Universität Rostock

Traditio et Innovatio

Realtime Publish/Subscribe for Cyber-Physical Systems

KSWS AVA / Projekt AVA / NEidI VHR

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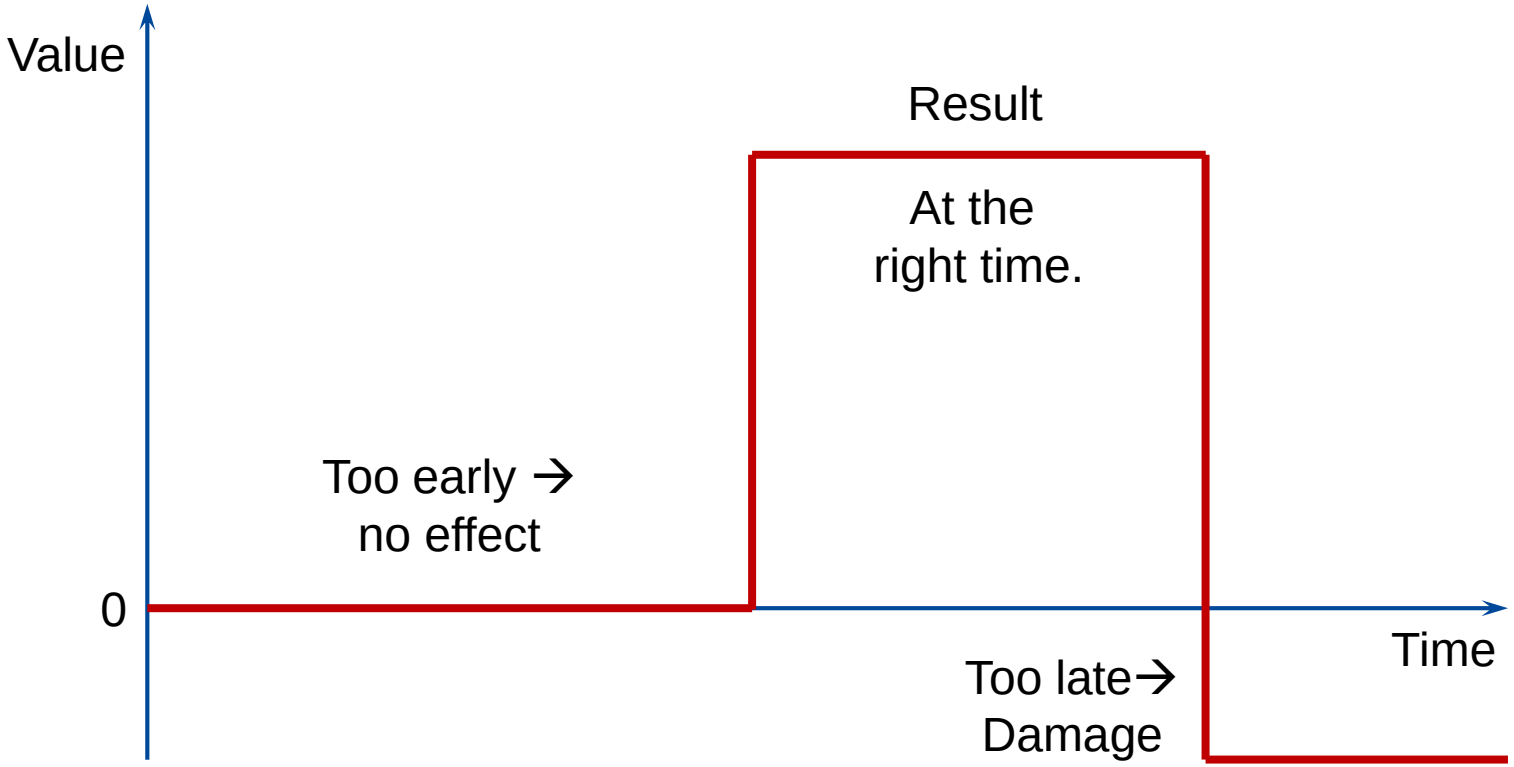
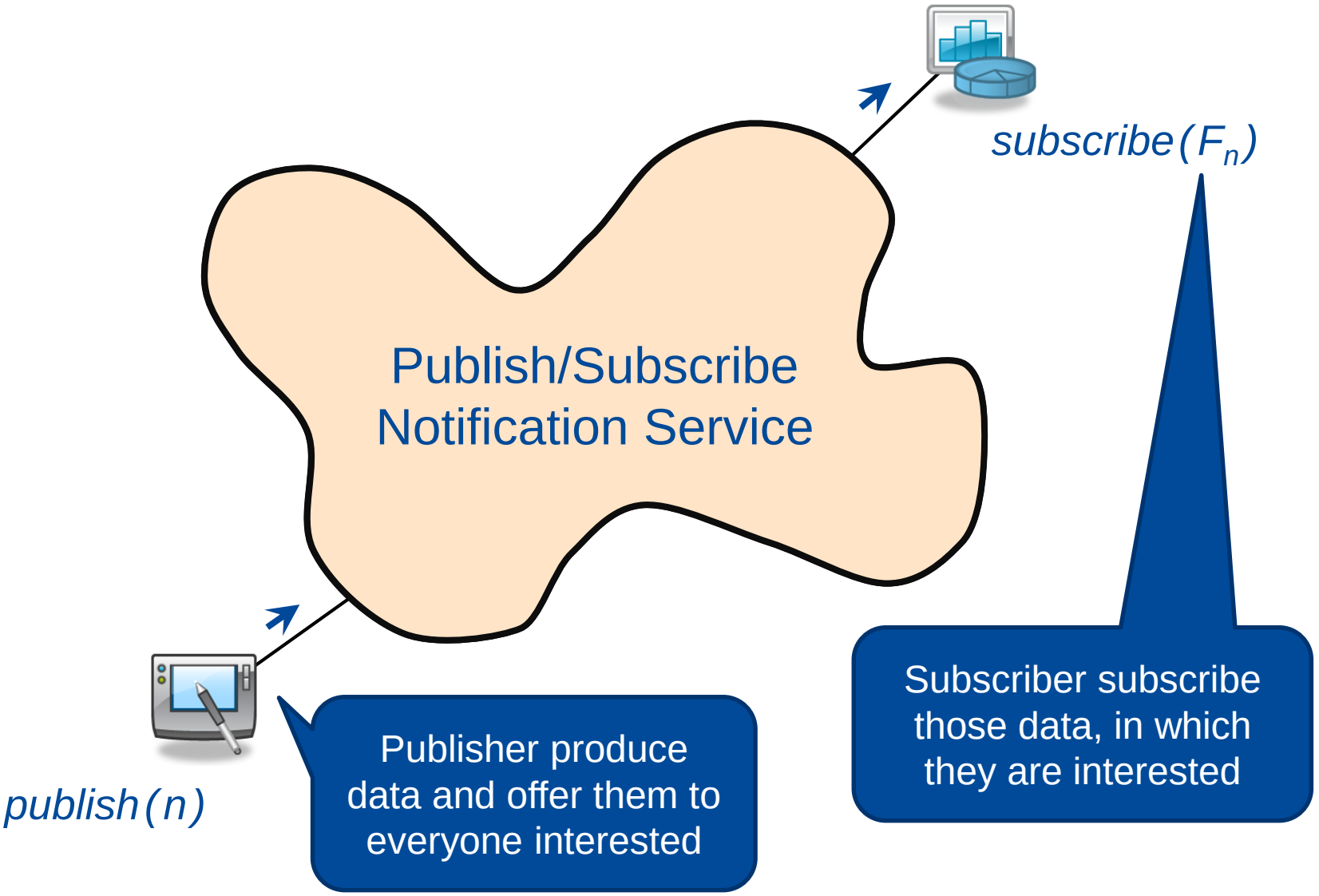
What is Realtime (Echtzeit)?

