Universität Rostock Traditio et Innovatio

Realtime Publish/Subscribe for Cyber-Physical Systems

KSWS VHR / Projekt VHR / NEidI VHR
Underwater Vehicles meet Smart Factory

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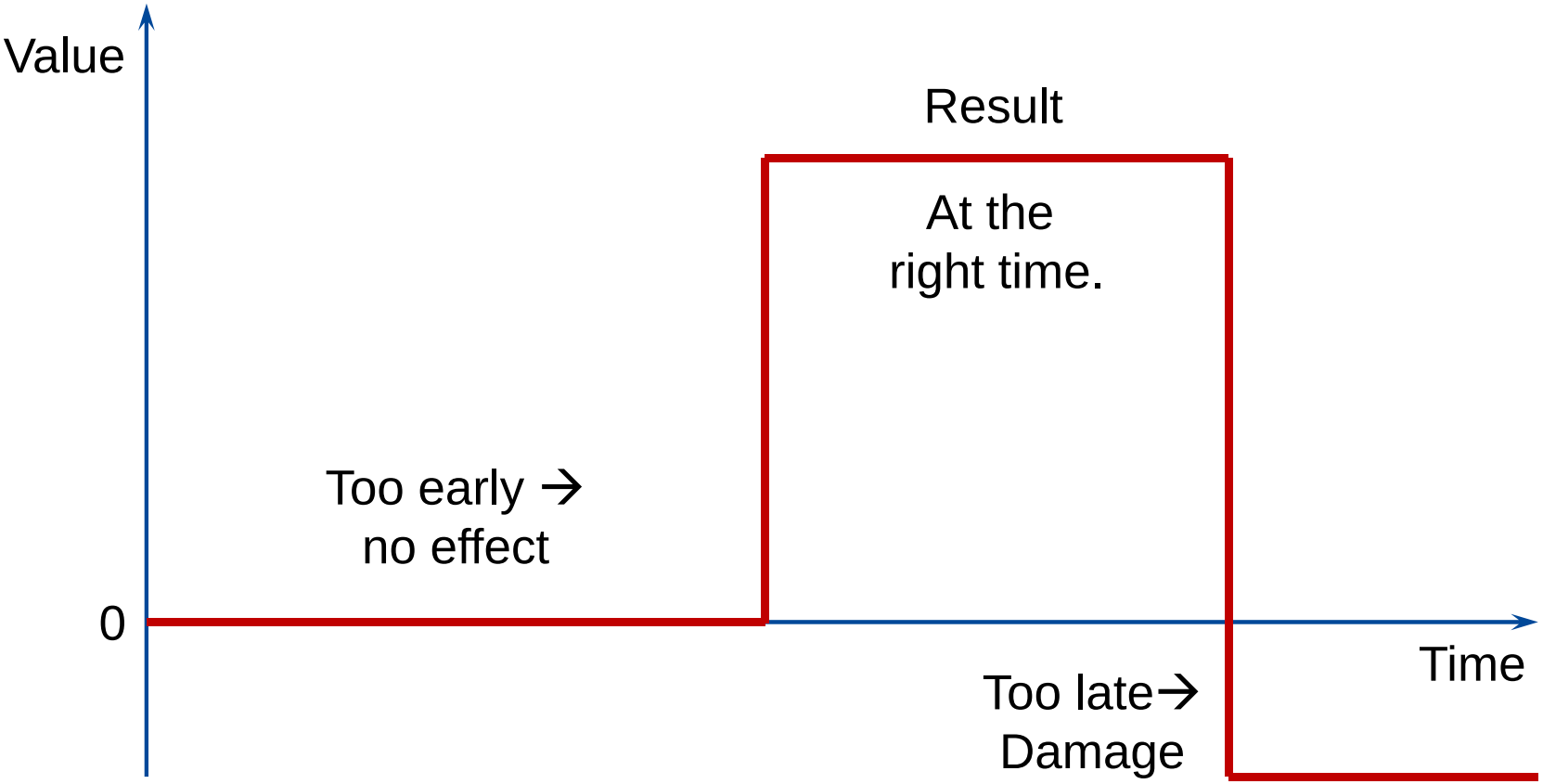
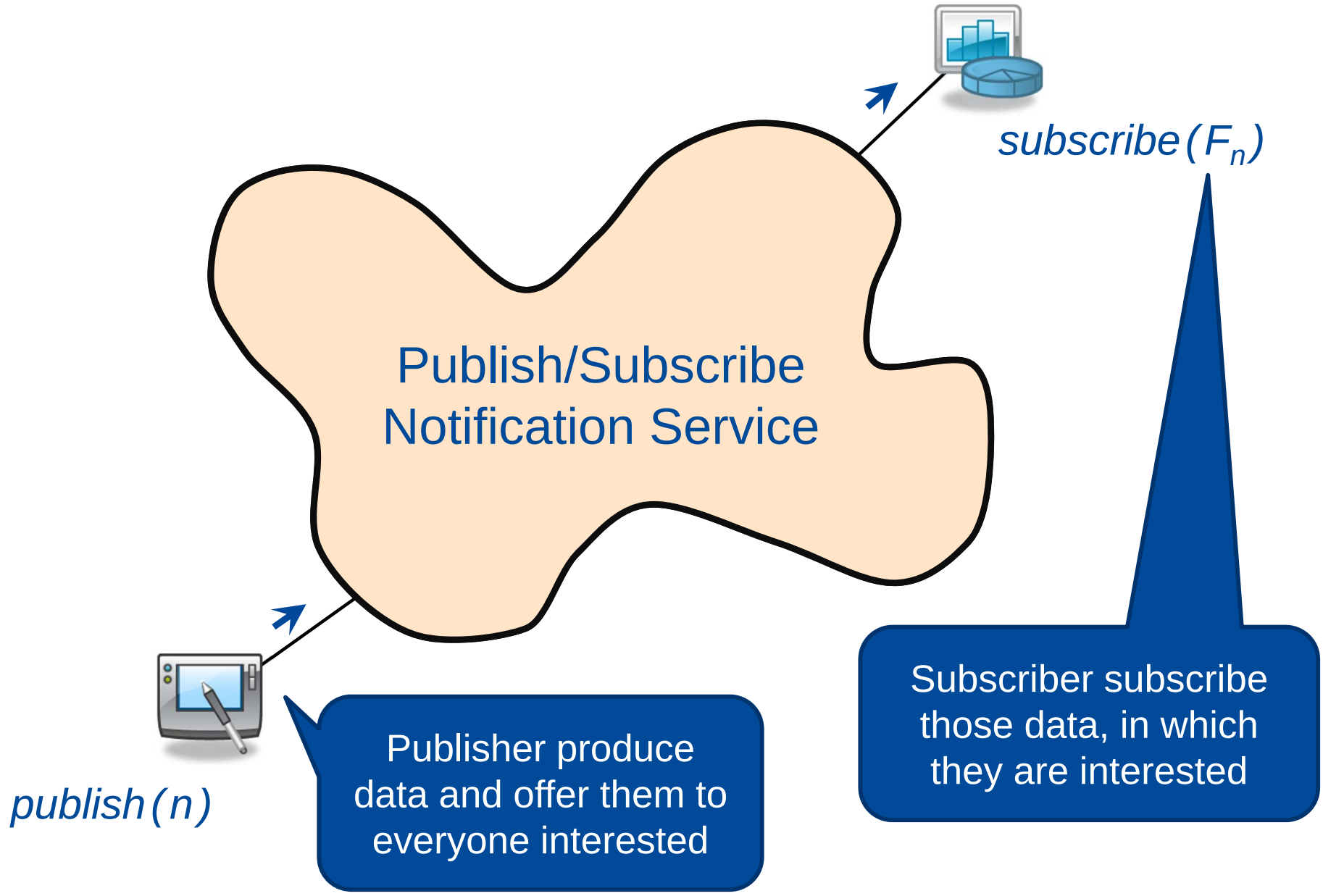
What is Realtime (Echtzeit)?

