# Embedded Software Engineering

3 Unit Course, Winter 2010

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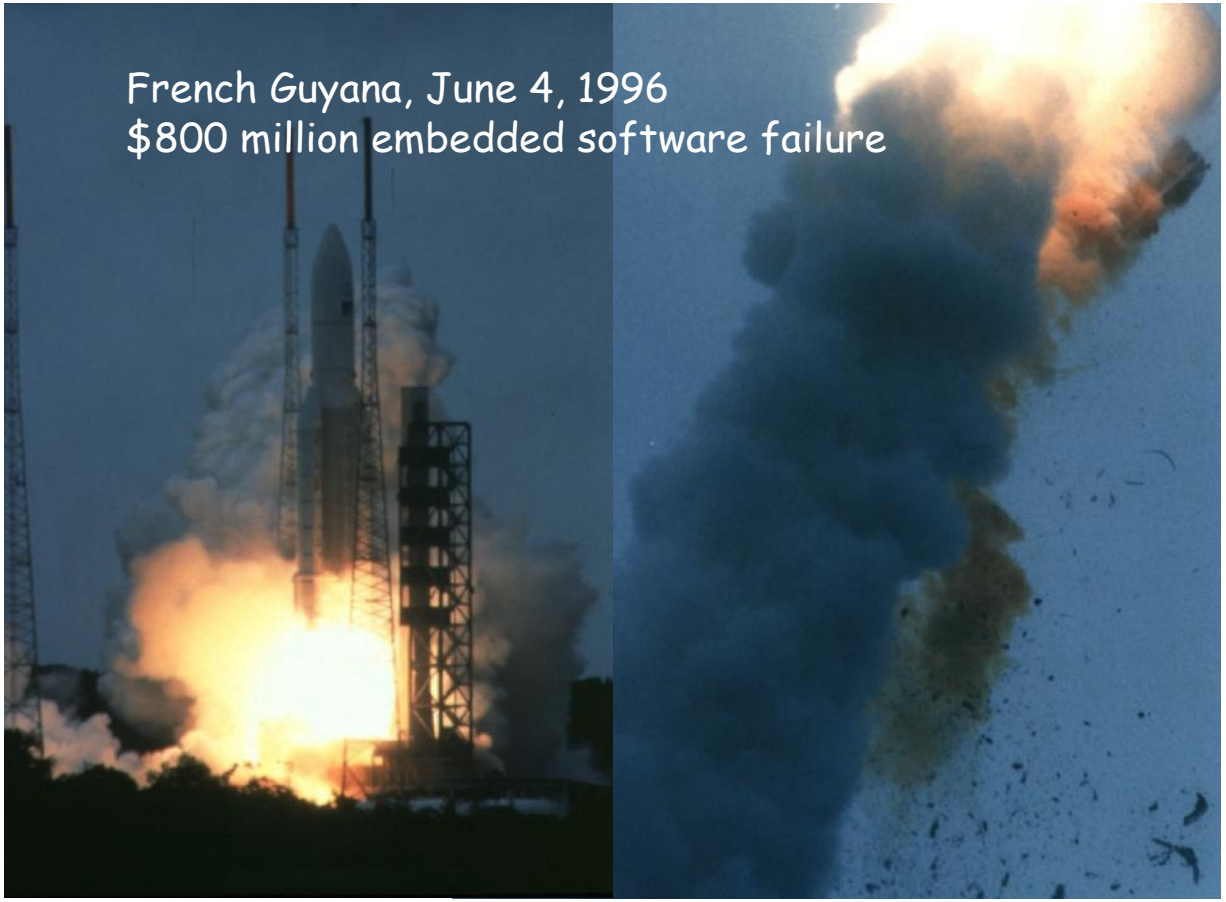
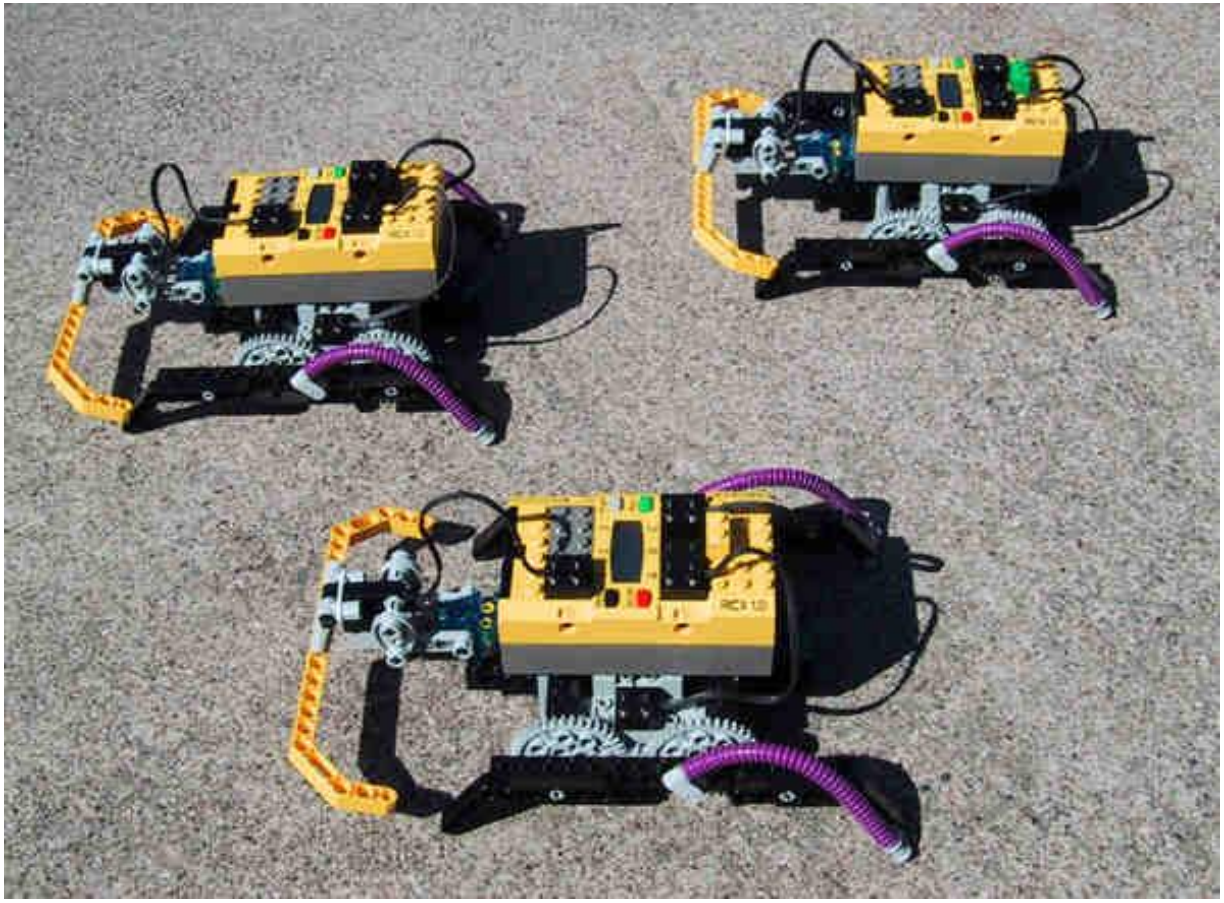
www.cs.uni-salzburg.at/~ck/teaching/ESE-Winter-2010

