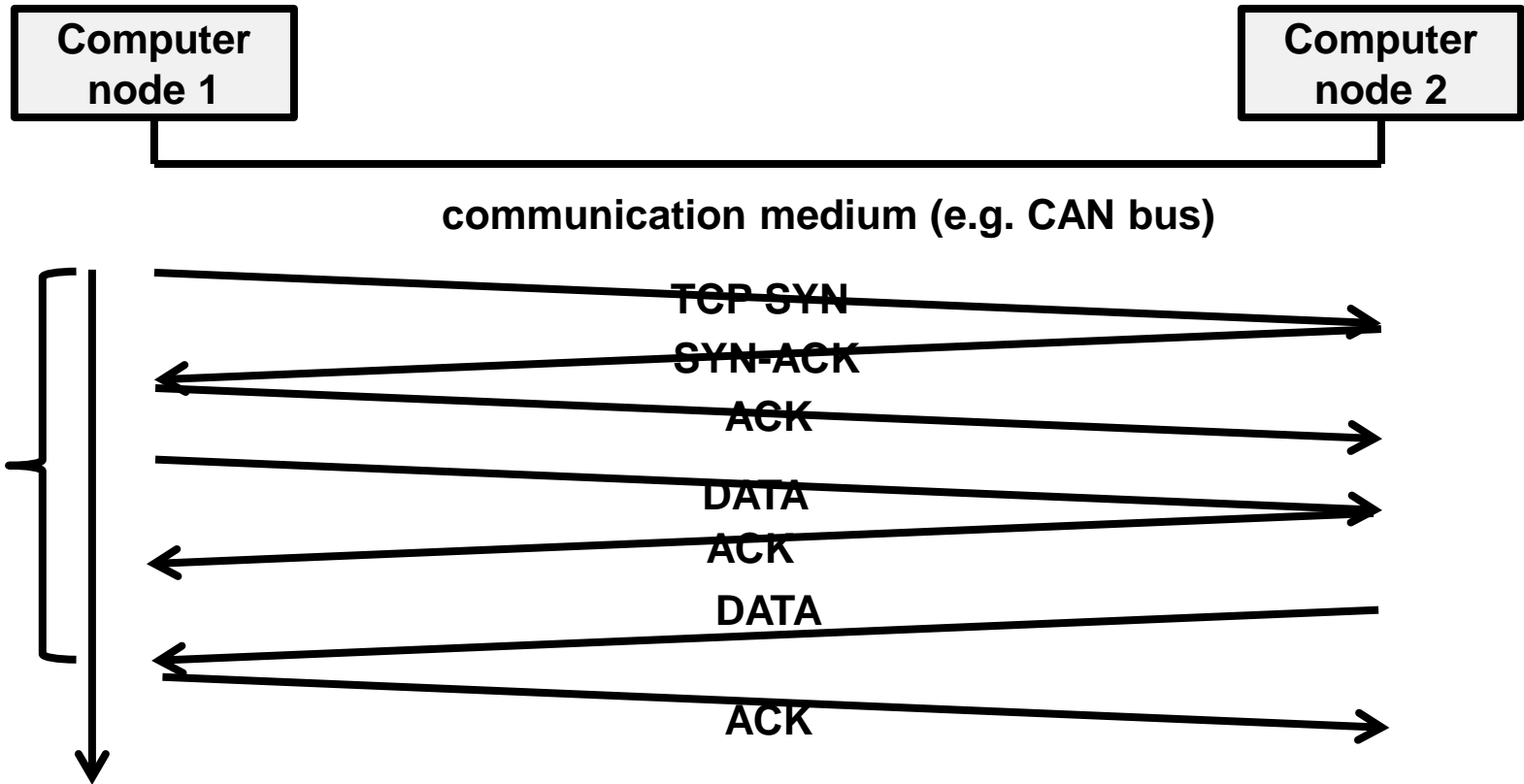
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Interface for complex protocols

