

Embedded Software Engineering

3 Unit Course, Winter 2004

CS Department, Univ. of Salzburg

Christoph Kirsch

www.cs.uni-salzburg.at/~ck/teaching/ESE-Winter-2004

It's significant

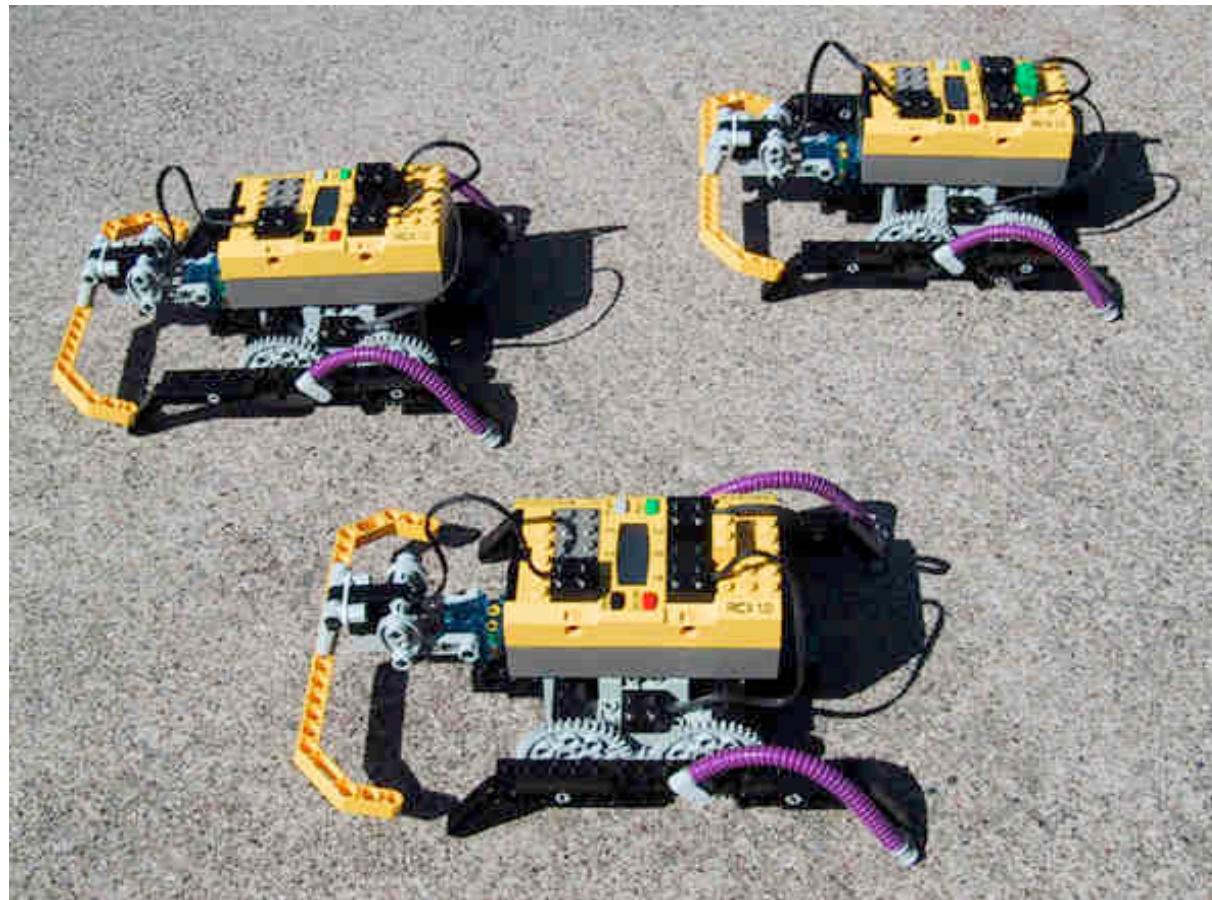


\$4 billion development effort
> 50% system integration & validation cost

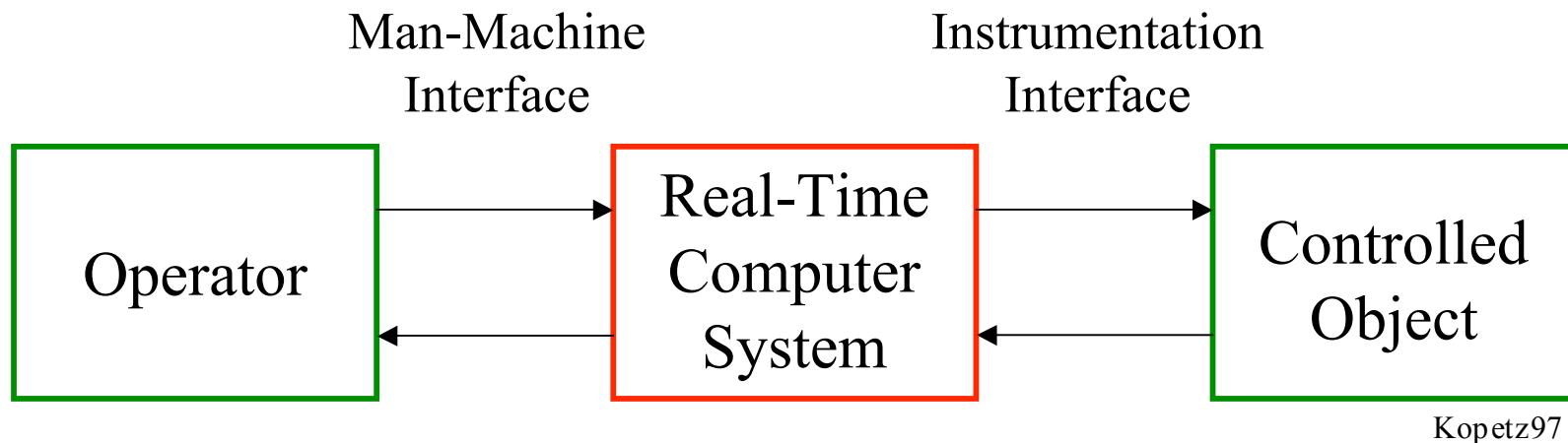
It's risky



It's fun