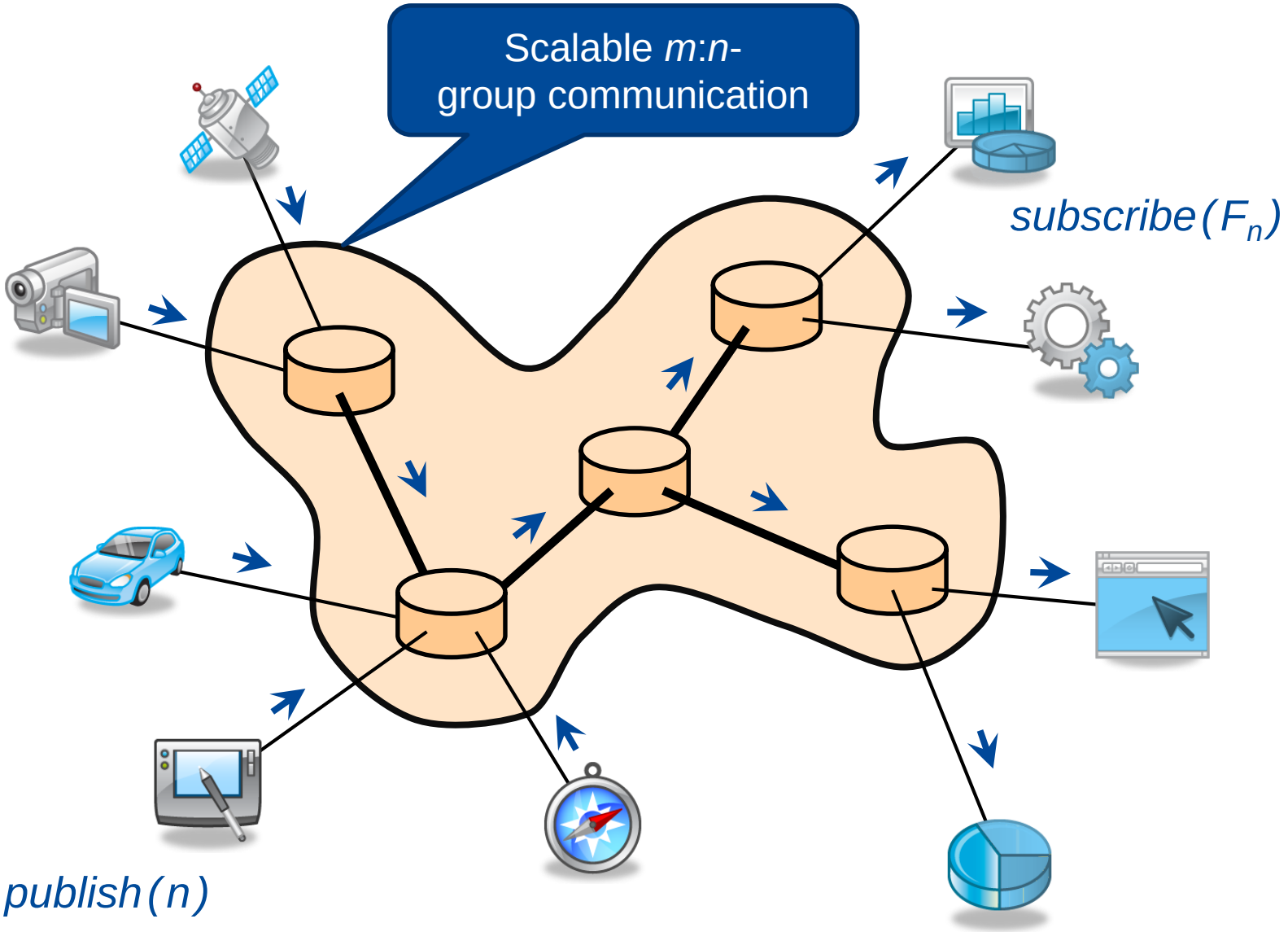


Not neccessarily fast, but predictable!

→ 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?