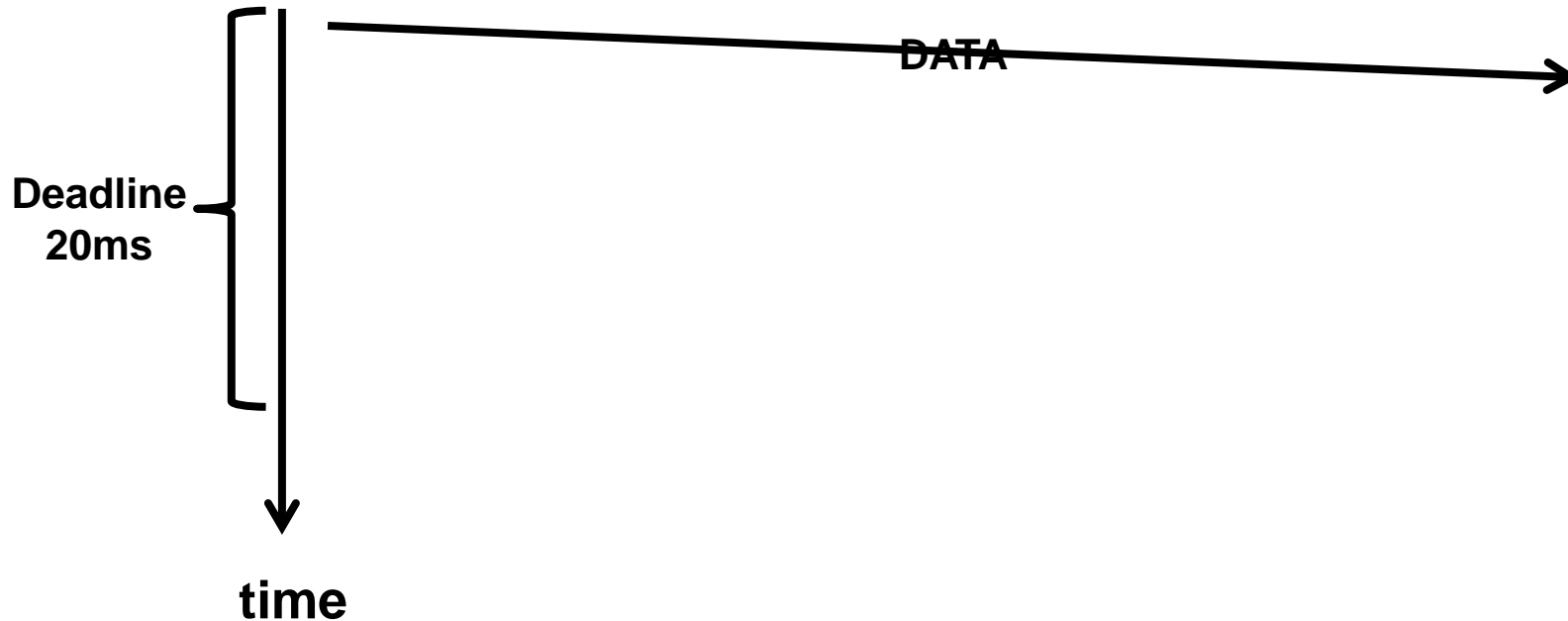


Problem: Create an interface that describes the resource consumption of the above messages (also deal with TCP flow control — more complex)

Interface for wireless traffic



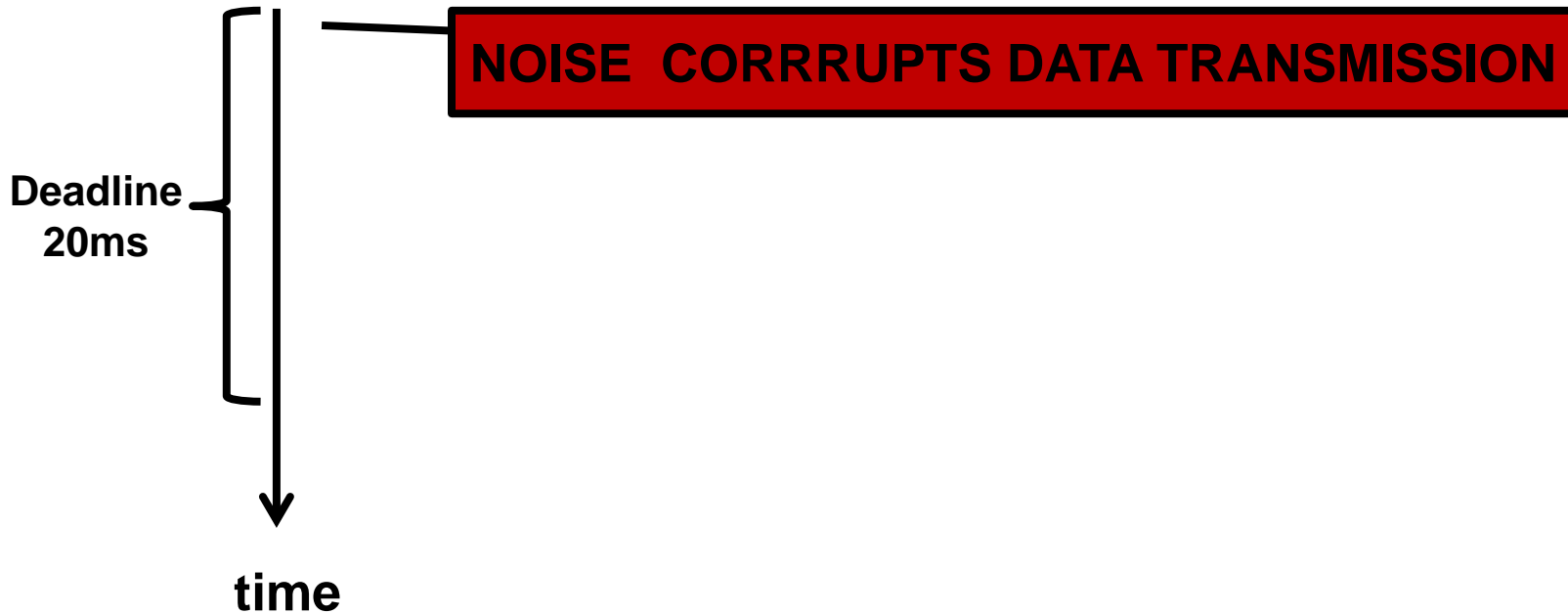
Wireless communication medium arbitrated through fixed-priority scheduling (e.g. WiDom)



