

Embedded Software Engineering

3 Unit Course, Winter 2009

CS Department, Univ. of Salzburg

Christoph Kirsch and Ana Sokolova

www.cs.uni-salzburg.at/~ck/teaching/ESE-Winter-2009

It's significant

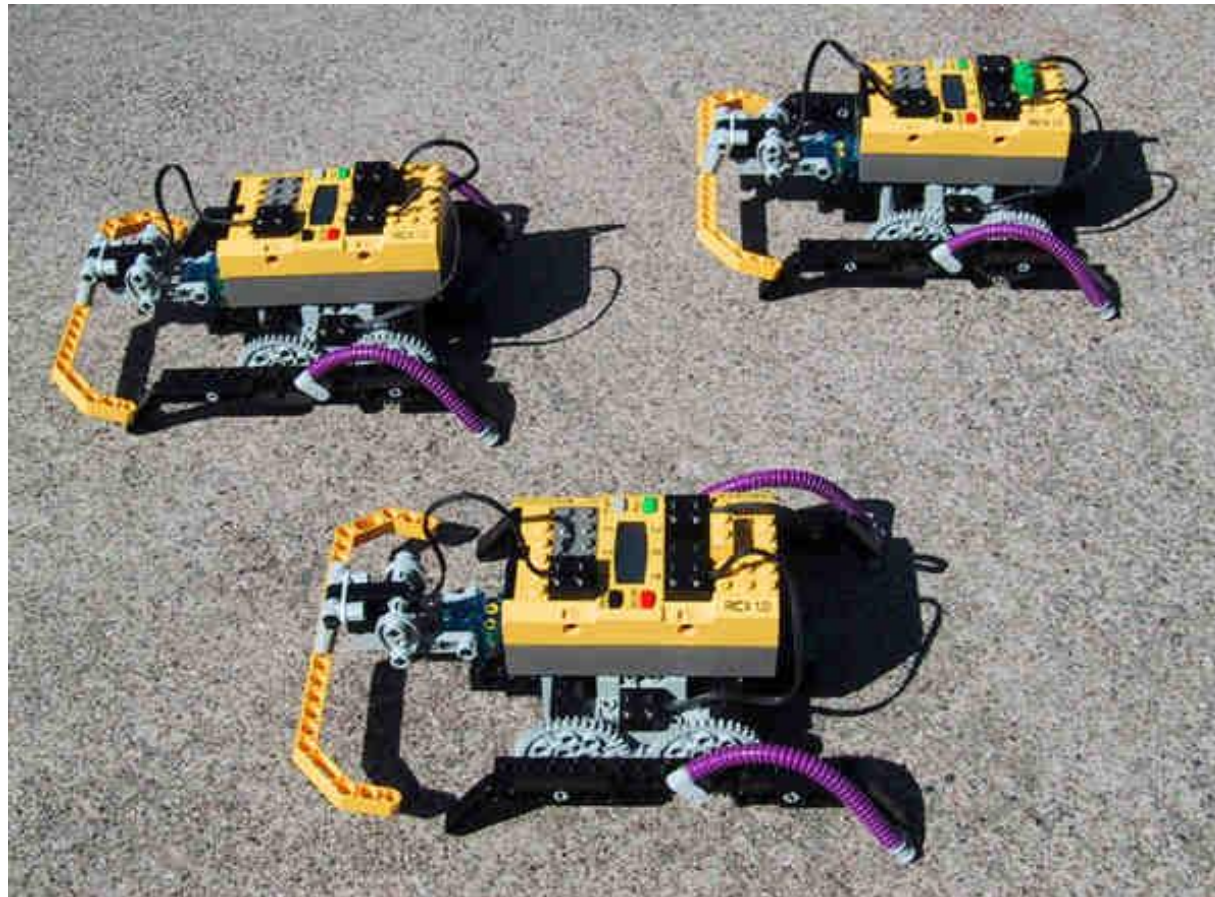


\$4 billion development effort
> 50% system integration & validation cost

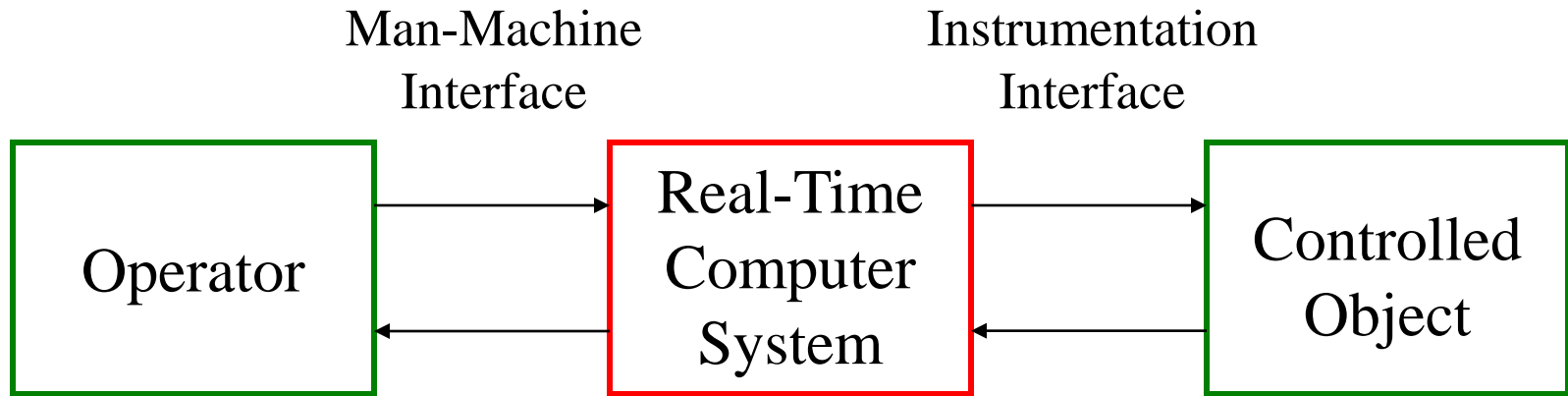
It's risky



It's fun



Problem

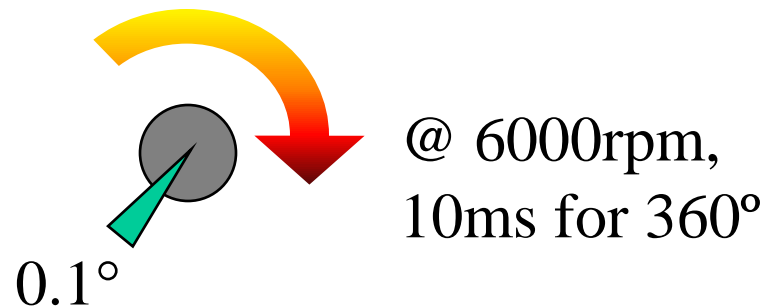


Kopetz97

Methodologies for the implementation of
embedded **real-time** applications

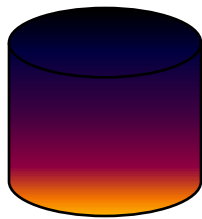
- Methodology: **tool-supported, abstract, compositional**
- Implementation: **compositional, scalable, dependable**

Engine Controller



- Temporal accuracy of 3μsec
- Up to 100 concurrent software tasks
- Hard real-time: no missed deadlines

Video Streaming



- 25 frames/sec
- Dynamic resource allocation
- Soft real-time: degraded QoS

Real-Time Systems

Characteristics	Hard	Soft
Response time	Hard-required	Soft-desired
Peak-load performance	Predictable	Degraded
Control of pace	Environment	Computer
Redundancy	Active	Checkpoint
Error detection	Autonomous	User assisted