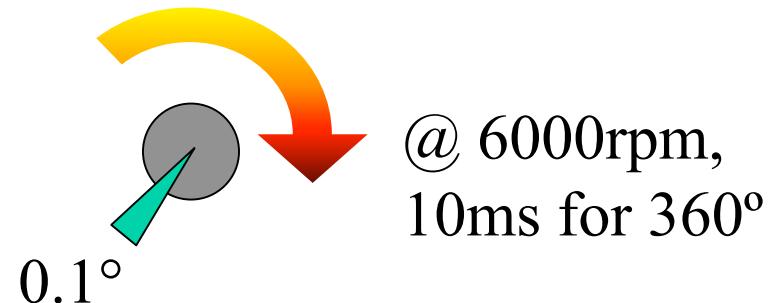
Problem



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

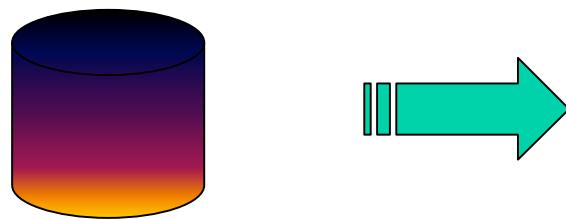
- Methodology: tool-supported, abstract, compositional
- Implementation: compositional, scalable, dependable

Engine Controller



- Temporal accuracy of $3\mu\text{sec}$
- 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