Interface for wireless traffic



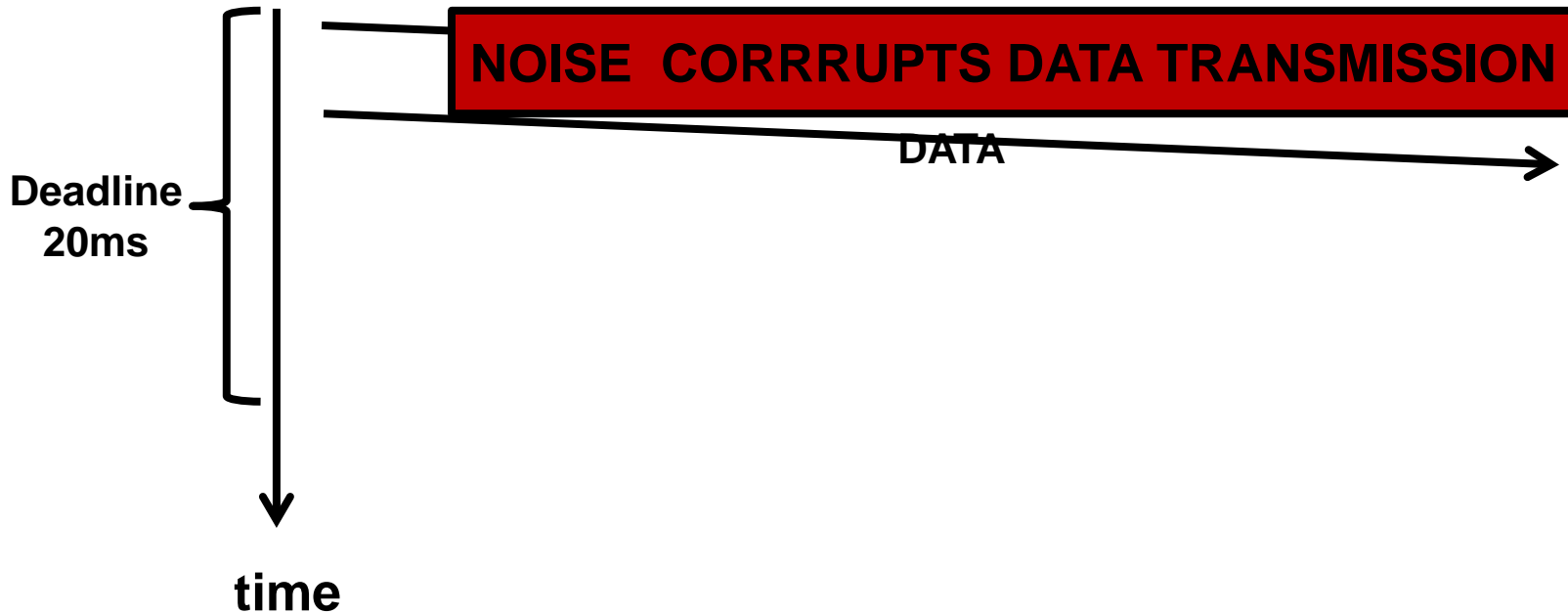
Wireless communication medium arbitrated through fixed-priority scheduling (e.g. WiDom)