Kopetz97

Mechatronics

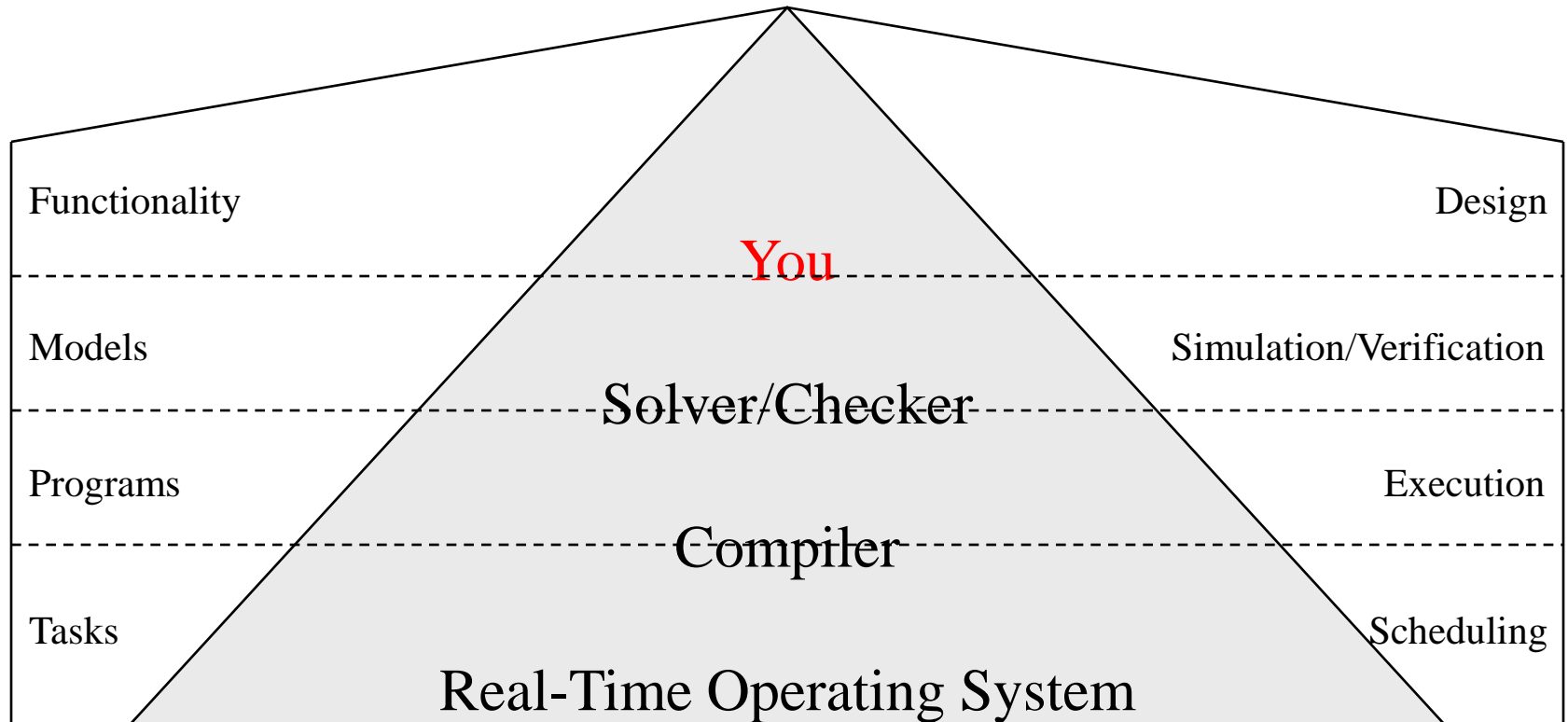


Fly-by-wire

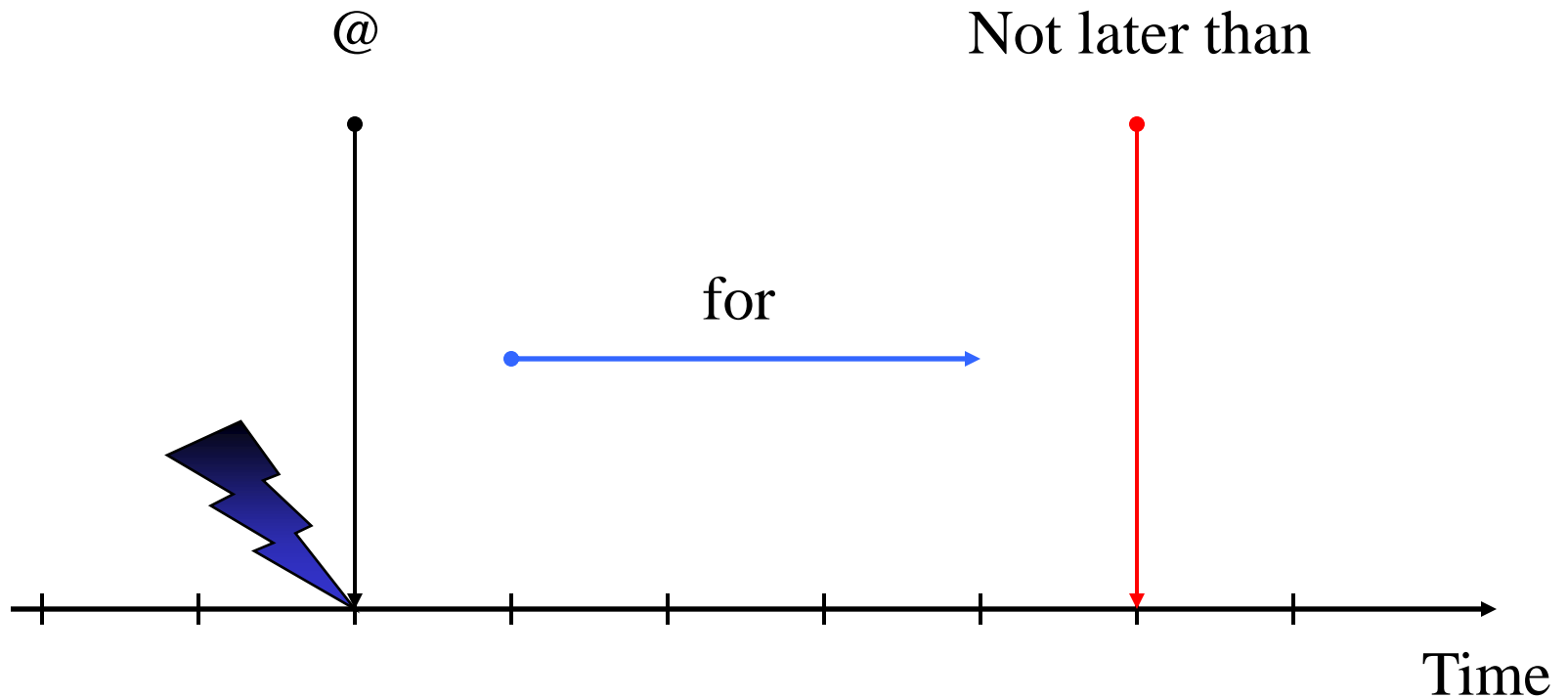


Drive-by-wire