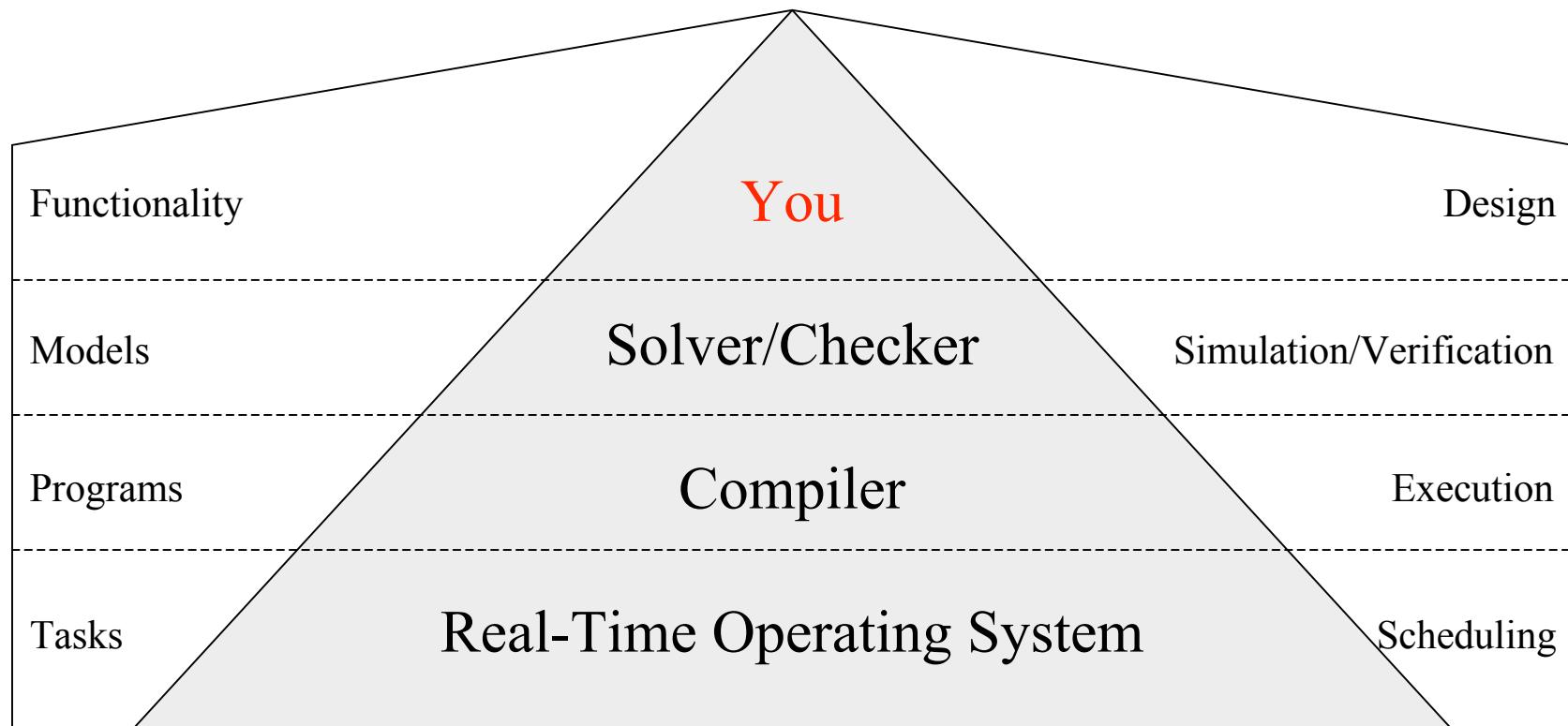


Fly-by-wire

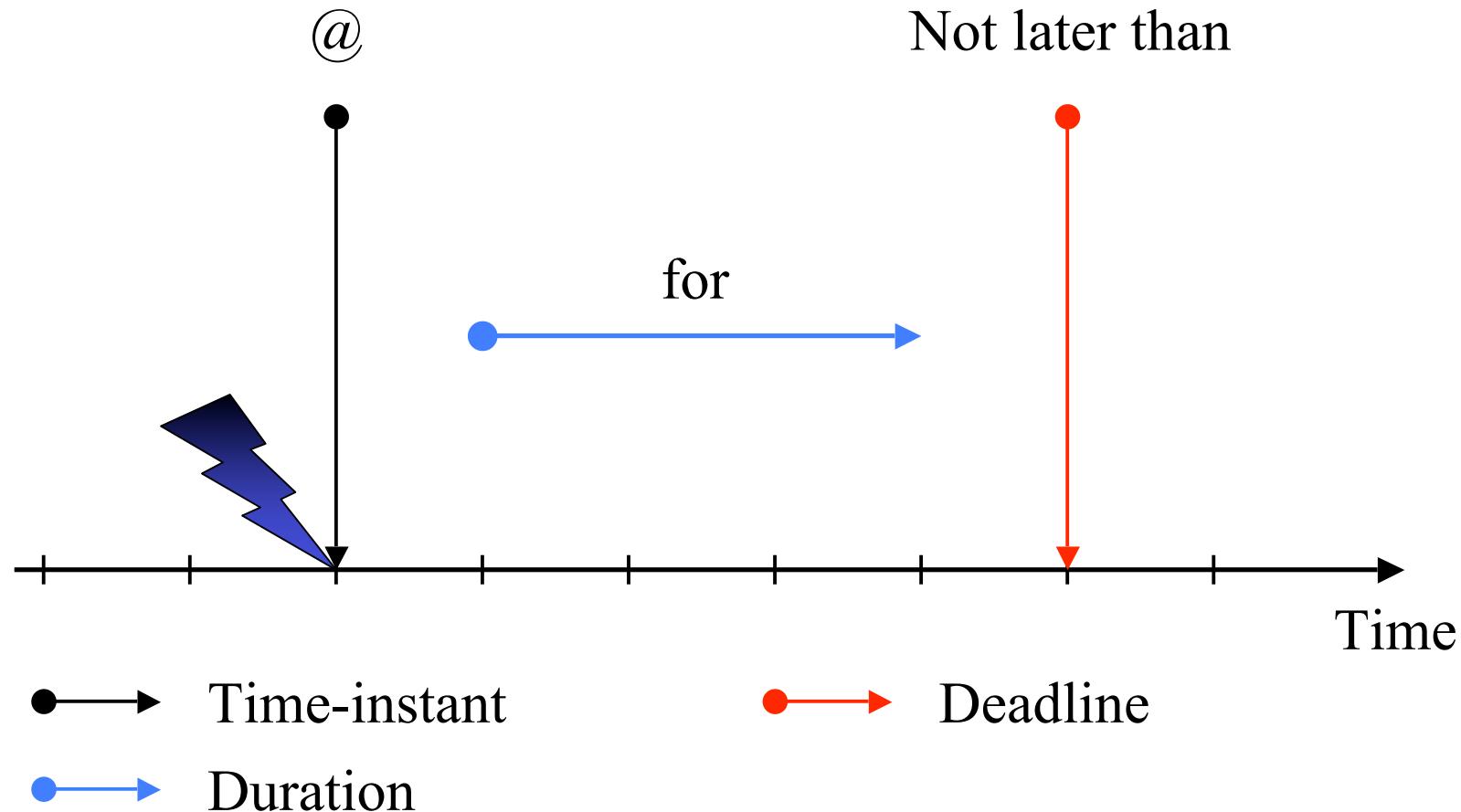


Drive-by-wire