# It's significant

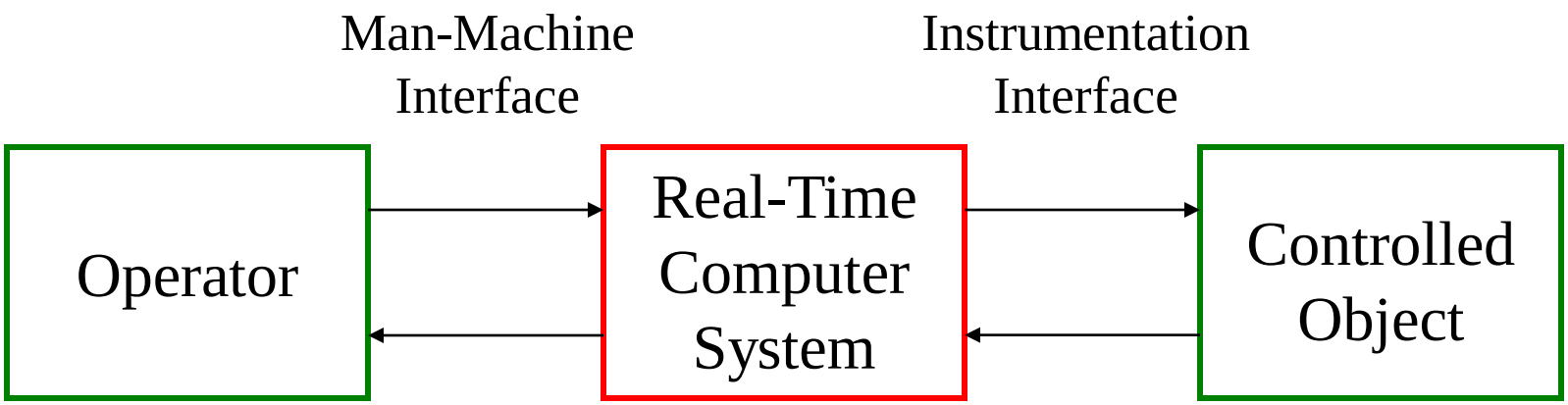
# It's risky


French Guyana, June 4, 1996
$800 million embedded software failure

# It’s fun



# Problem

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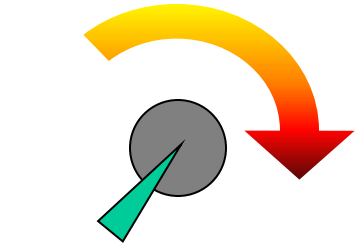
Methodologies for the implementation of embedded real-time applications