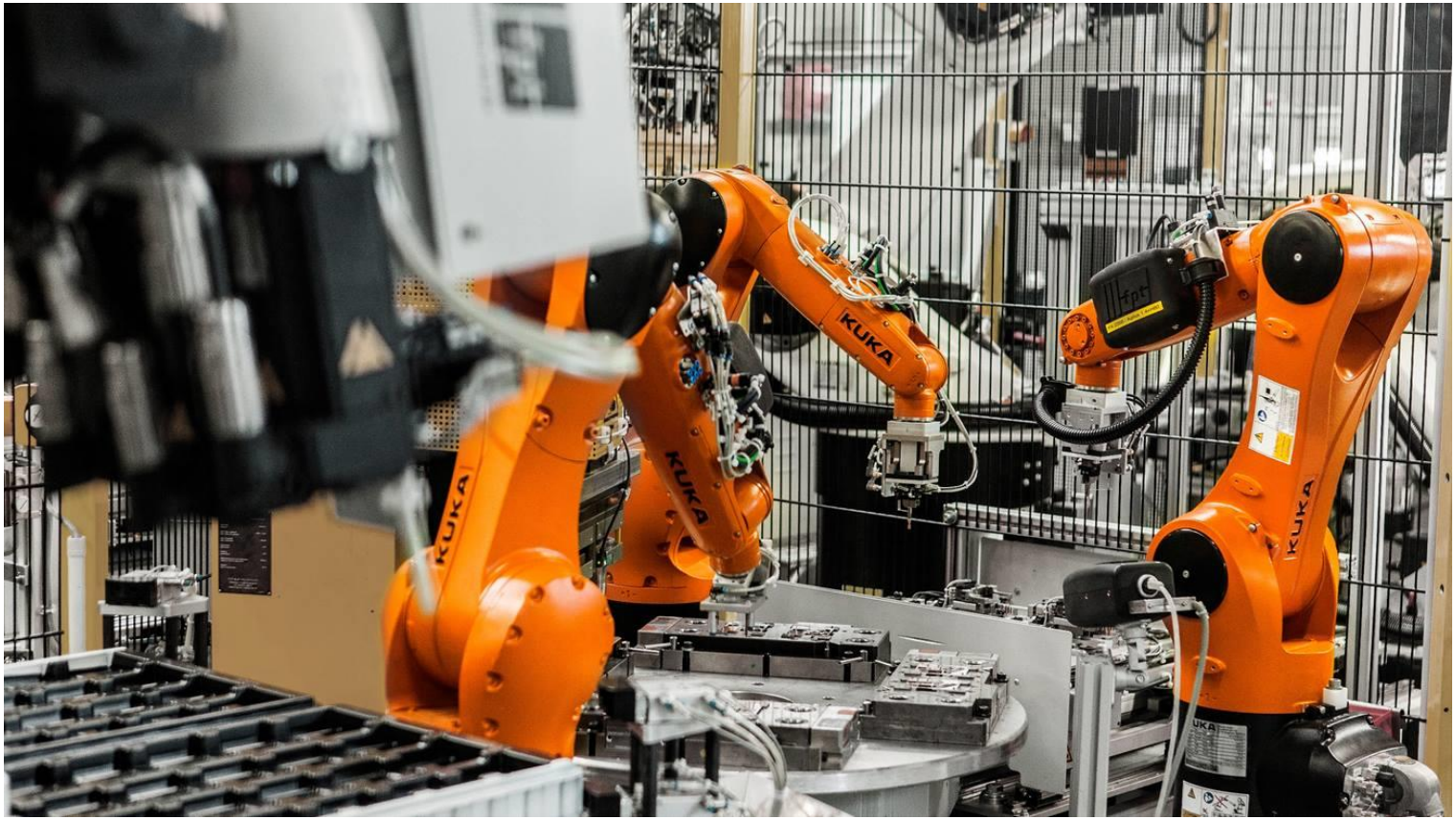
- Systems containing software components and mechanical or electronic parts that are interconnected via network
- Interact with the real, physical world
  → are subject to physical laws
  → have requirements w.r.t (real) time
- Examples
  - Industry robots
    - Production line in the smart factory
    - Reconfigurable production cell of a smart factory
  - Modern (autonomous) vehicles
    - Steer/fly by wire
    - Autopilots of any kind

Industry Robots in a Smart Factory

Industry robots made by Kuka

Time-critical communication when handing over work pieces.