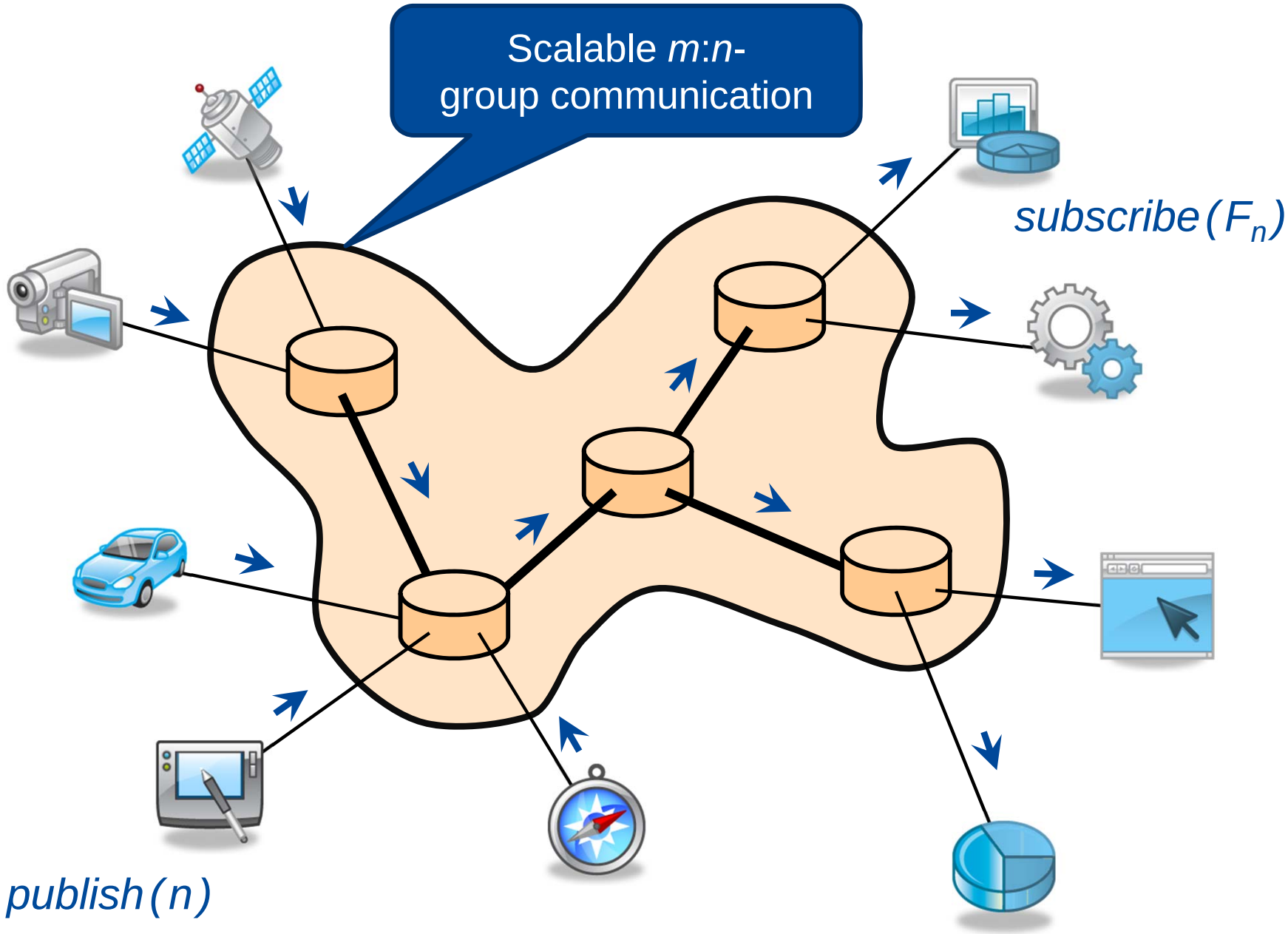


Not neccessarily fast, but predictable!