Embedded Software Engineering



Real-Time



Concurrency

Task1



Host

Task2

Message1



Network

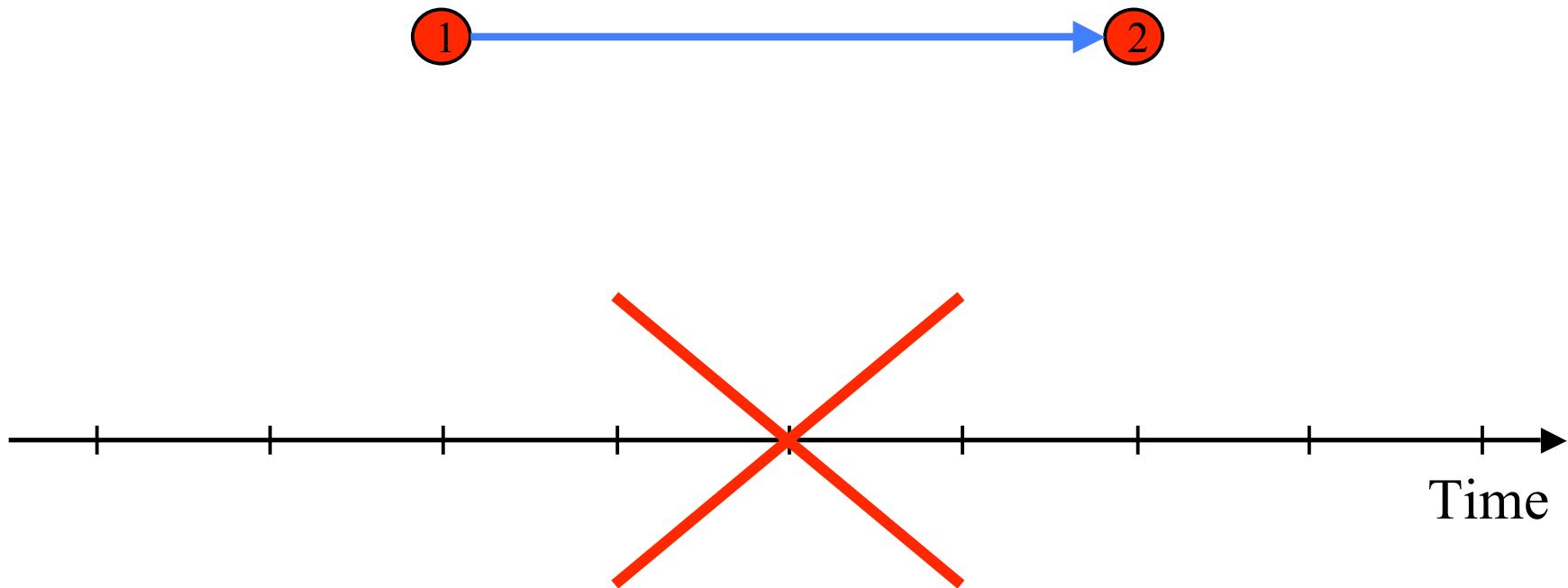


Message2

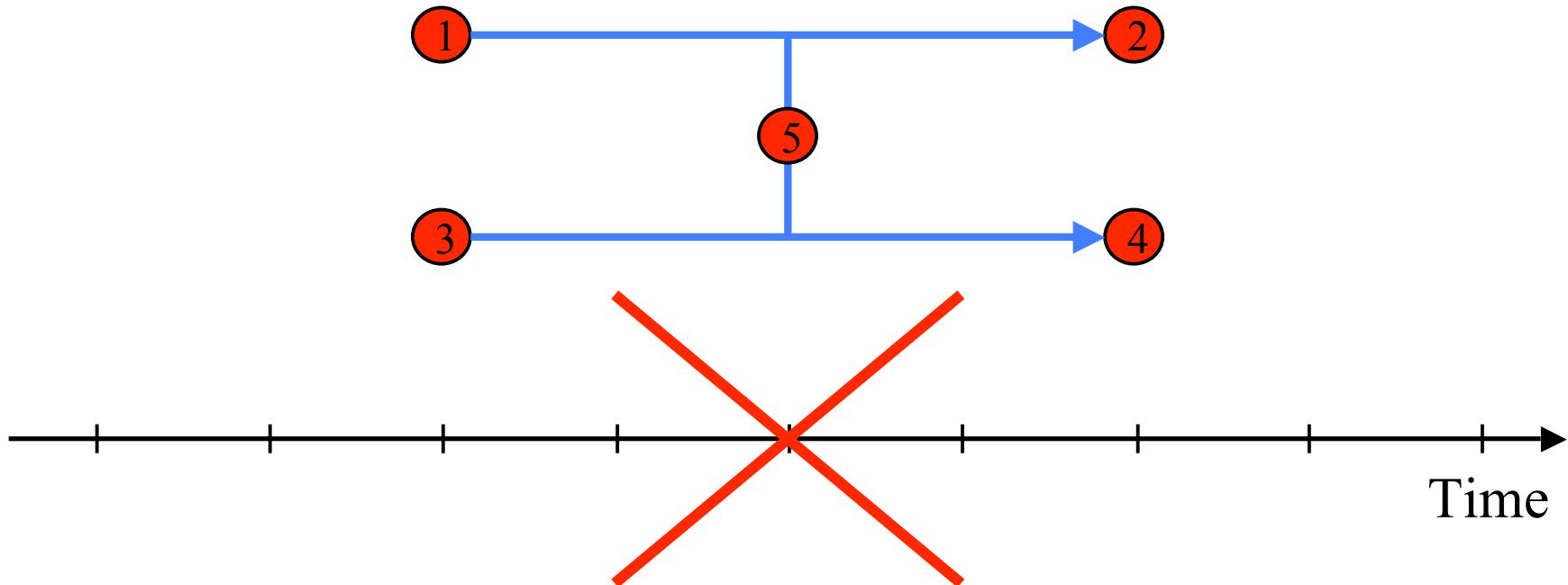
In addition:

- Other resource constraints
- Time constraints

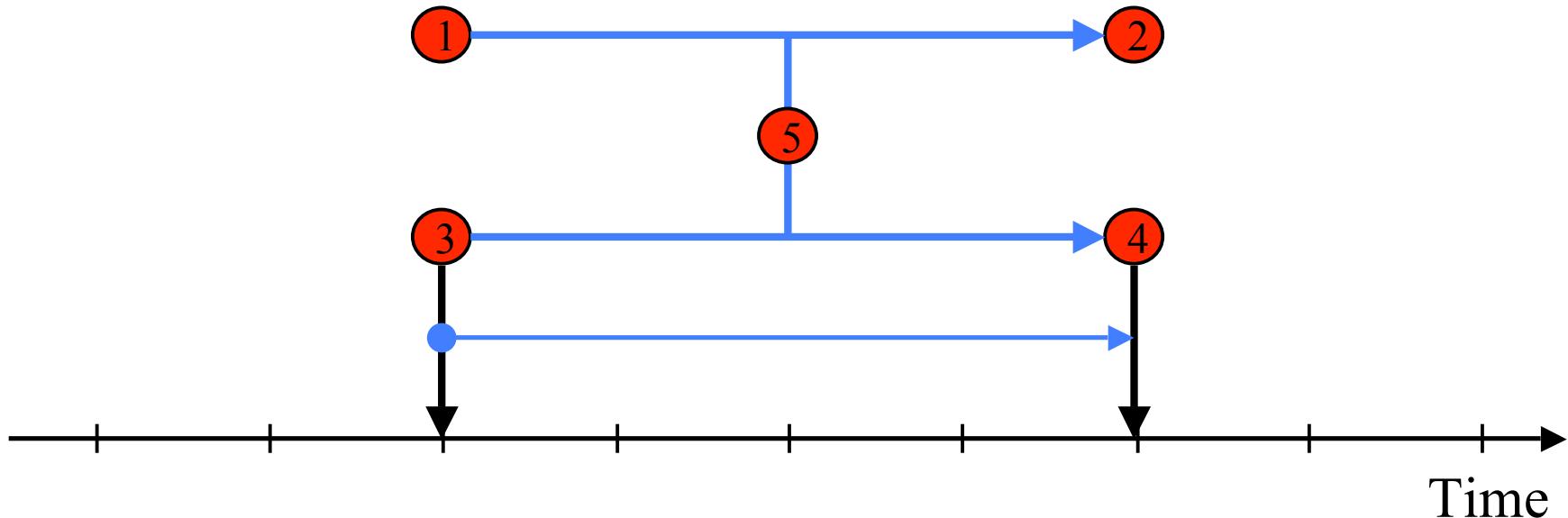
Sequential Programming