Interface for wireless traffic



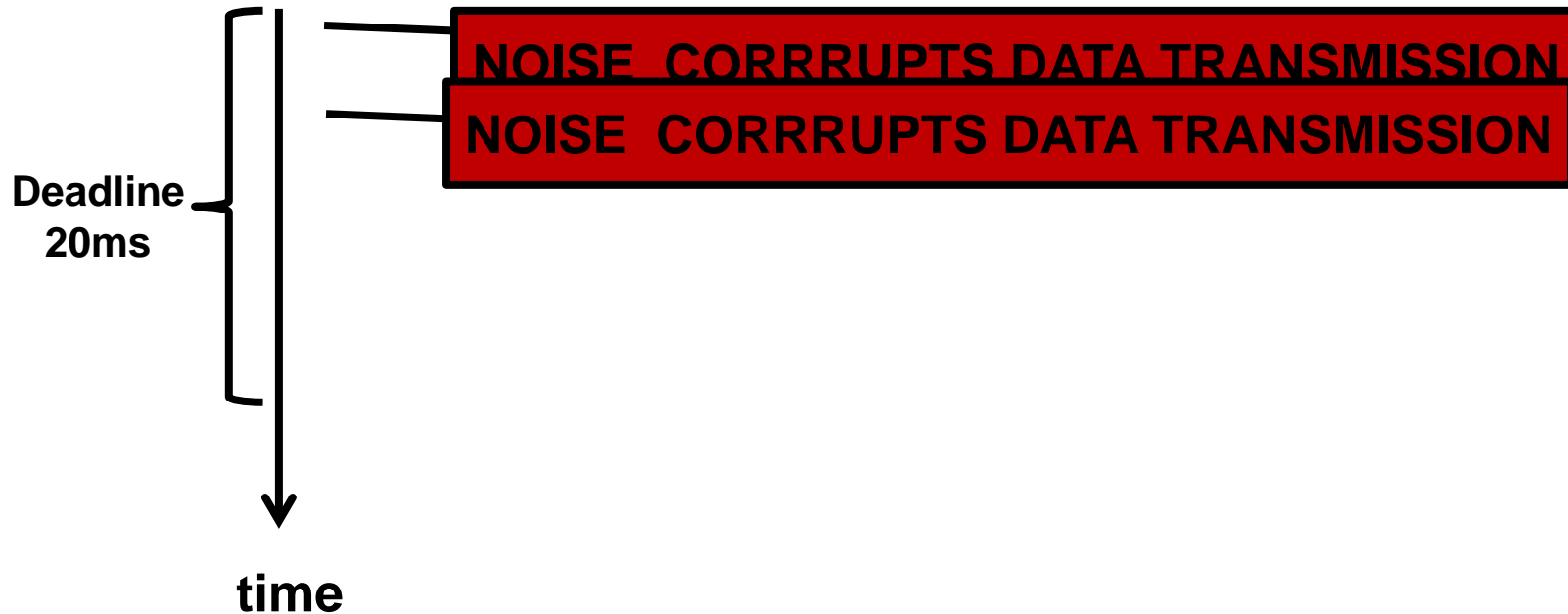
Wireless communication medium arbitrated through fixed-priority scheduling (e.g. WiDom)



Interface for wireless traffic



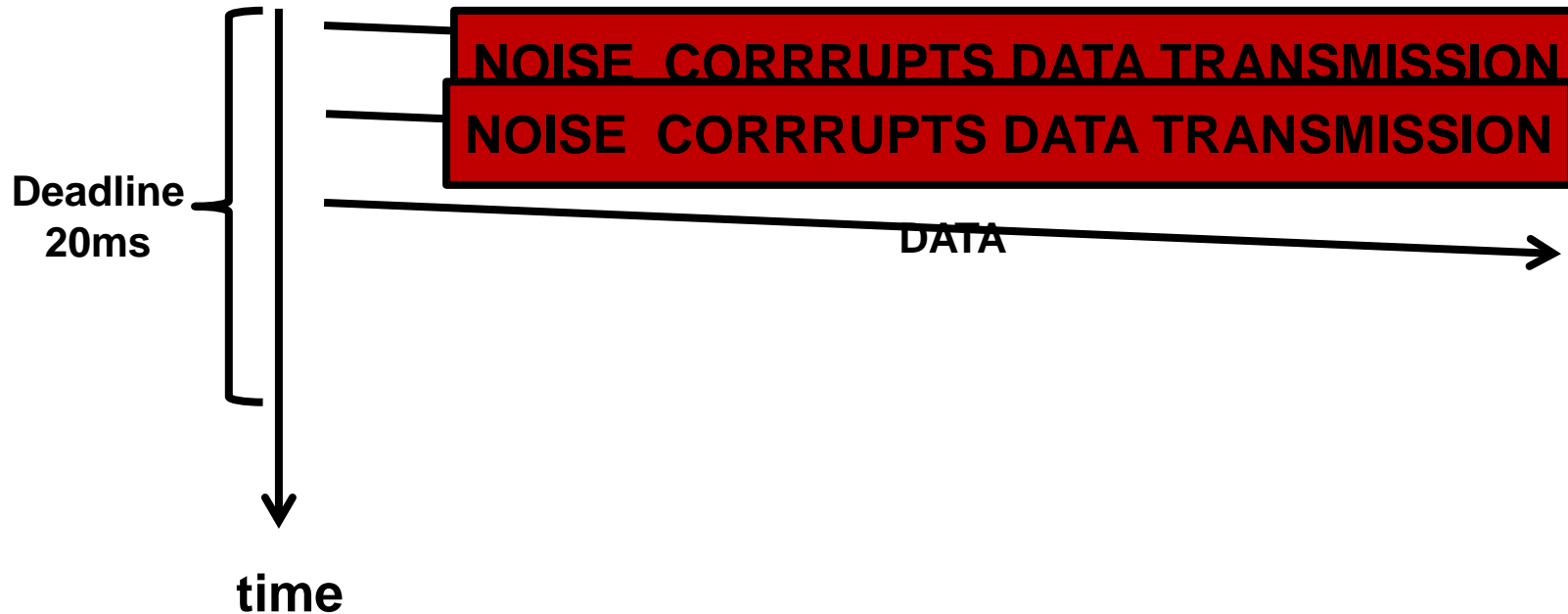
Wireless communication medium arbitrated through fixed-priority scheduling (e.g. WiDom)



