Distributed and Sensor Based Spatial Data Infrastructure for Dike Monitoring

FIG Working Week 2016

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Recovery from disaster

Dr.-Ing. Ralf Becker, RWTH Aachen University

Geodetic Institute - Chair for Computing in Civil Engineering & GIS

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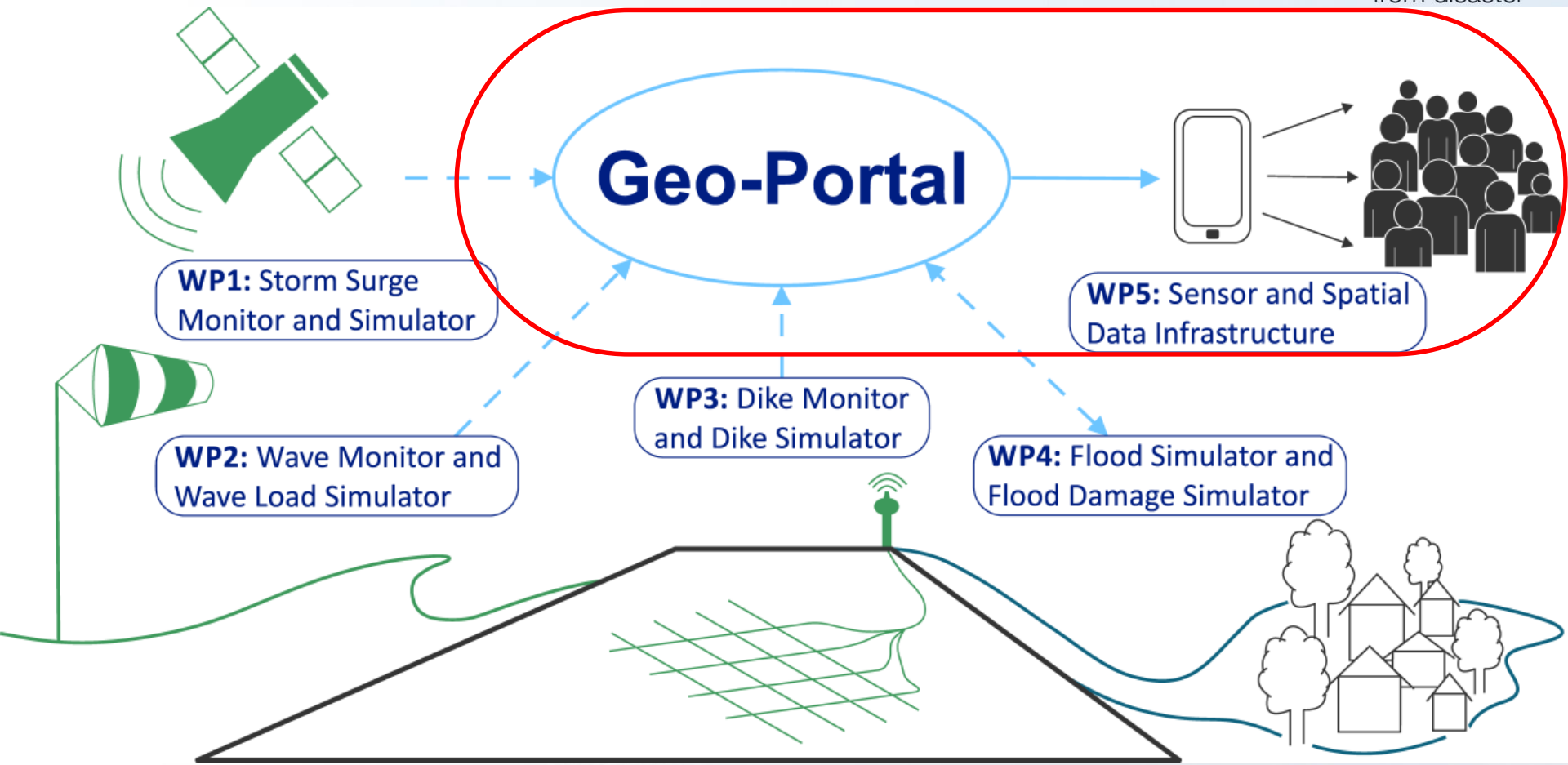
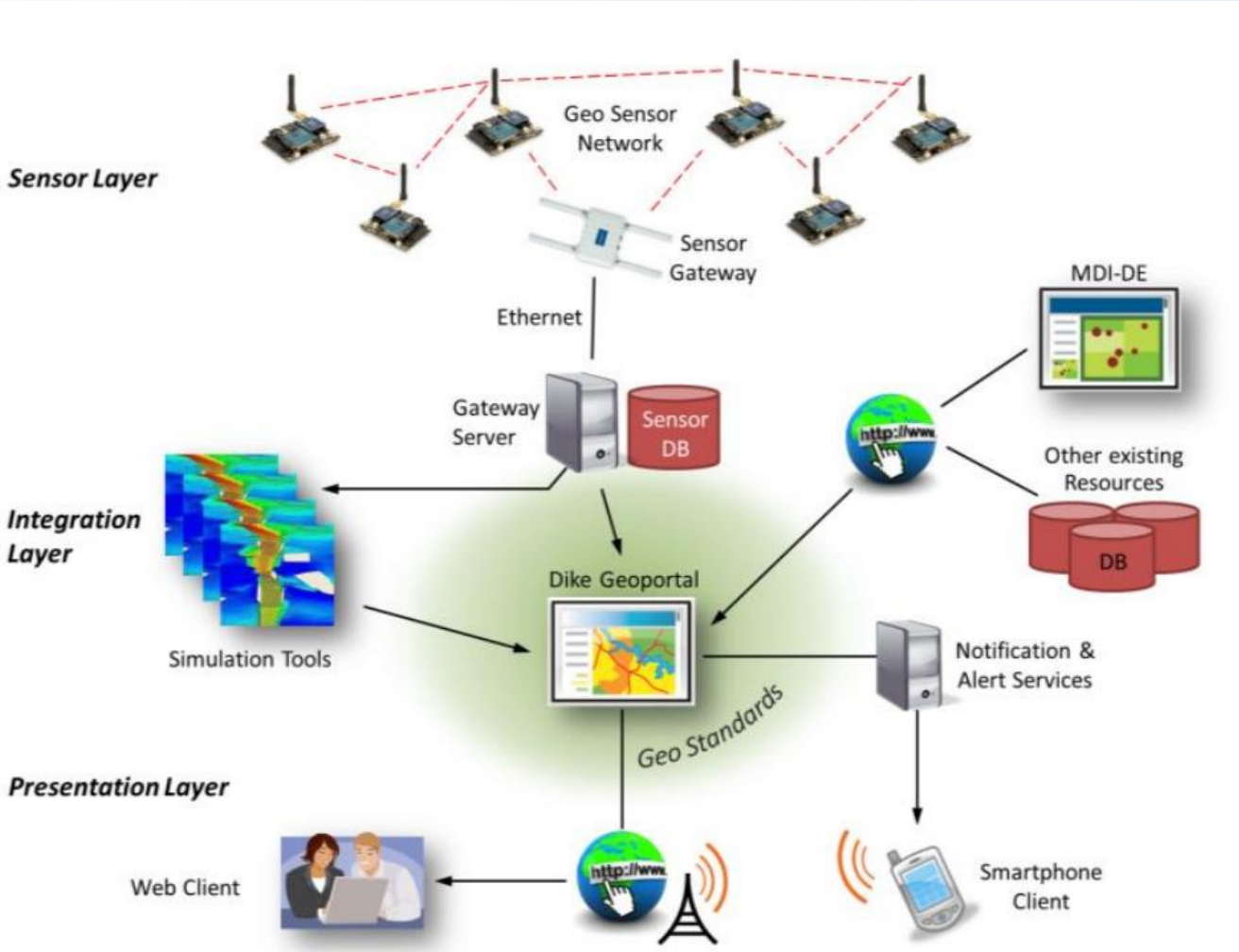
- 12.000 km² protected by more than 1,200 km of sea dikes
- 2,400,000 people endangered
- more than 10 Billions of Euro value in the city of Hamburg
  more than 48 Billions of Euro value in Schleswig-Holstein

