Real-Time Systems: Introduction and Demonstration

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FOSSL Open Source Bootcamp: Linux Kernel Development

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Agenda

1. What is Real-Time?
2. Challenges in RT systems
3. Scheduling and Priority-Inversion
4. RT at Integrated Communication Systems Group
5. Demo

What is Real-time?

- System requirements:
  - Result must be correct
  - Result must be available within specified time

- Real-time is about:
  - guarantees and determinism
  - low-jitter and deadlines

- Real-time is not about:
  - high performance
  - low latency

} this is just nice to have

Challenges in RT systems

- RT system design stretches over all components
- If one single components fails
  → complete system might fail

- Components include:
  - CPU and memory management
  - Cache misses
  - Interrupt management
  - I/O devices, DMA
  - ..

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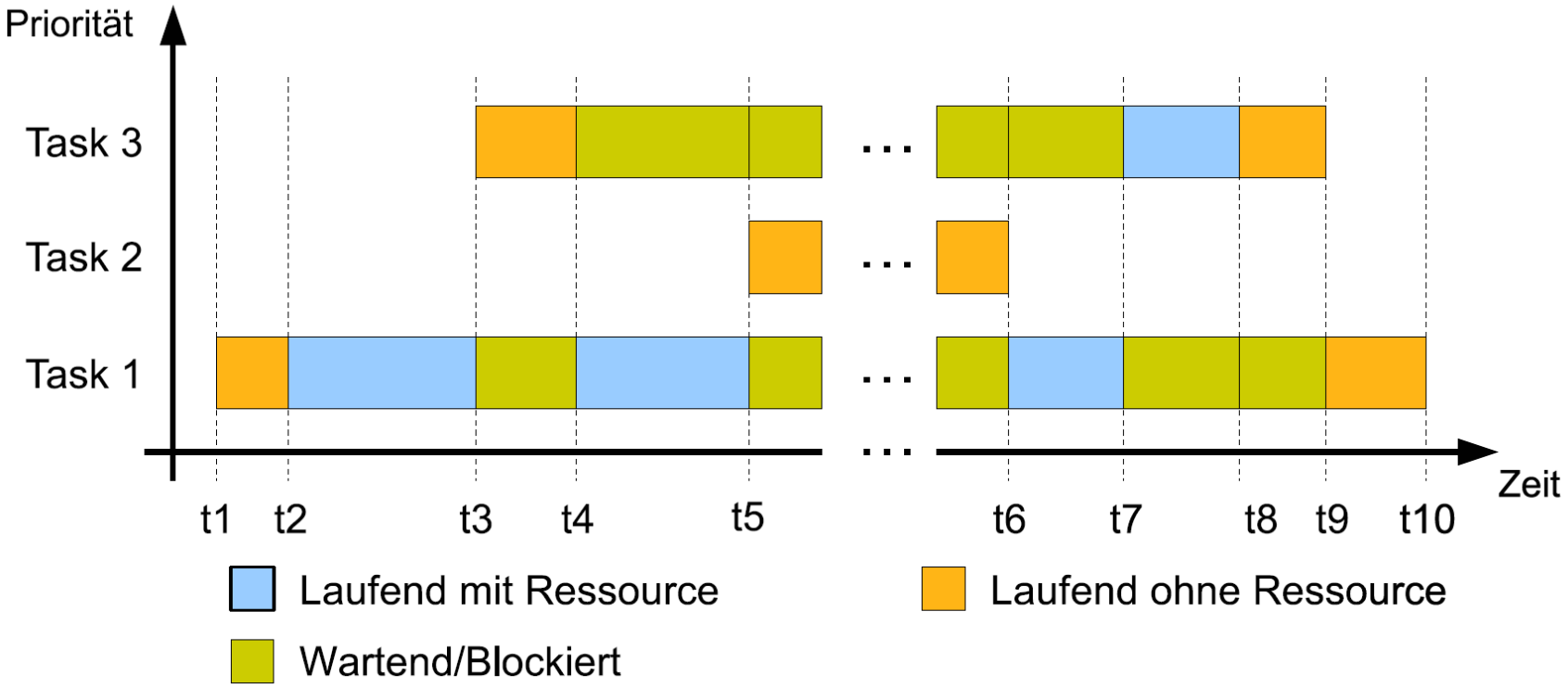
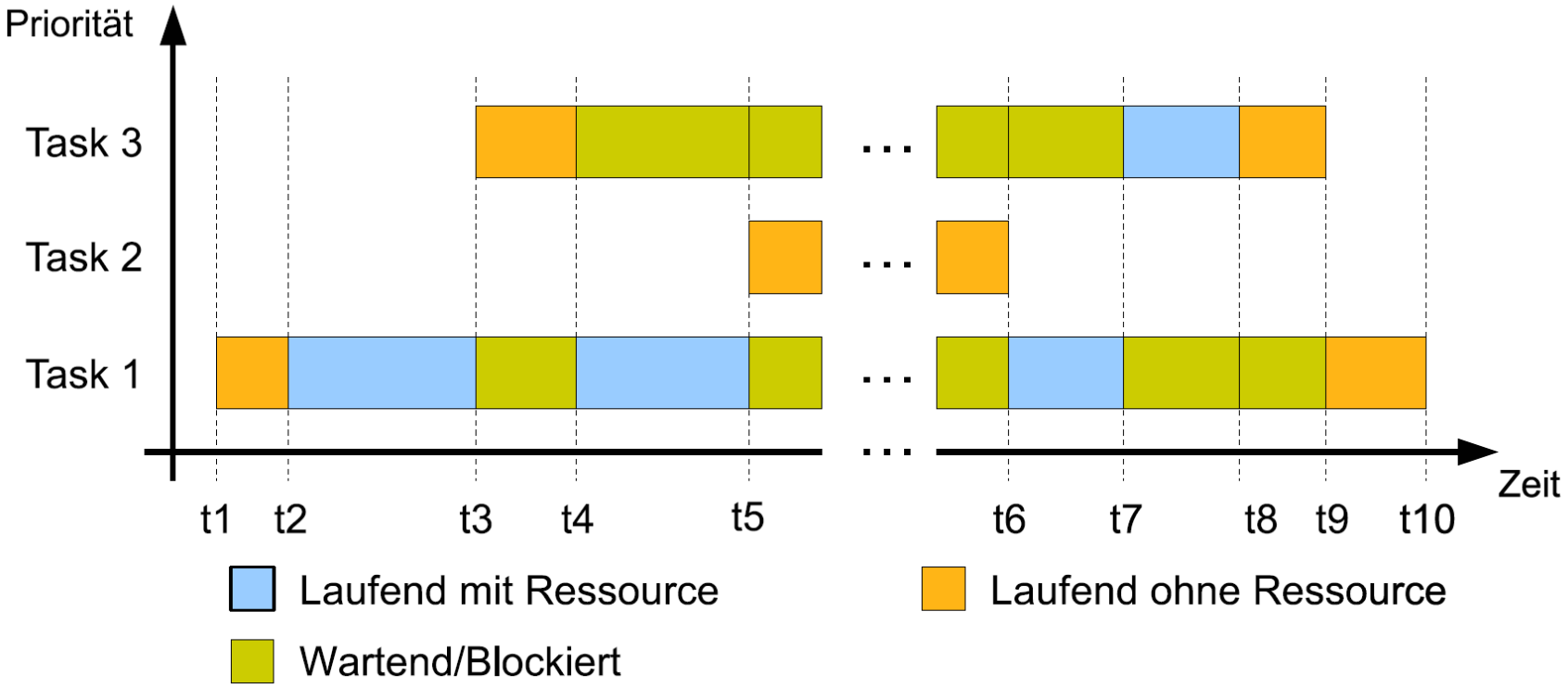
CPU Scheduling