Interface for wireless traffic



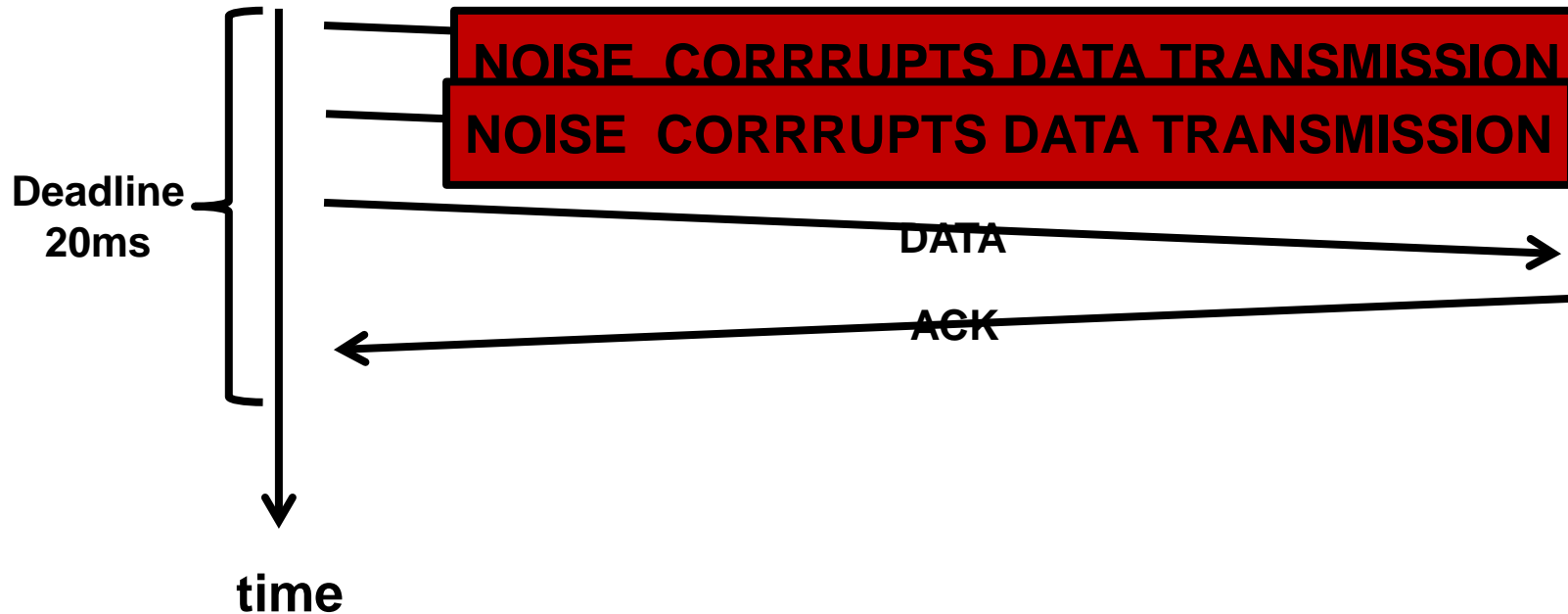
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Interface for wireless traffic



Wireless communication medium arbitrated through fixed-priority scheduling (e.g. WiDom)