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

# Engine Controller

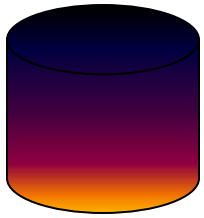


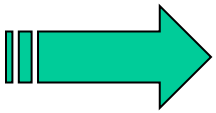
@ 6000rpm,
10ms for 360º

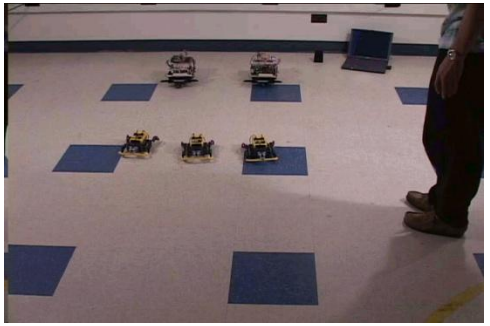
0.1°

- 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 |

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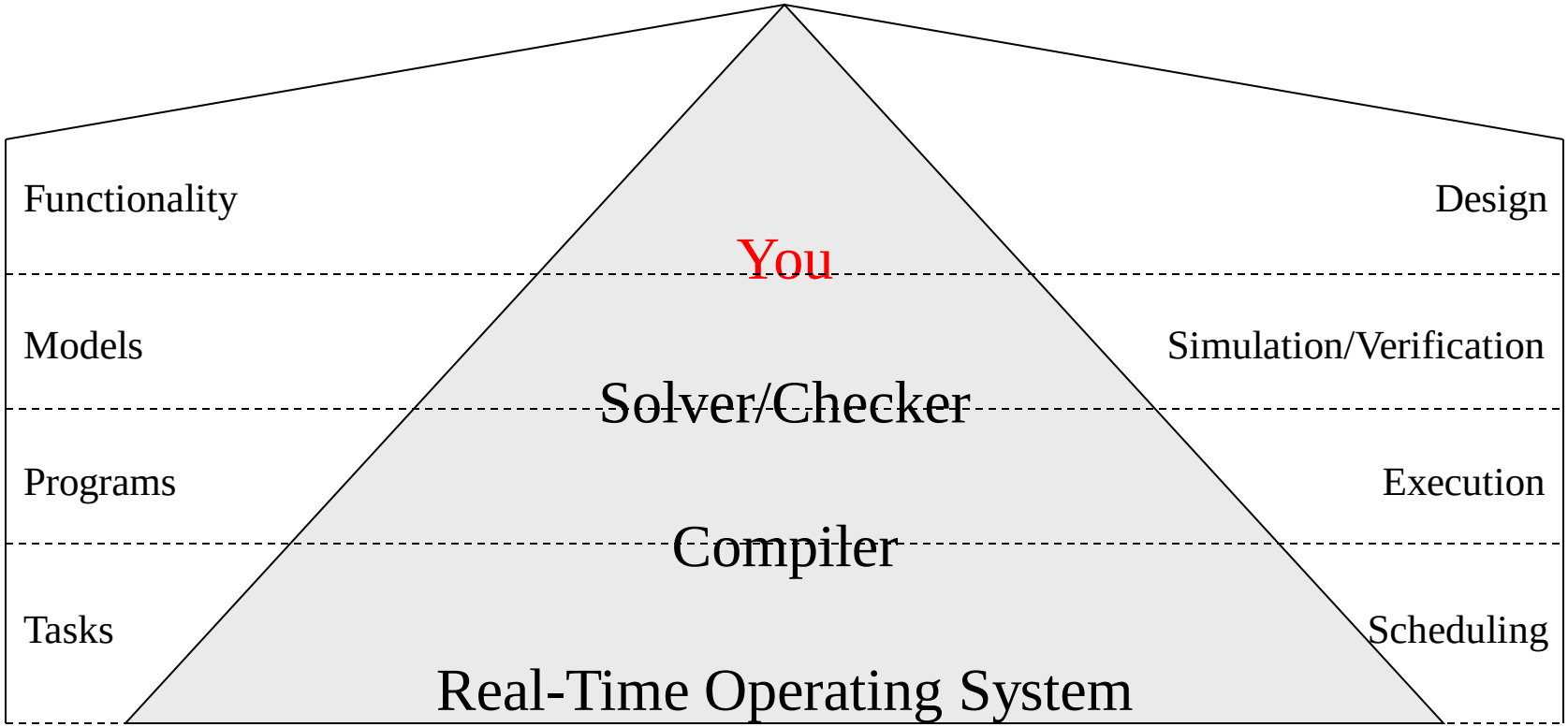
# Mechatronics