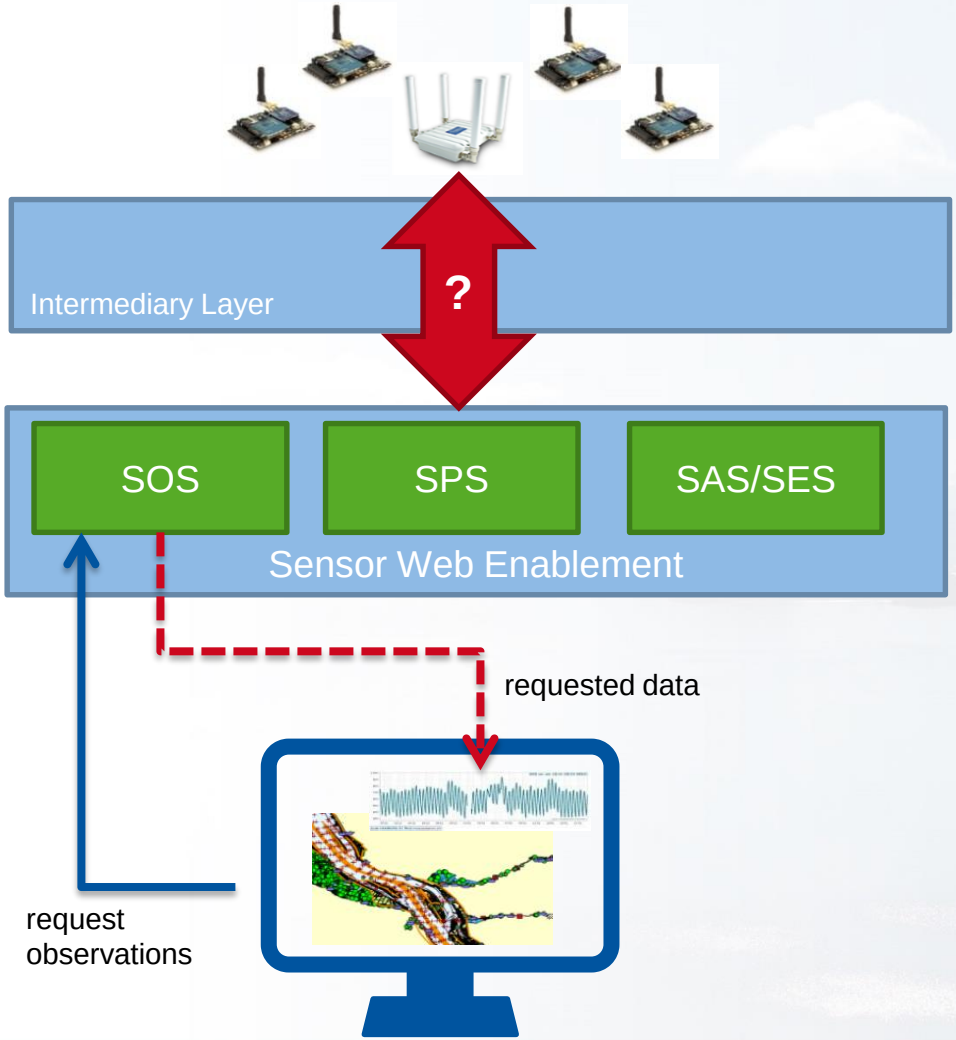
- Current early warning systems are only based on
  water level observations and
  water level predictions

- Current early warning systems
  do not take into account:
  - wind-induced waves
  - currents
  - resistance of coastal dikes