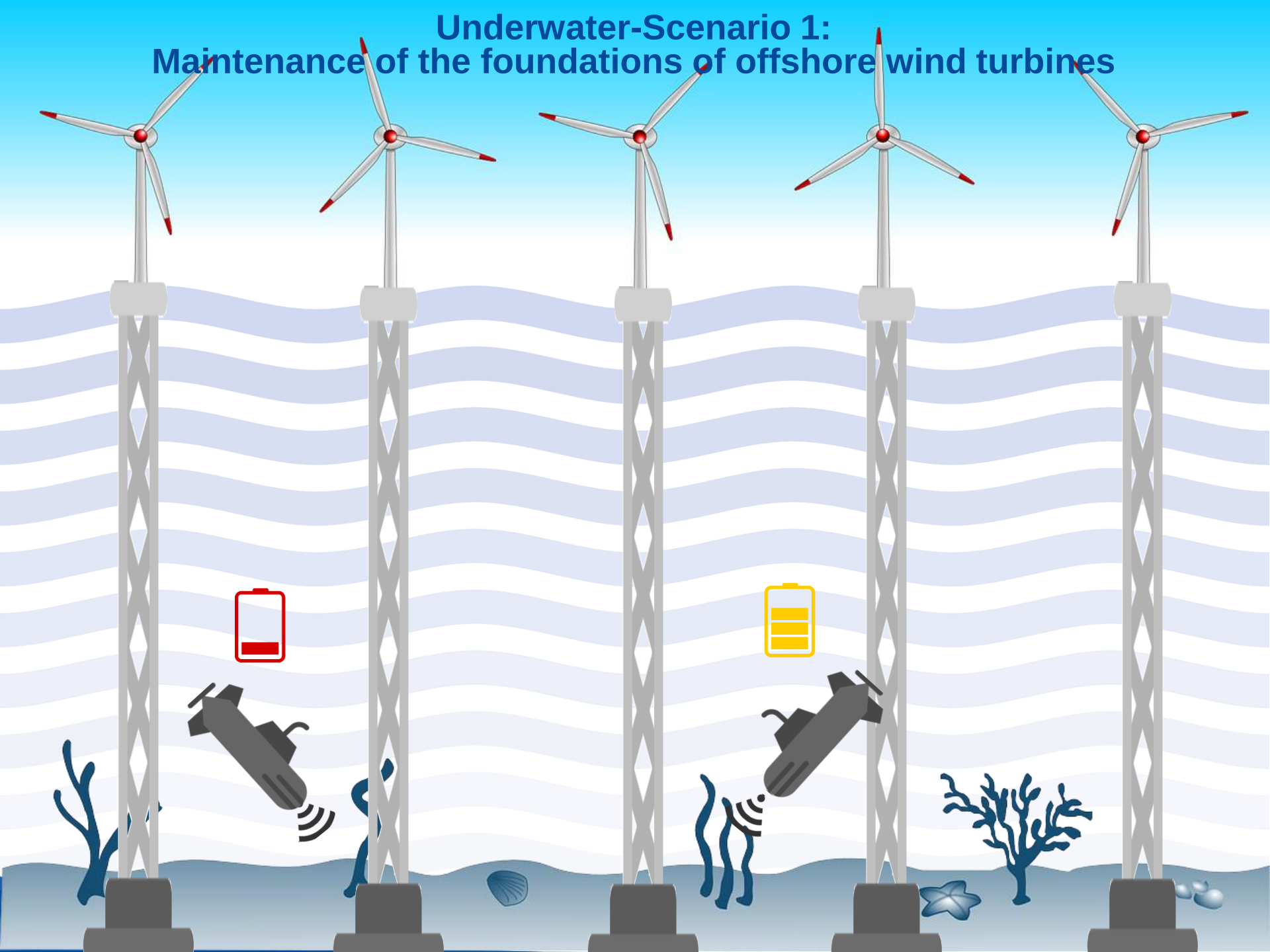
Reconfigurable Production Cell



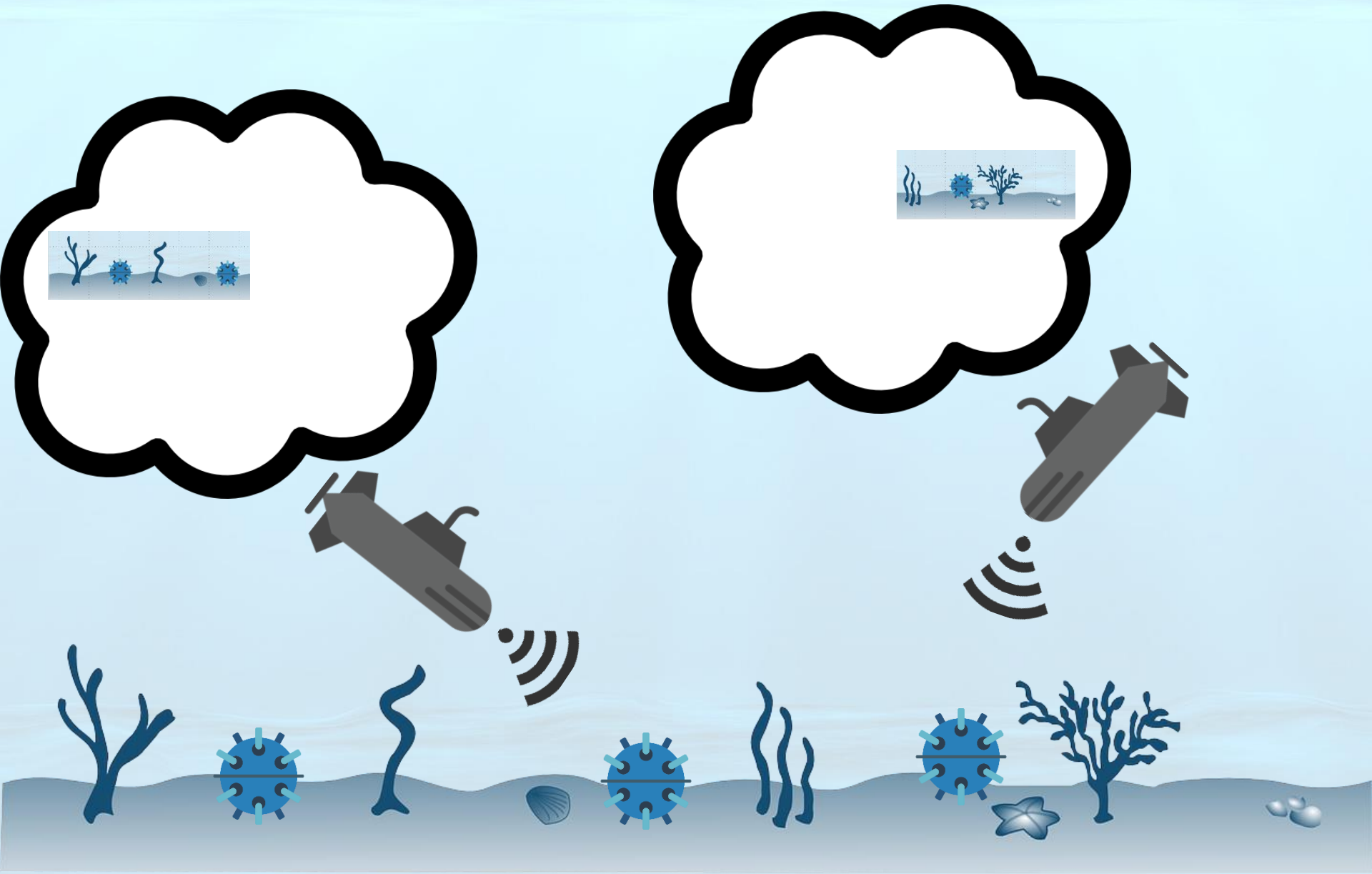
Industry robots made by Kuka

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



Projects and Collaborations

- Realtime publish/subscribe communication
  - Part of a DFG project
  - Planning of flexible communication patterns and reservation of required time slots on communication links
  - Formal models and methods for scheduling
  - Estimation of the worst case runtime for publishing and filtering (content-based if necessary) a notification
  - Application scenario within a smart factory
- 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

Tasks: Realtime Publish/Subscribe

- Simulation models for realtime communication (TSN standards)
  - TSN configuration (IEEE 802.1Qcc)
  - Time synchronization (IEEE 802.1AS)
  - Controlled timing (IEEE 802.1Qch)
  - Reliable communication (IEEE 802.1Qca, IEEE 802.1Qci)
  - Test/extension of the new TSN features of OMNeT++/INET
- TSN controller (CUC and CNC)
  - Implementation of TSN configuration option (IEEE 802.1Qcc)
  - Based on Ryu framework for SDN controller
  - Integration of a trivial planning component
- Development and test platform for prototypes
  - Scripts for configuring TSN switches
  - Generators for test data
  - Management tools for different purposes

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

Organizational Matters

- Up to two teams
  - Team A: Realtime publish/subscribe
    (probably more fine-grained distribution of tasks)
  - Team B: Autonomous Underwater Vehicles (AUVs)
- 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

- Enrolement in respective Stud.IP course

1. 23846 (Lecture) KSWS: AVA
2. 23848 (Lecture) Neueste Entwicklungen der Informatik (Verteiltes Hochleistungsrechnen)
3. 23847 (Project) Projekt: AVA

- Questions via email to Peter Danielis and Helge Parzyjegla
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  - helge.parzyjegla@uni-rostock.de