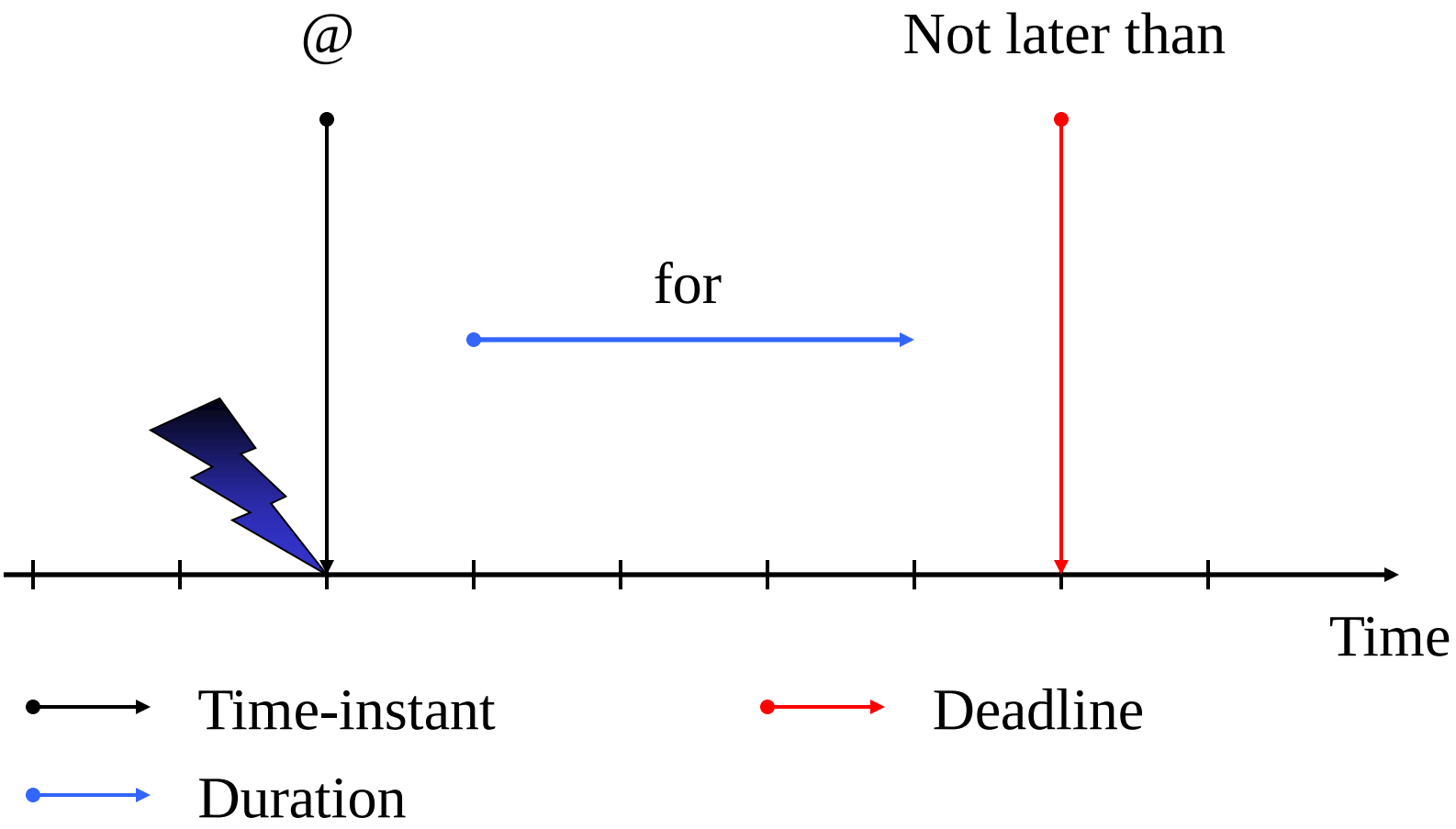
Fly-by-wire

Drive-by-wire

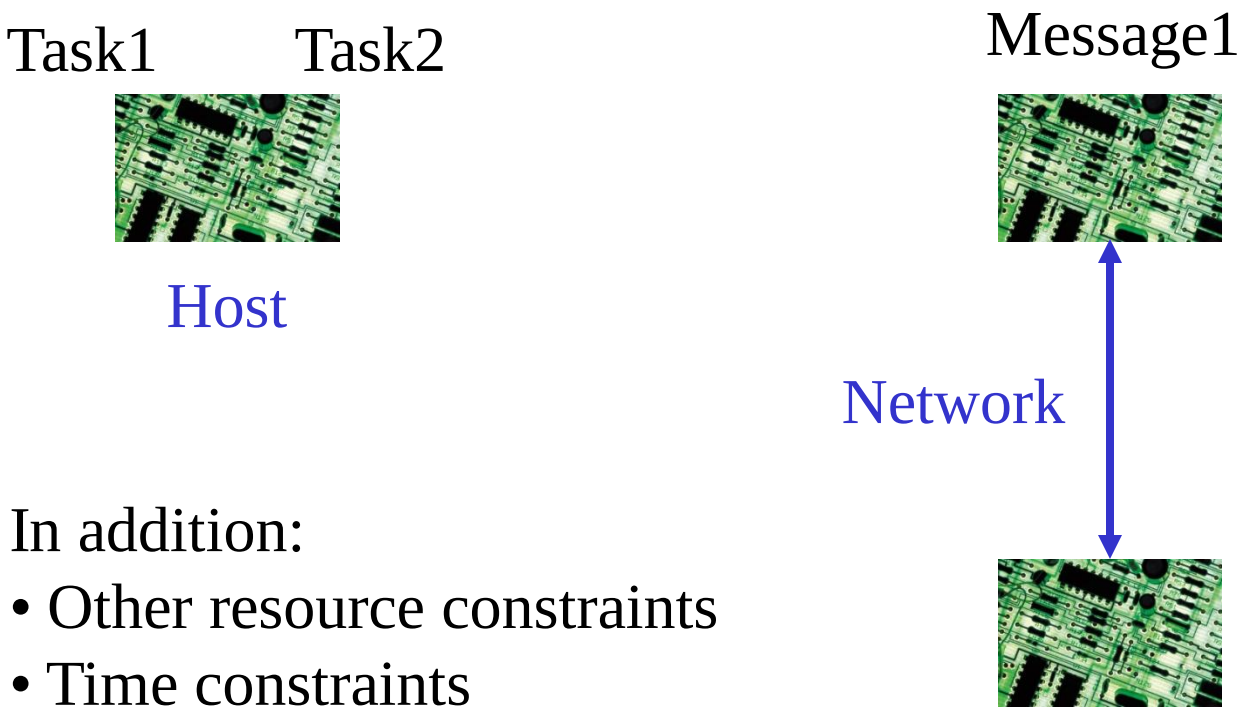