- " …aim is to develop a Sensor and Spatial Data Infrastructure (SSDI) for early warning…"
- "In order to ensure interoperability thereby international standards from geo information science defined by INSPIRE of the European Union and the OGC are adapted."
- "…interoperable access of sensor data is accomplished by using data types and services of the SWE initiative, e.g. Sensor Observation Service (SOS)…"



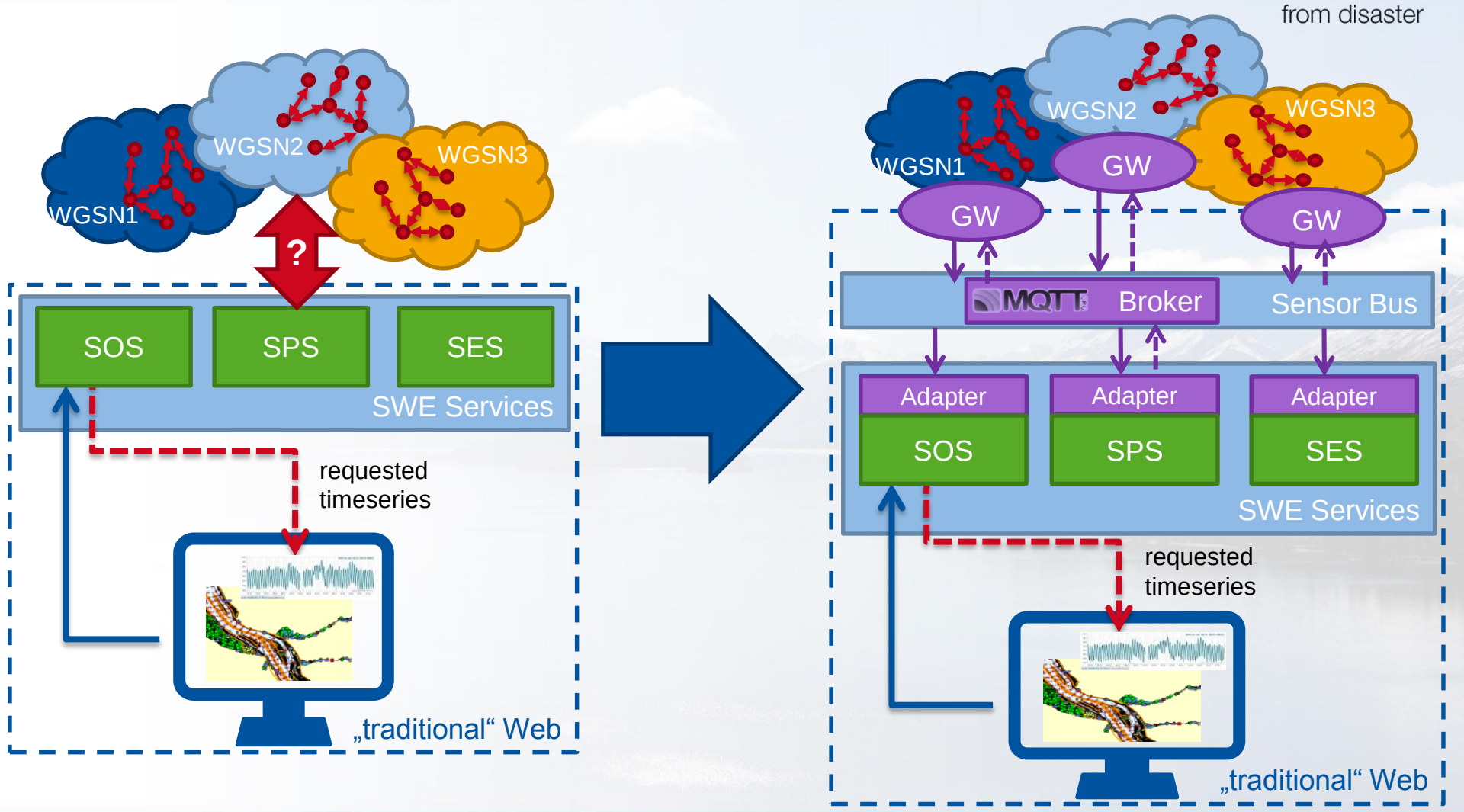


- Wireless Geo Sensor Networks (WGSN)
  - Waspmote = Arduino clone & gateway
  - Low-level protocol:
    - ZigBee (connectionless protocol)
    - Proprietary data format
- OGC Sensor Web Enablement (SWE)