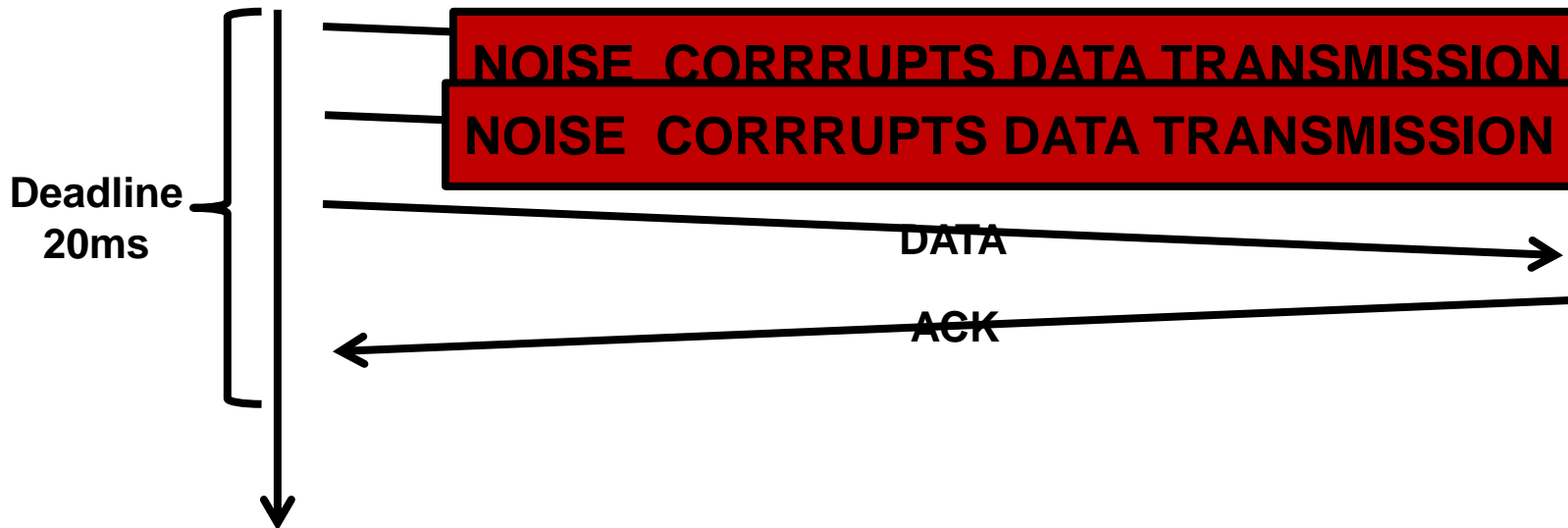


Interface for wireless traffic

Computer node 1

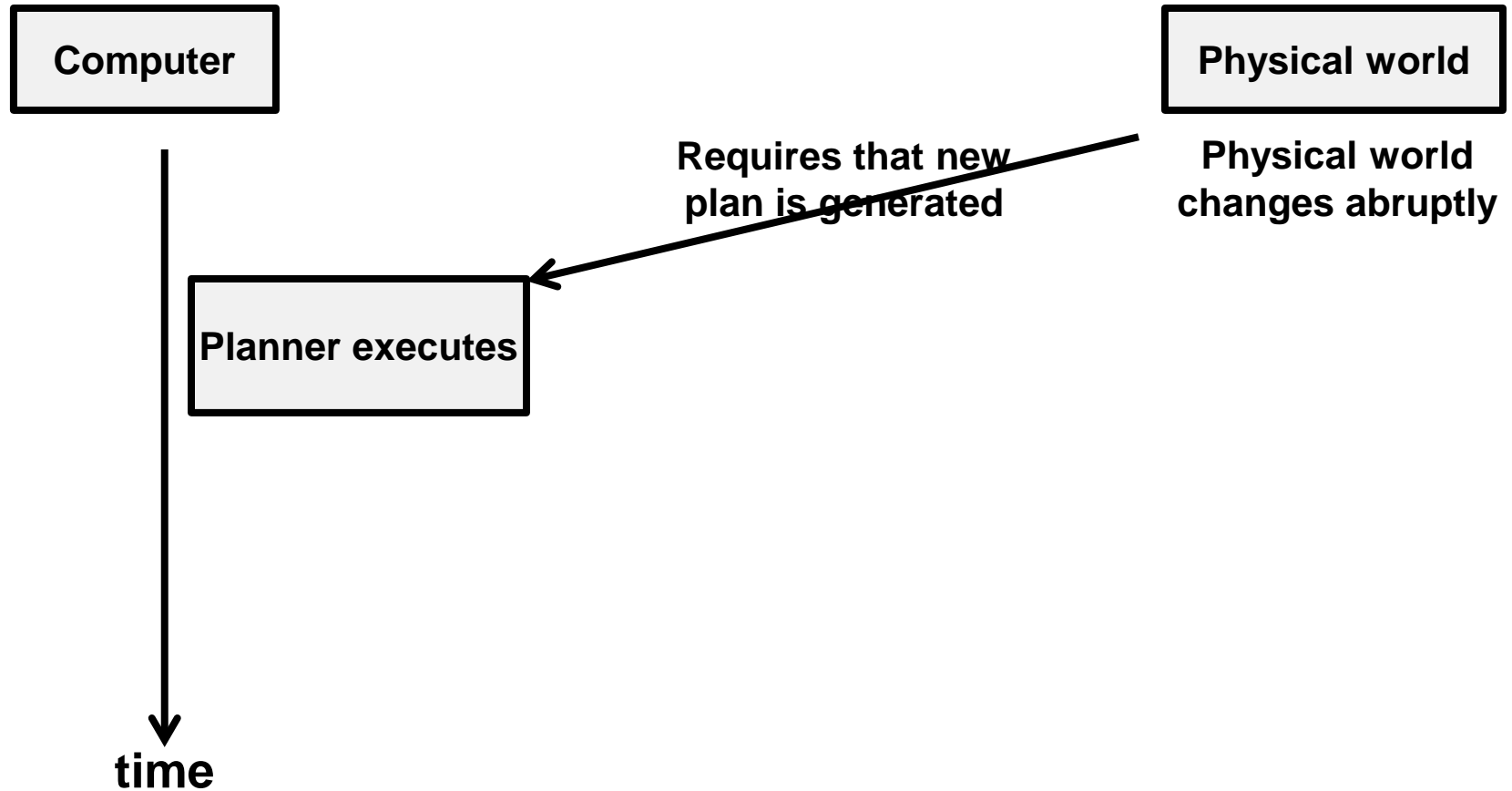
Computer node 2

Wireless communication medium arbitrated through fixed-priority scheduling (e.g. WiDom)