Embedded Software Engineering



Real Time



● → Time-instant

● → Deadline

● → Duration

Concurrency

Task1

Task2

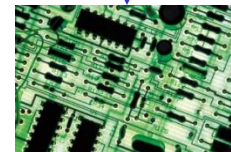


Host

Message1



Network

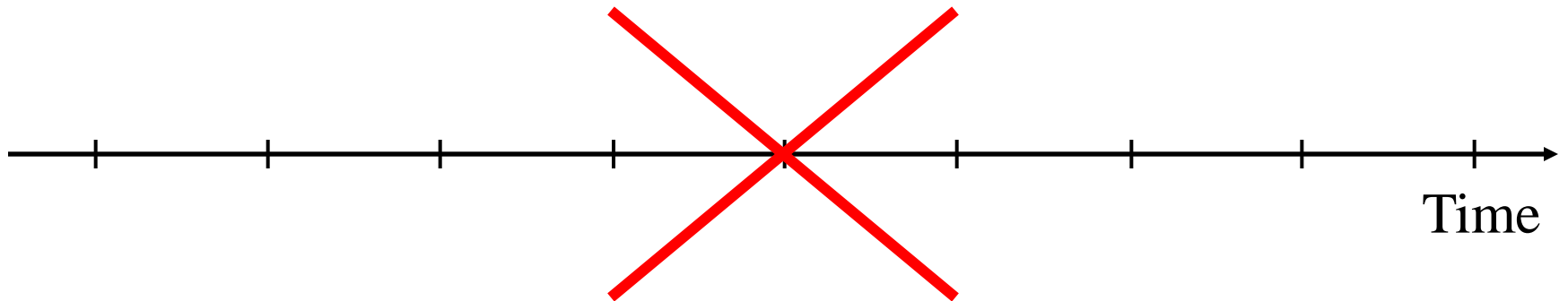


Message2

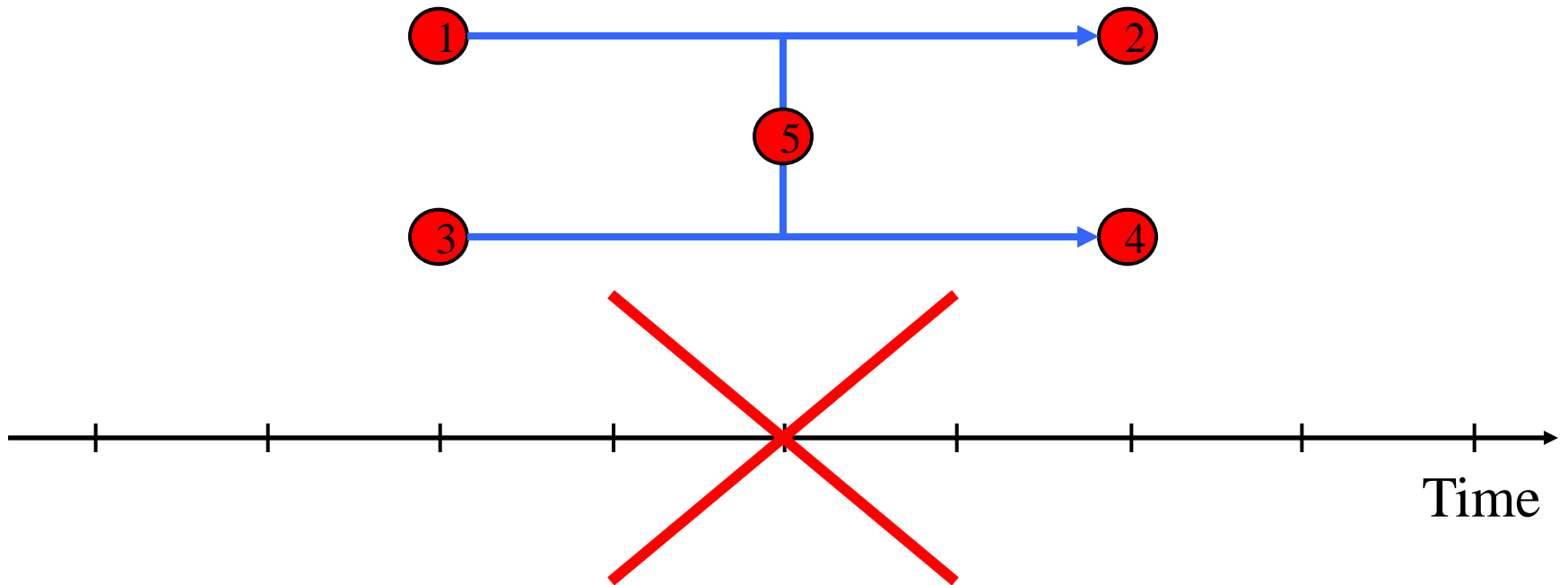
In addition:

- Other resource constraints
- Time constraints

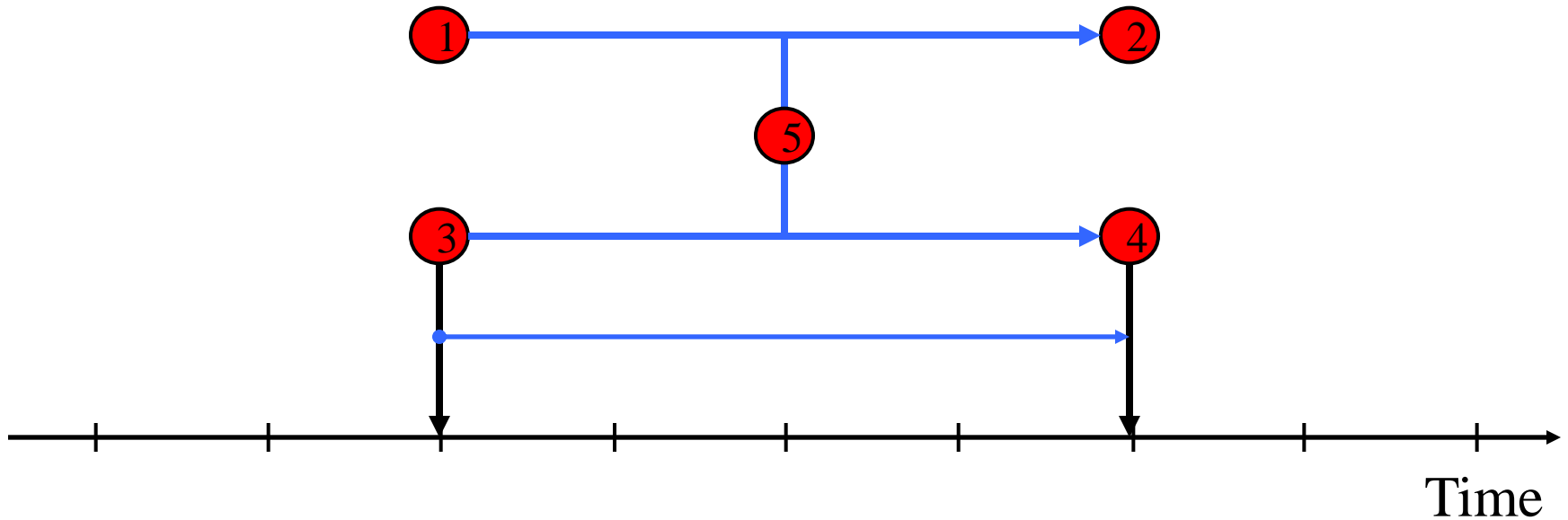
Sequential Programming



Multiprogramming



Real-Time Programming



Embedded Software



Environment

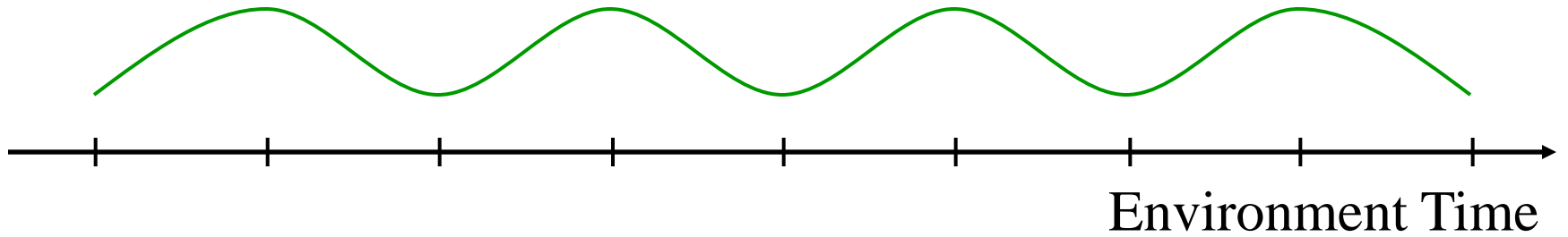
Environment Processes

Software Processes

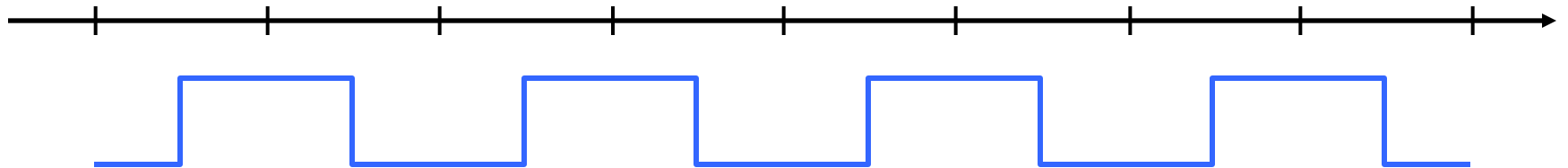
Software

Environment vs. Platform Time

Environment



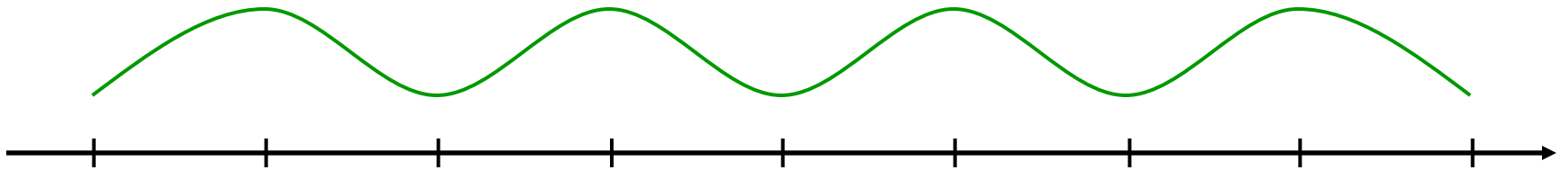
Platform Time



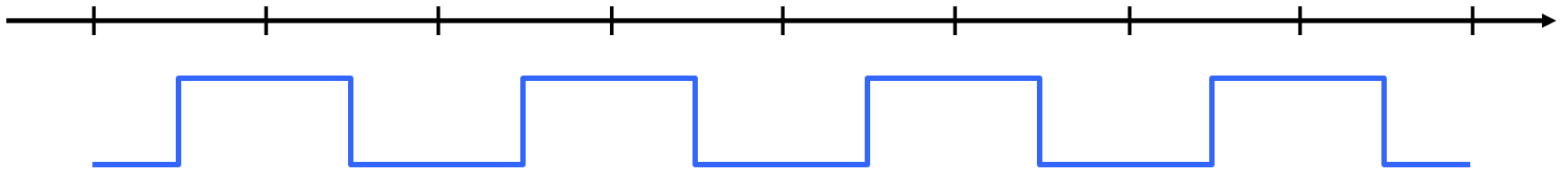
Software

The Art of Embedded Programming

Environment



Embedded Programming



Software