  - Different standards for discovering, accessing and using sensors and sensor data repositories via the Web
  - High-level protocols:
    - TCP/IP
    - XML documents for transfer

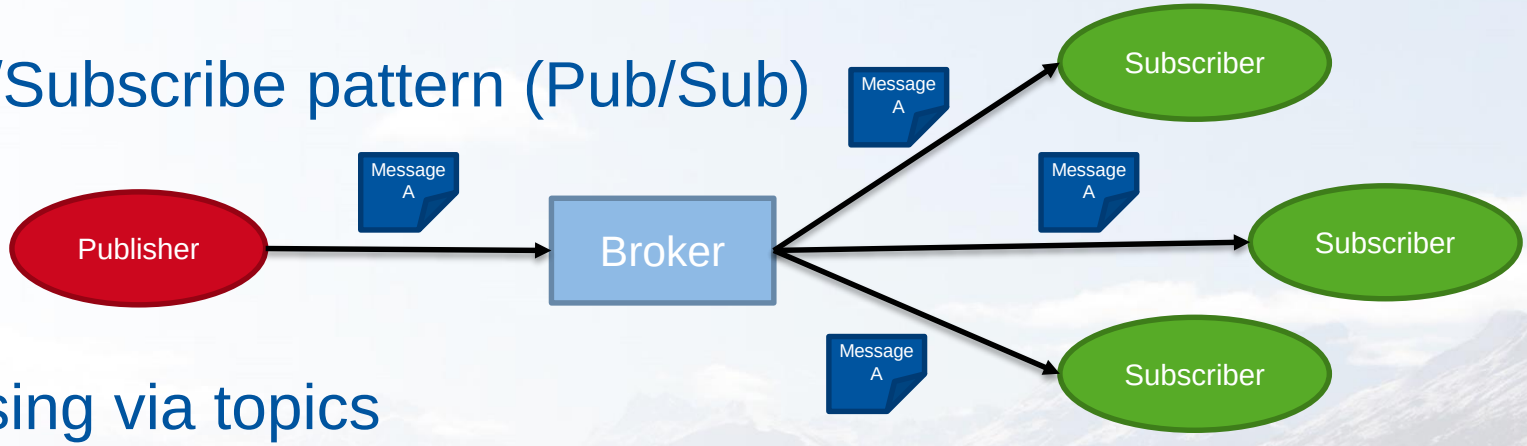
→ Solution: Introducing a **Sensor Bus** (Broering, Foerster & Jirka 2010)

- Push-based technology instead of Pull (or Poll)

Recovery from disaster



- Publish/Subscribe pattern (Pub/Sub)



- Addressing via topics
  - Subscribe to topics – topic-hierarchy with „/“:

  → sensor_node/id_2/temperature

  - Wildcards
    - „+“: single level wildcard → sensor_node/+/temperature
    - „#“: multi level wildcard → sensor_node/id_2/#
- MQTT-SN for connectionless transmission → ZigBee