# Embedded Software Engineering



# Real Time



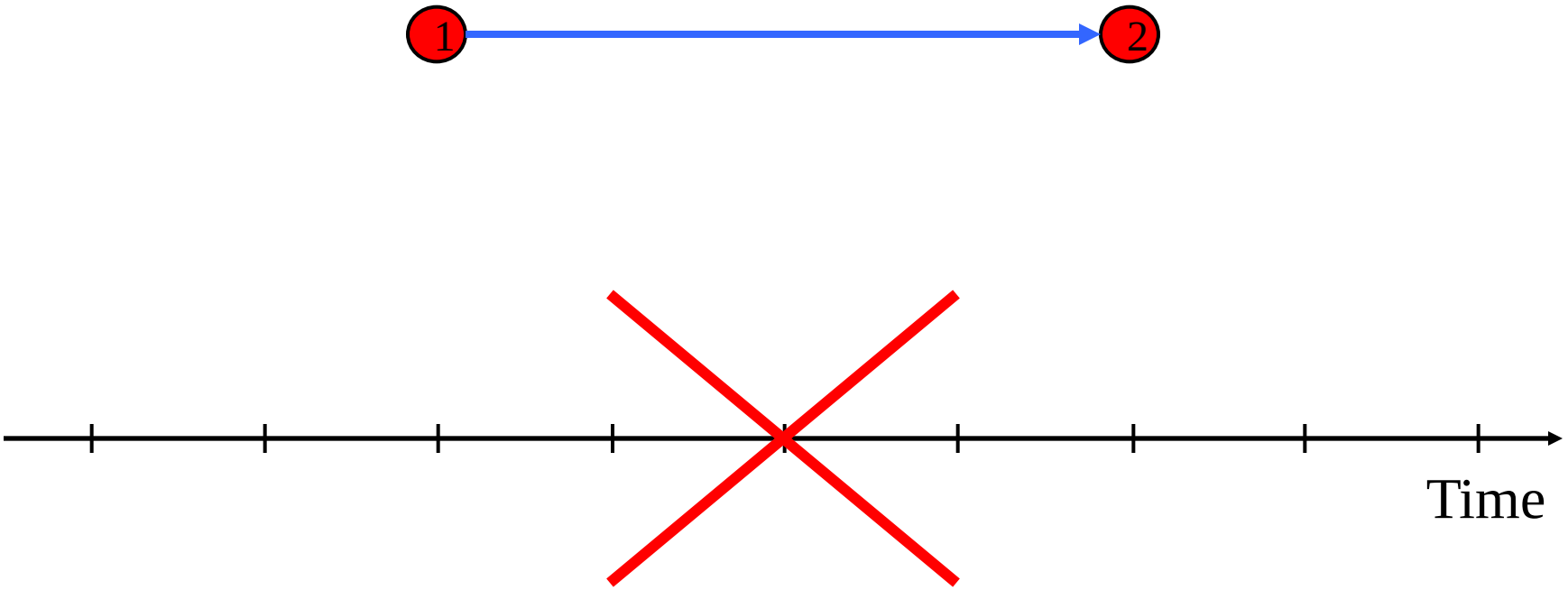