→ Do the right thing at the right time.

What is Publish/Subscribe?




Scalable m:n-
group communication
subscribe (F_n)
publish (n)

What are Cyber-Physical Systems?

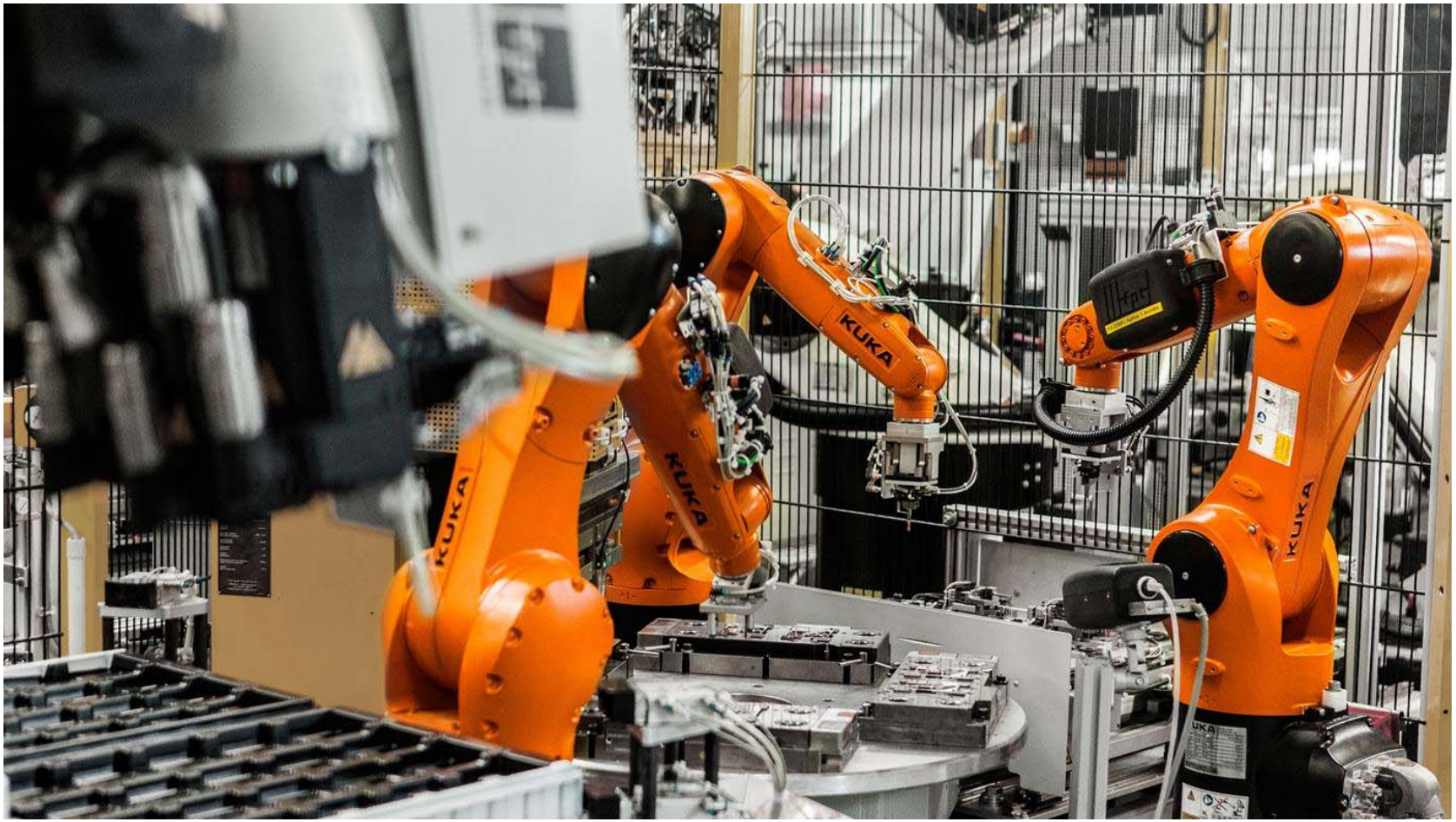
- Systems containing software components and mechanical or electronic parts that are interconnected via network
- Interact with the real, physical world
  → are subject to physical laws
  → have realtime requirements
- Examples
  - Swarm of Autonomous Underwater Vehicles (AUVs) for
    - Maintenance of the foundations of offshore wind turbines
    - Clearance of Unexploded Ordnance (UXO) from WW II
  - Industry robots
    - Production line in the smart factory
    - Reconfigurable production cell of a smart factory