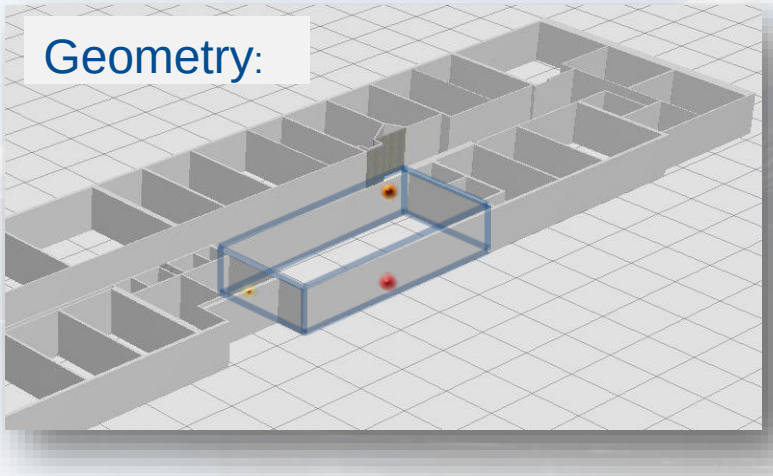
- Based on MQTT but introduces temporal & spatial filter
- Subscription:

Topic:
- node/+/air_temperature

Temporal:
- Start: 0 0 8 ? * SAT
- Intervall: 120 min.