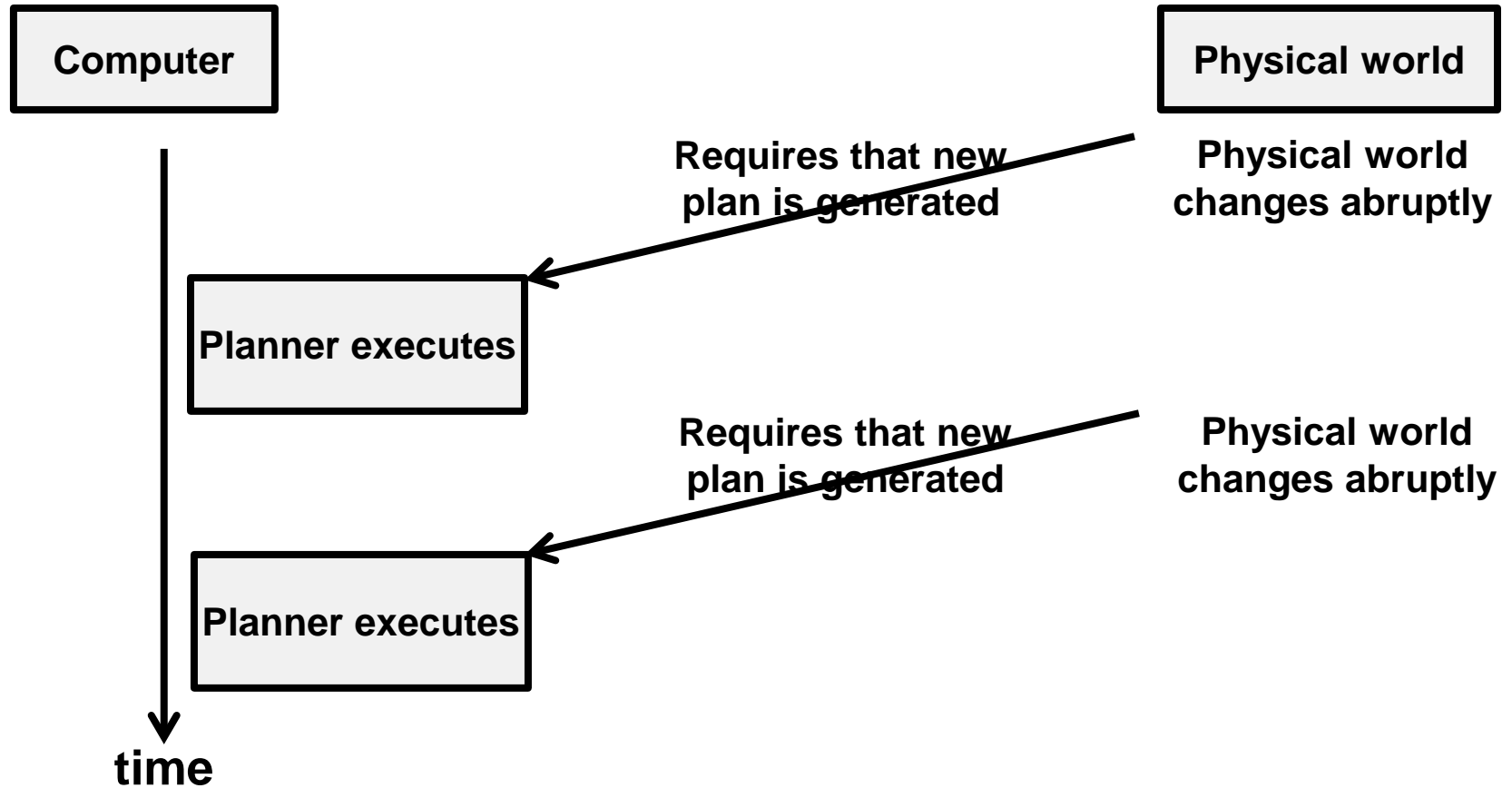
Problem: Create an interface that describes the resource consumption of the above messages as a function of channel imperfections (noise/distortion)