Industry Robots in a Smart Factory

Industry robots made by Kuka

Time-critical communication when handing over work pieces.

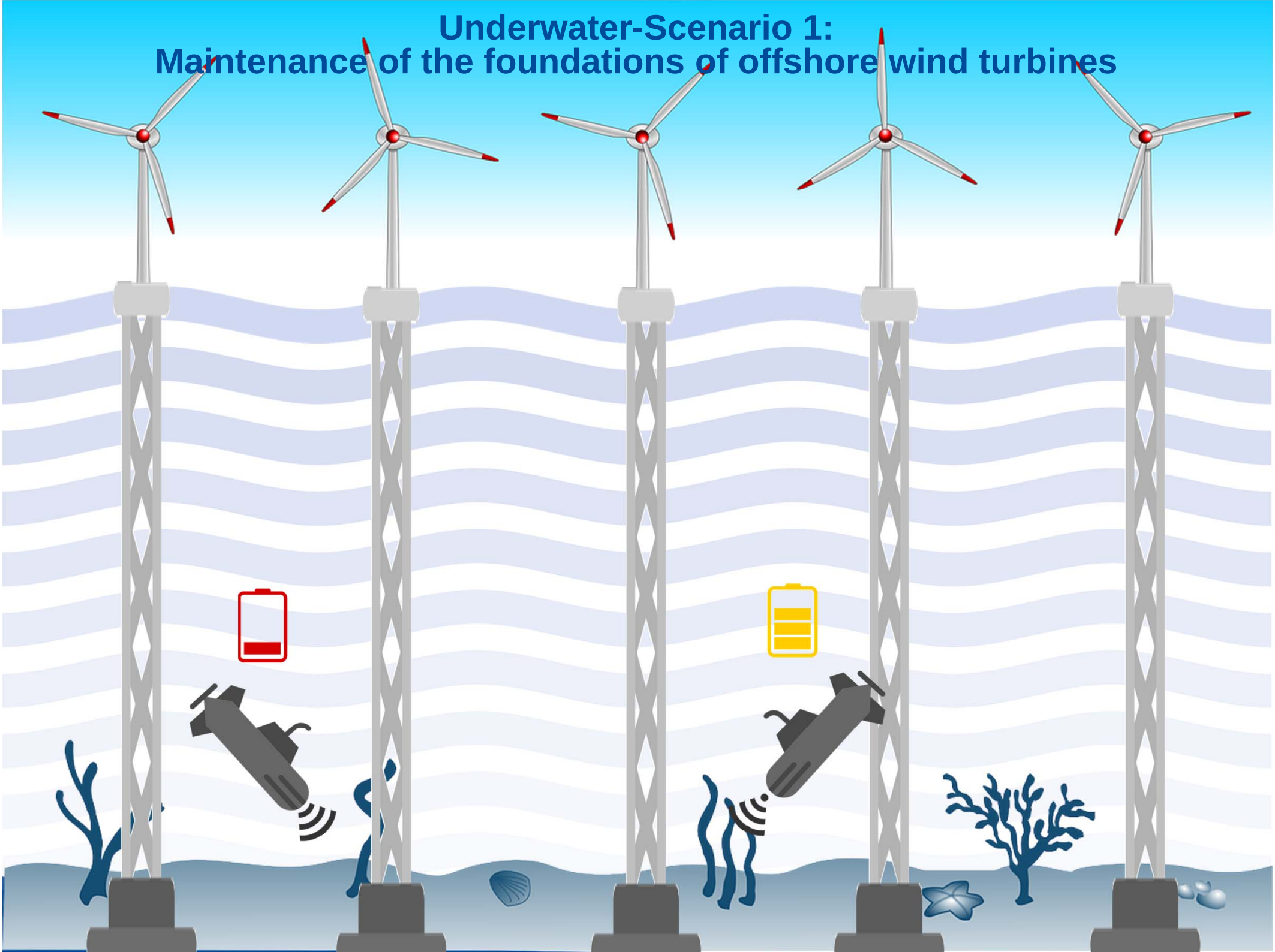
Reconfigurable Production Cell



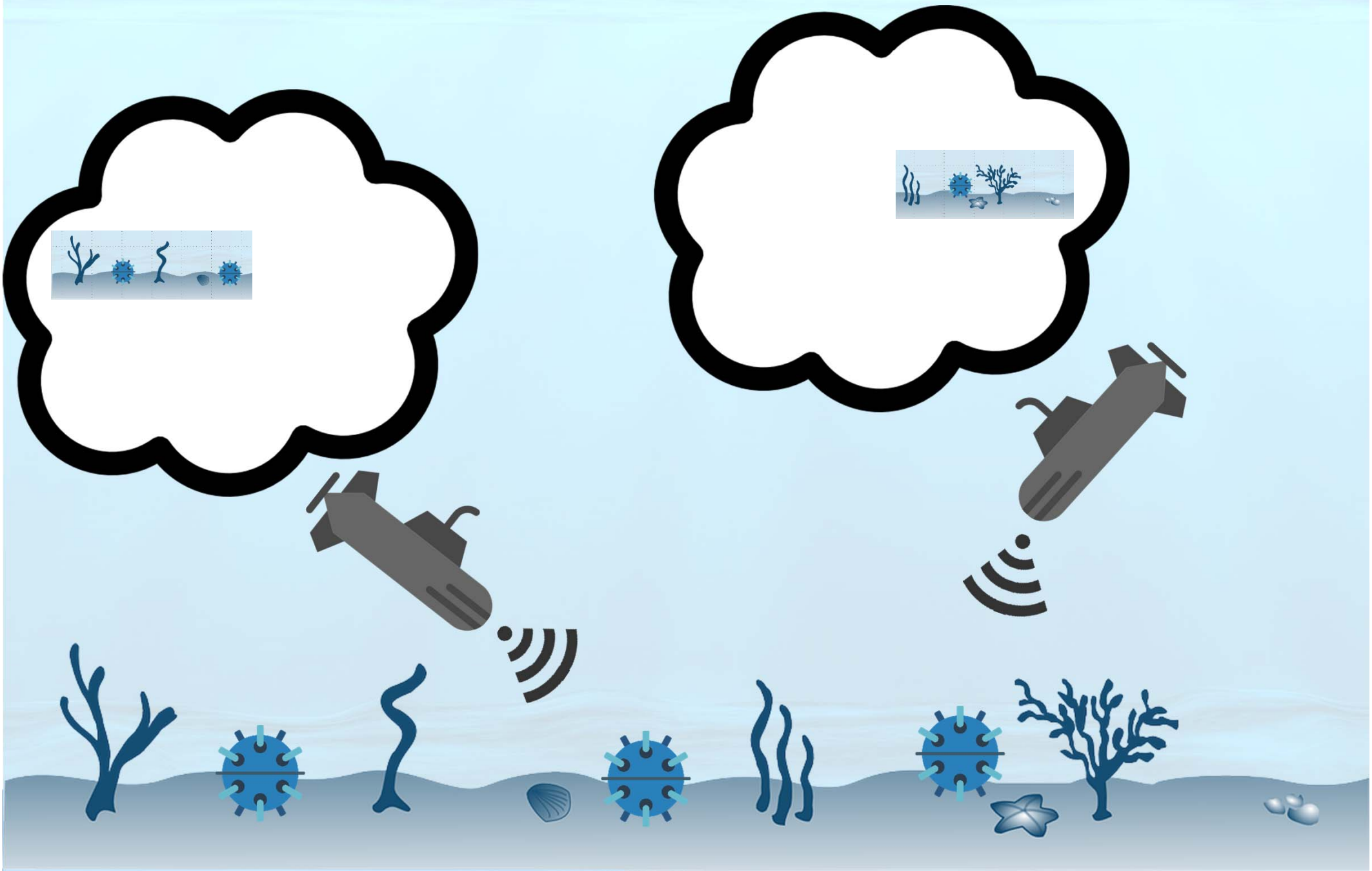
Industry robots made by Kuka

Flexible communication in case of task changes.

Underwater-Scenario 1:
Maintenance of the foundations of offshore wind turbines



Underwater-Scenario 2:
Clearance of Unexploded Ordnance (UXO) from World War II



AUVs und Echtzeit-Kommunikation

- Autonomous Underwater Vehicles (AUVs)
  - Cooperation with the Institute for the Protection of Maritime Infrastructures, Resilience Department of Maritime Systems, German Aerospace Center (DLR) Bremerhaven
  - Cooperative navigation of several AUVs
  - Limited Energy restricts movement and usage of sensors
  - Opportunistic communication via acoustic modems
- Realtime publish/subscribe communication
  - Part of a DFG project (VHR, AVA und IMD)
  - Planning of flexible communication patterns and reservation of required time slots on communication links