# Concurrency



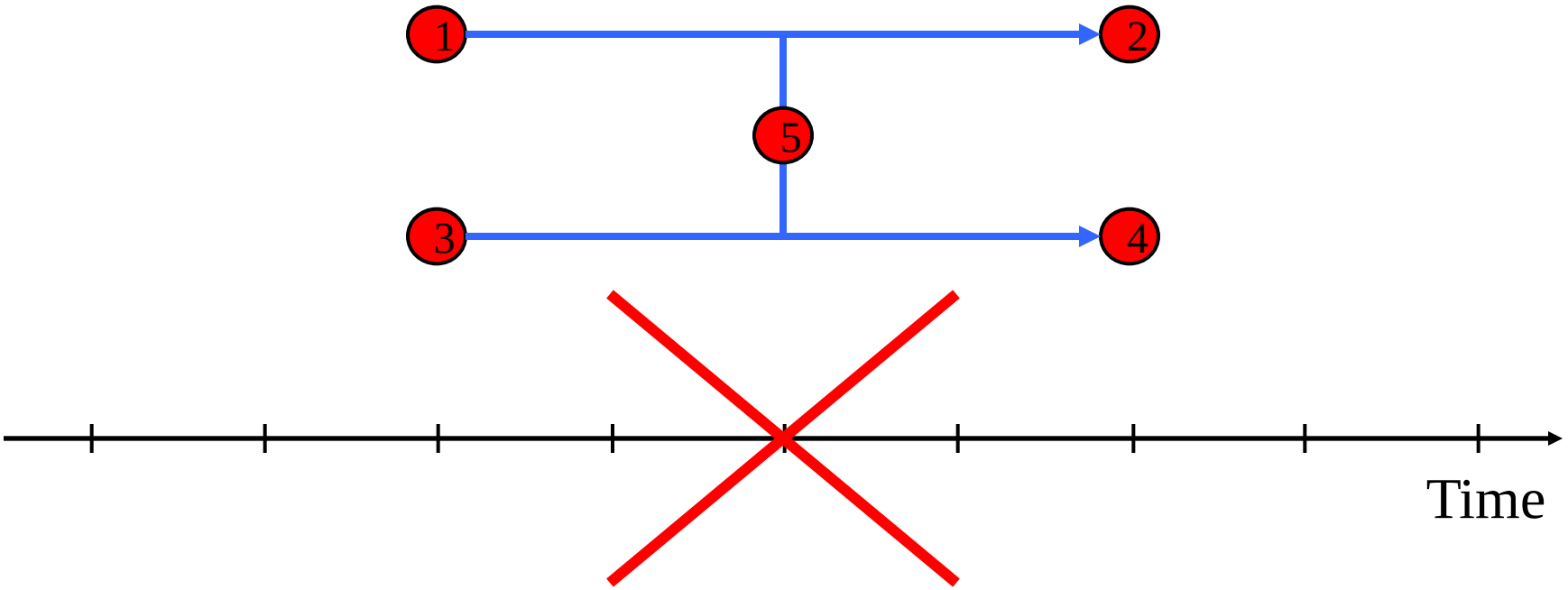

In addition:

- Other resource constraints
- Time constraints

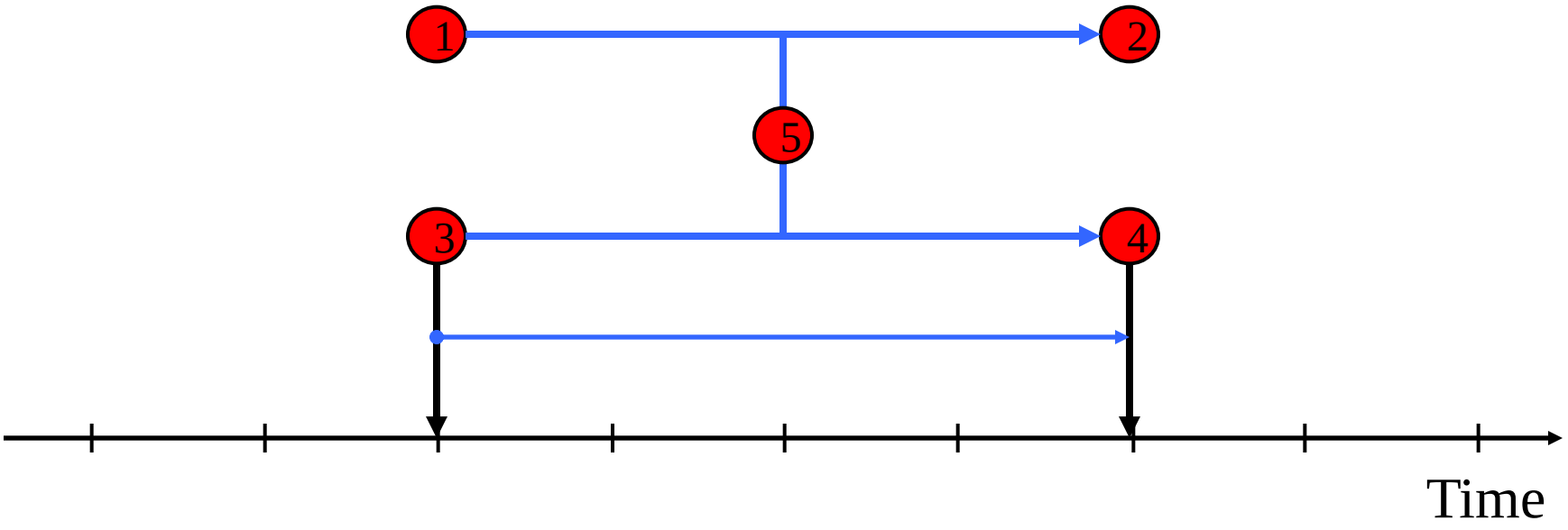
# Sequential Programming



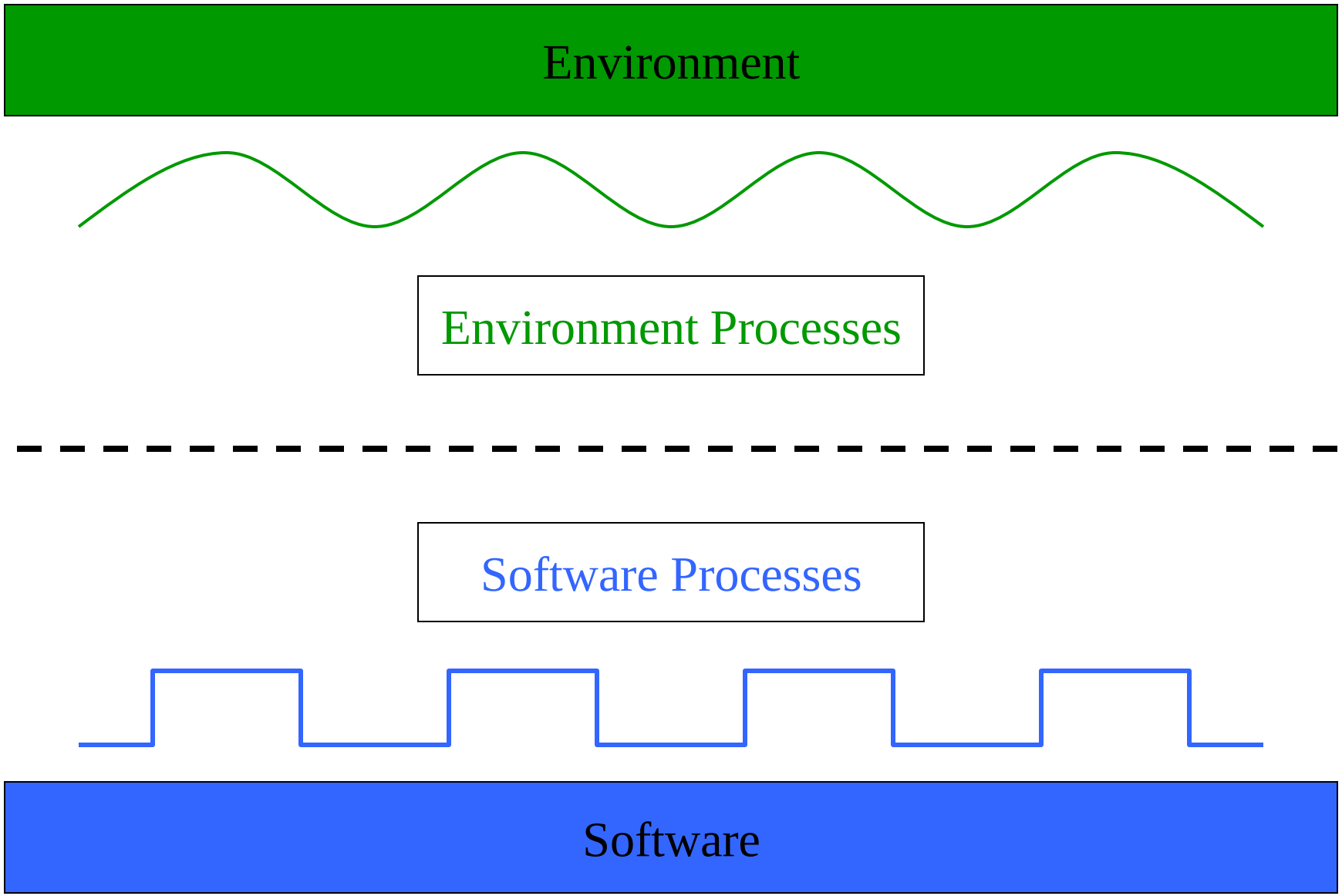