Interface for autonomous cars



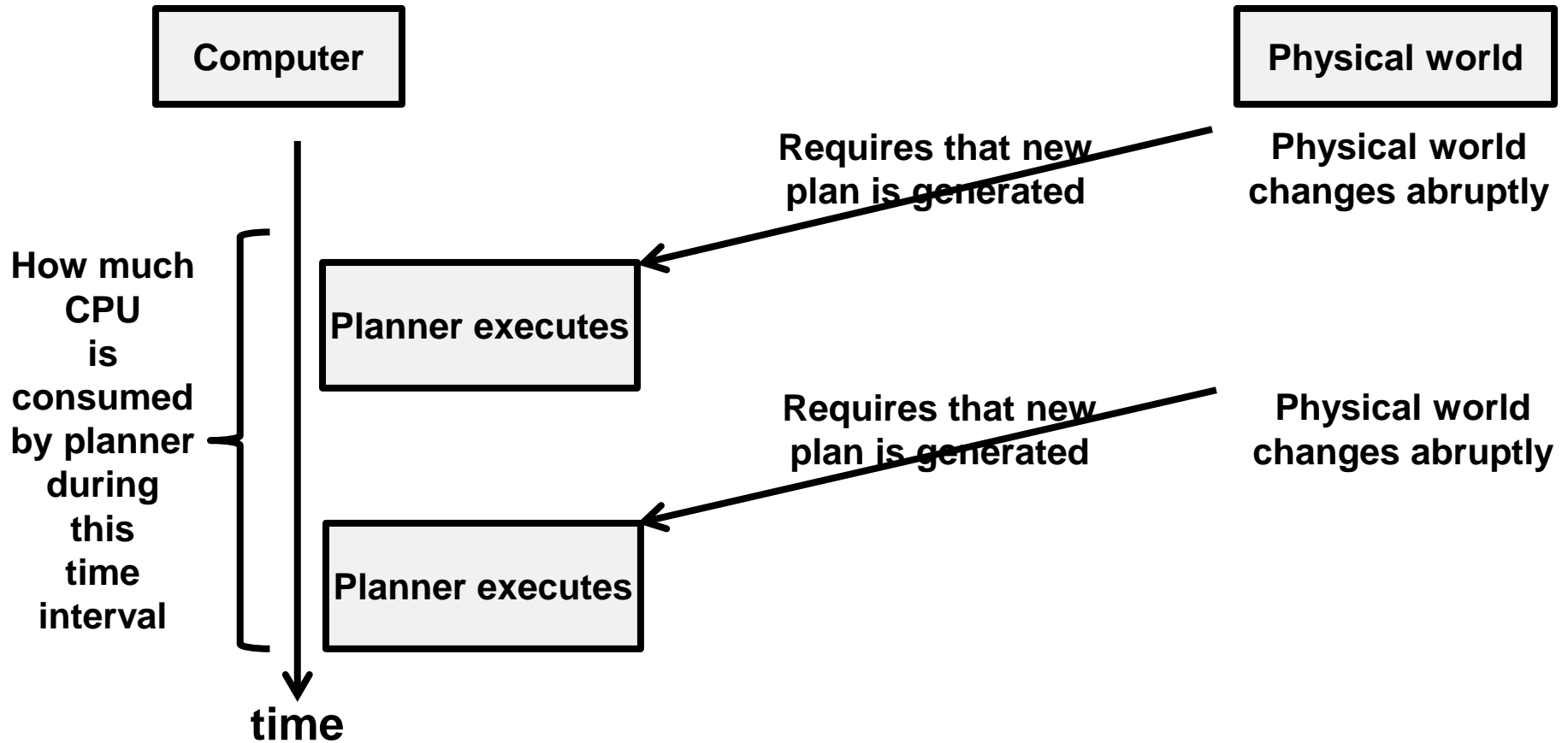
Problem: Create an interface that describes the resource consumption of the planner software as a function of the “eventfulness” or “unexpectedness” of the environment.

Interface for autonomous cars



Problem: Create an interface that describes the resource consumption of the planner software as a function of the “eventfulness” or “unexpectedness” of the environment.

Interface for autonomous cars



Problem: Create an interface that describes the resource consumption of the planner software as a function of the “eventfulness” or “unexpectedness” of the environment.



Summary of the state-of-the-art

Interface design problem	Status
Interface for constrained-deadline sporadic tasks on a single processor	Partial solution
Interface for memory accesses	Very crude solutions
Interface for complex protocols	No solutions
Interface for wireless traffic	No solutions
Interface for autonomous cars	No solutions



Thanks!



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