  - Estimation of the worst case runtime for publishing and filtering (content-based if necessary) a notification
  - Application scenario within a smart factory

Tasks: Autonomous Underwater Vehicles

- Cooperative navigation of several AUVs
  - Implementation of motion models
  - Implementation of localization algorithms
- Energy consumption caused by motion and activated sensors
  - Implementation of models for energy consumption for movement and activated sensors
  - Implementation of models for energy consumption for image processing algorithms
- Opportunistic communication via acoustic modems
  - Implementation of realistic underwater communication
- Implementations using Simulator OMNeT++ and C++
  - Python for scripting and evaluation of simulation results
- Realtime platform for prototyping
  - Evaluation of suitability of Linux with Preempt-RT-Patch and RTAI-Linux with user space extension

Tasks: Realtime Publish/Subscribe

- Data models and filter models
  - Design of suitable data models
  - Design of corresponding filter models
  - Prototypical implementation (probably) in C
- Realtime properties
  - Estimation of Worst Case Execution Time (WCET)
  - Scalability analysis (#Filter, #Daten, #Subscriber)
  - Test/measurement of implementation
- Realtime platform for prototyping
  - Evaluation of suitability of Linux with Preempt-RT-Patch and RTAI-Linux with user space extension

Organizational Matters

- Two teams with up to five persons each
  - Team A: Autonomous Underwater Vehicles
  - Team B: Realtime publish/subscribe
- Design methodology
  - Agile development
  - Three milestones w.r.t. design, implementation, documentation

Type and size/scale of tasks depends on number and interests of participants!

Registration and Contact

- Enrollment in respective Stud.IP course

1. 23850 (Vorlesung) KSWS: Verteiltes Hochleistungsrechnen
2. 23848 (Vorlesung) Neueste Entwicklungen der Informatik (Verteiltes Hochleistungsrechnen)
3. 23851 (Projekt) Projekt: Verteiltes Hochleistungsrechnen

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  - helge.parzyjegla@uni-rostock.de