# Multiprogramming



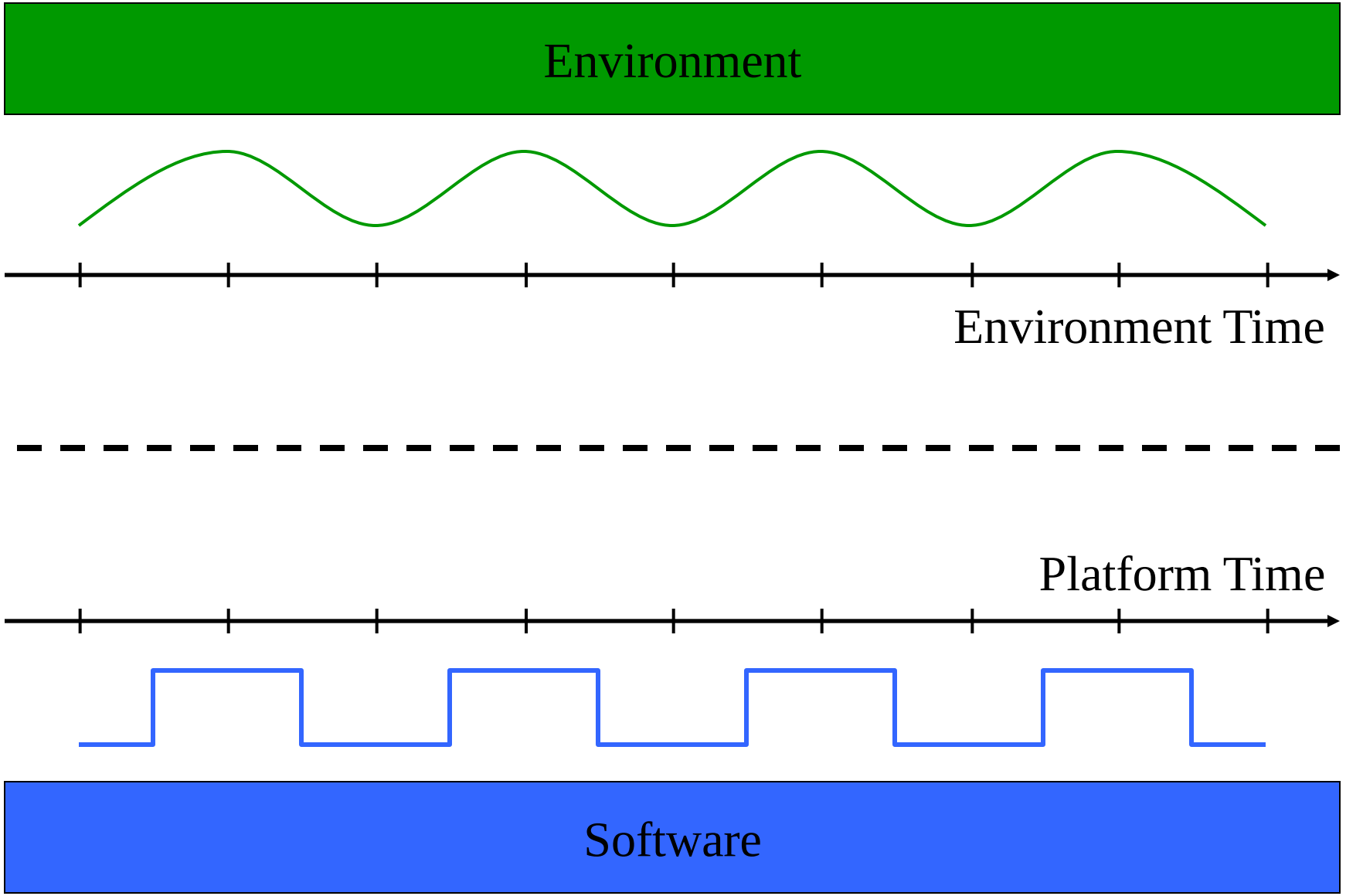
# Real-Time Programming



# Embedded Software



# Environment vs. Platform Time



# The Art of Embedded Programming