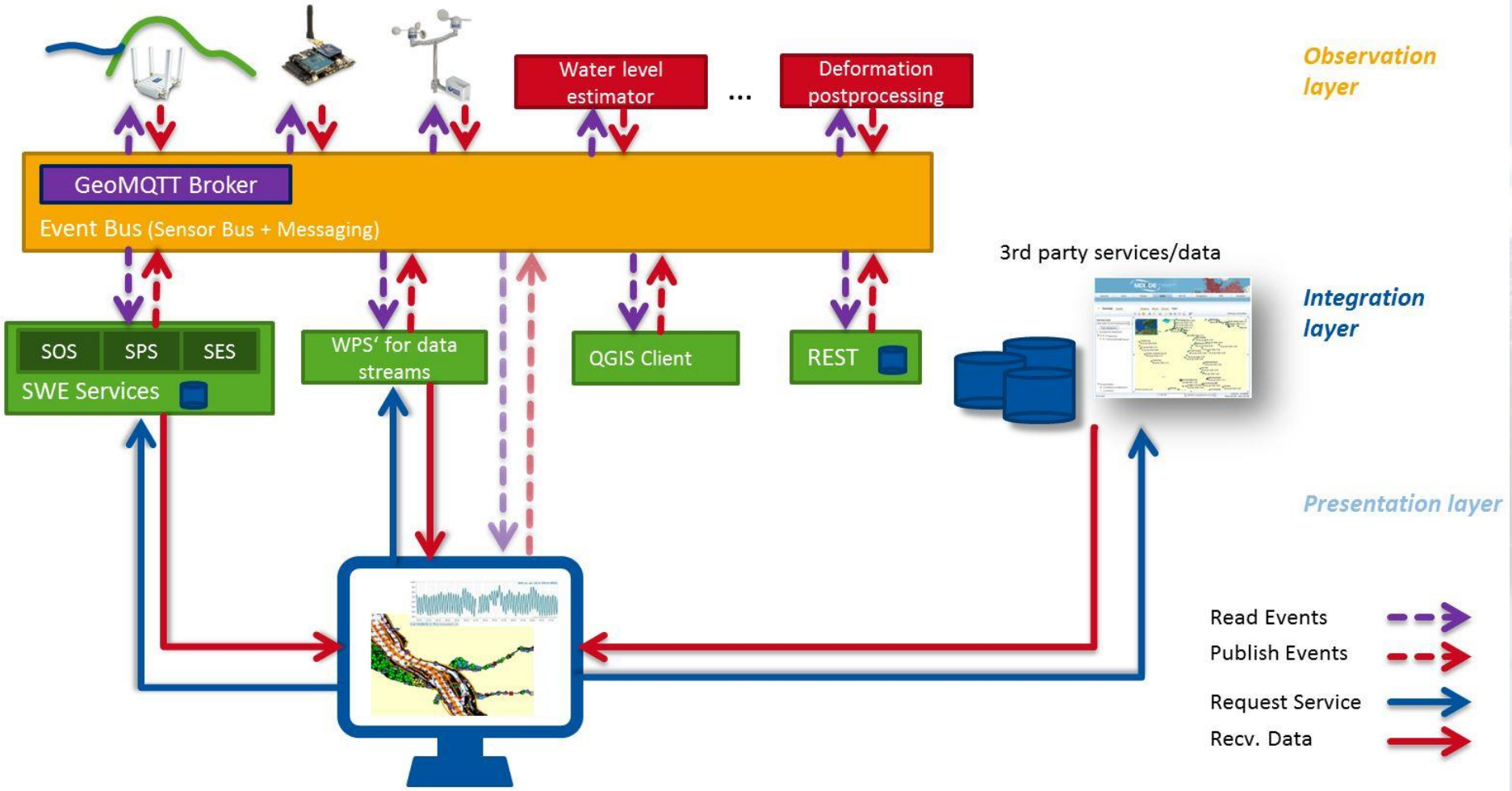
→Every Saturday morning from 8-10 AM

Geometry:

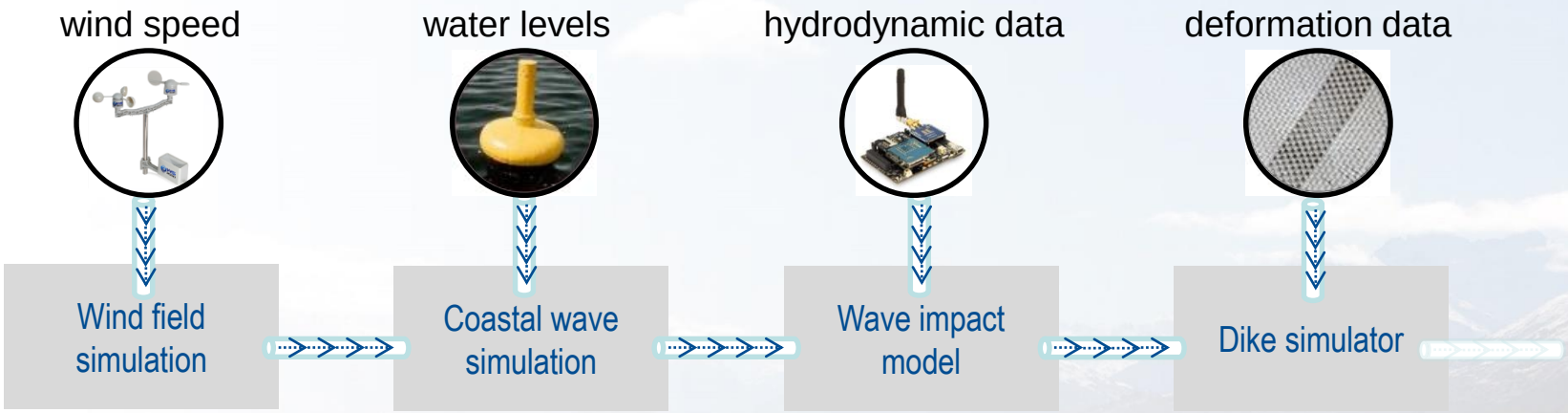


- GeoPublish Message:

(2015-09-22T11:21+*00:00;* 50.77906 6.06799; node/2/air_temperature; …)