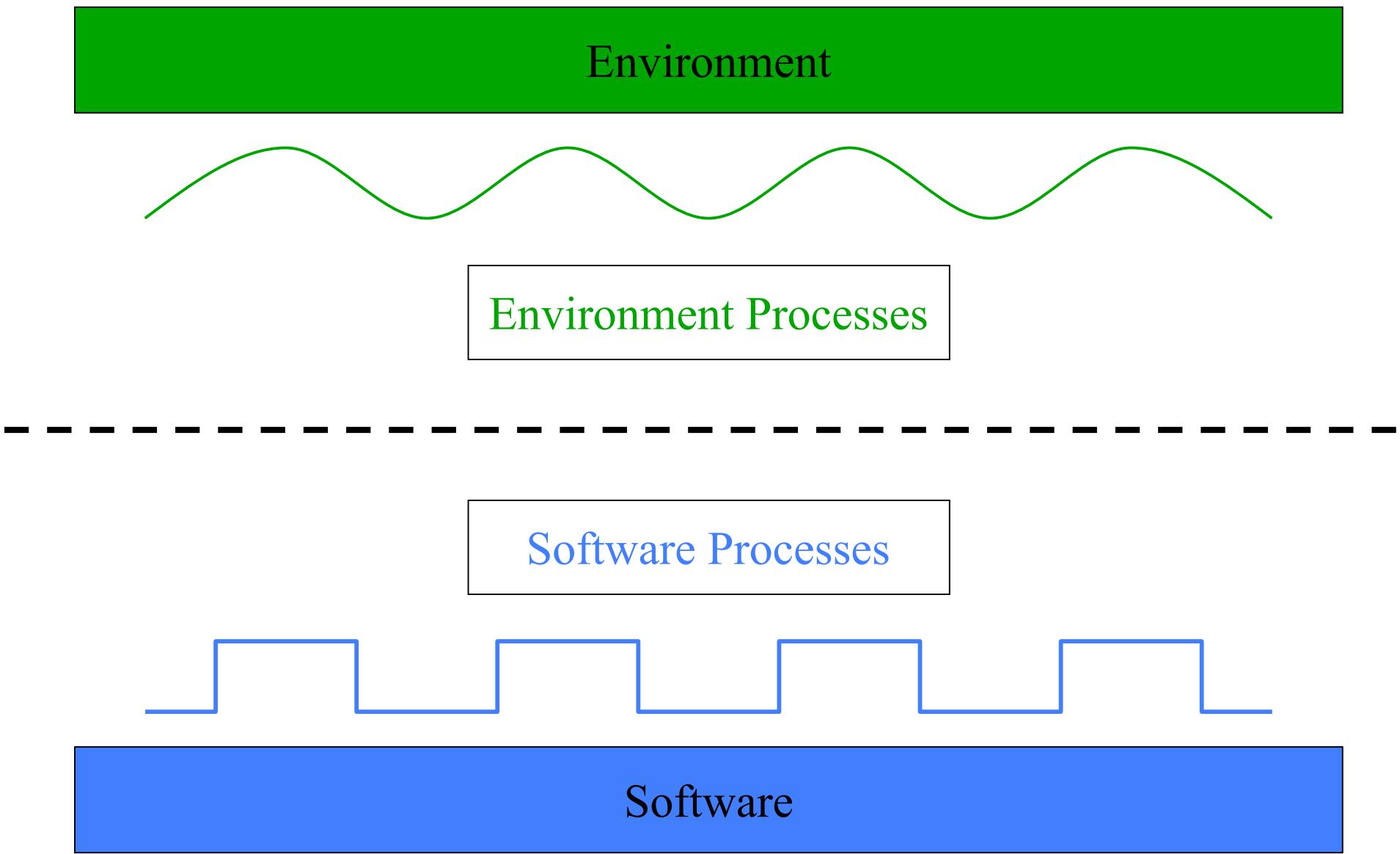
Multiprogramming



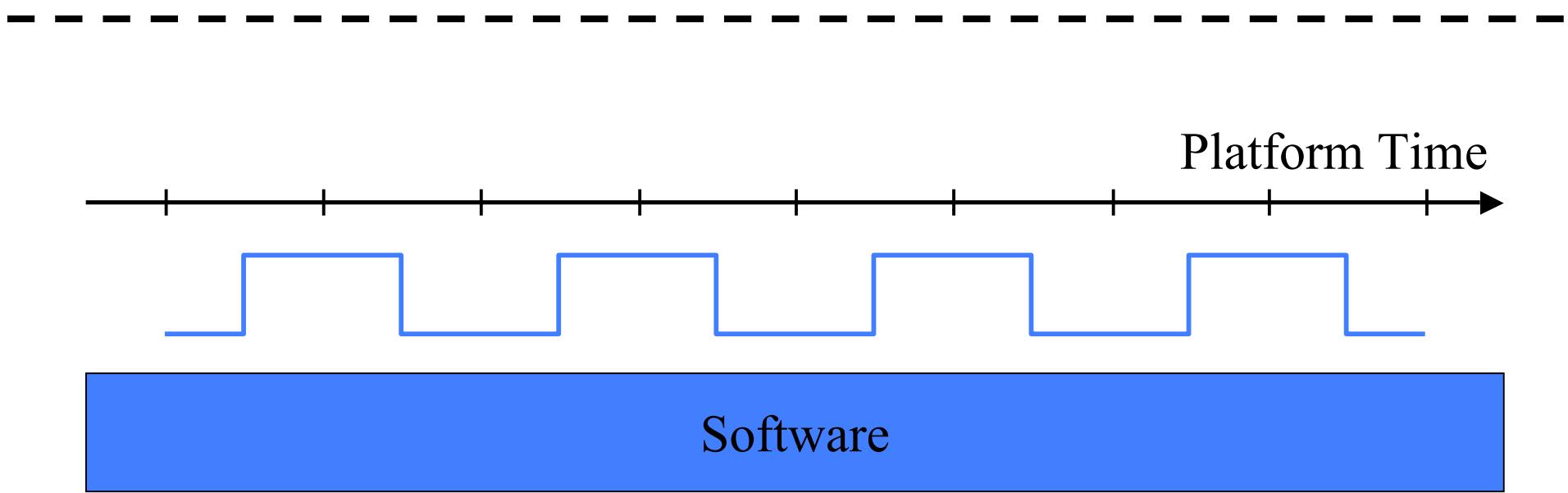
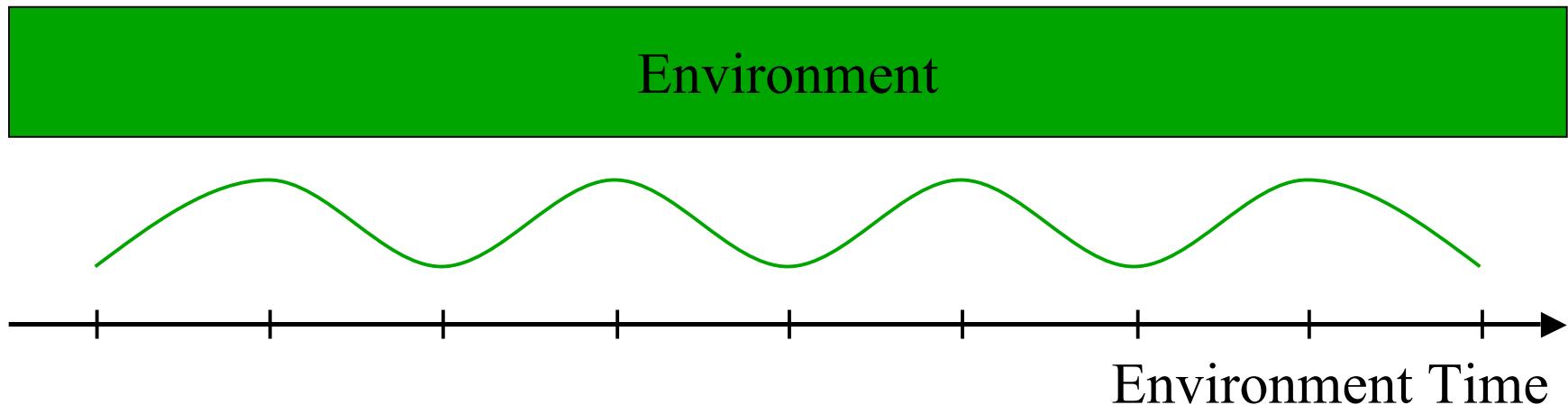
Real-Time Programming



Embedded Software



Environment vs. Platform Time



The Art of Embedded Programming