- Purpose?
  - Assign CPU to processes
- How?
  - Priority controlled (unfortunately no deadlines)
  - Pre-emptive
- Problem?
  - Priority-Inversion

Priority Inversion



Priority Inversion



Userspace solution: PI-Futex

Real-time at ICS

- Flight control Quadrocopters:
  - periodically acquires sensor data
  - controls actors

- Cognitive Radio Wireless Communication System:
  - TDMA MAC protocol
  - assumes nodes match slot times of MAC protocol

Demo - Squarewave

- Pseudocode:

```
while true
  - wait for absolute timer
  - toggle IO pin
  - calculate next timer
```

- What is the expected outcome, how does load impact?
  - Non-RT system
  - RT system

[1] https://rt.wiki.kernel.org/index.php/Squarewave-example

Final statement

You got a real-time system? I got a hammer!

Figure by Paul E. McKenney

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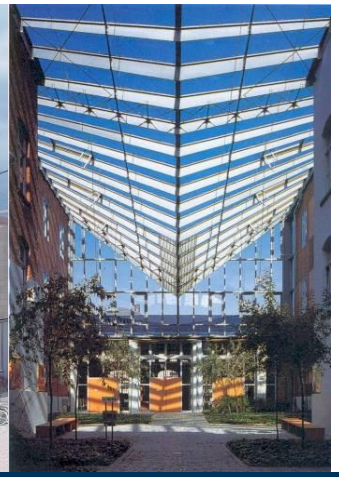

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