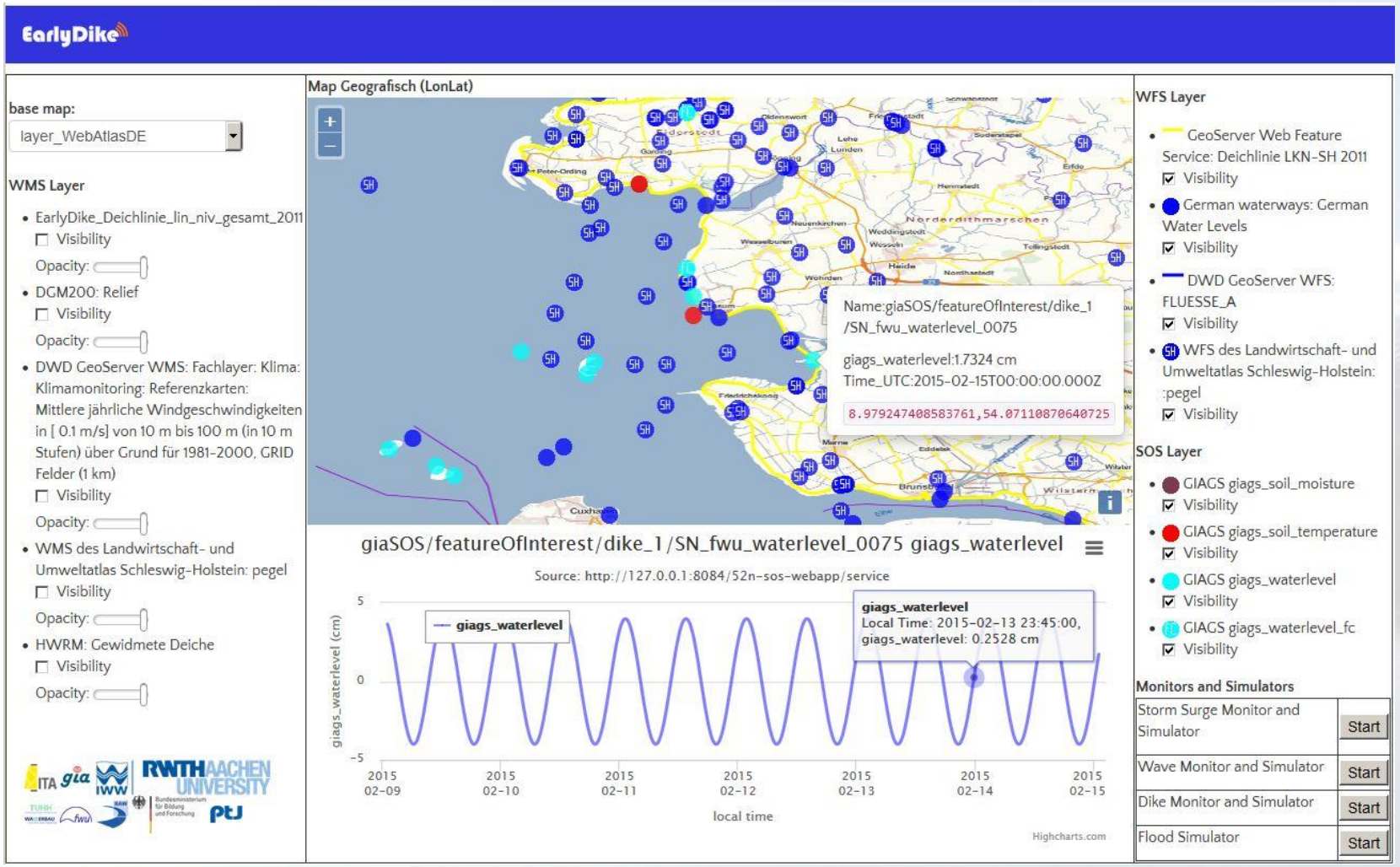


- Event-driven process chains (e.g. threshold)



- User-driven process chains

→ „Streaming“ Web Processing Service (WPS)



- „EarlyDike“ is an innovative real-time early warning system for dike breaches with a sophisticated sensor and spatial data infrastructure (SSDI)
- MQTT is extended to a GeoMQTT
- Event Bus and Process chains enable complex spatial workflows from data measuring till visualization in real-time
- Dike monitoring and simulating is only one use case. The architecture also allows other scenarios (e.g. energy or traffic management)

Franz Karl Basler-Kopp (1879–1937): Der Schimmelreiter (engl.: The Rider on the White Horse)

Thanks for your attention !