



**AGH UNIVERSITY OF SCIENCE  
AND TECHNOLOGY**

# **Enriching WSN environment with context information**

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# Agenda

- Sensors and *Internet of Things (IoT)*
- Data-centric approach in distributed systems
- Context information
- Improving wireless communication
- Localization as a context information
- Challenges



# Pervasive computing

- Pervasive/ubiquitous computing has around 20 year if history
  - developing mobile and pervasive devices
  - equip those devices with wireless connectivity
  - add sensor to give the devices environmental awareness
  - create app and services for those environmental-aware device



# Applications



**Predictive maintenance**



**Enable New Knowledge**



**Food & H2O Quality**

**Energy Saving (I2E)**



**Intelligent Building**



**High-Confidence Transport and assets tracking**



**Healthcare**



**Defense**



**Improve Productivity**



**Enhance Safety & Security**

- Limited resources
  - battery, memory, processing capability ...
  - wireless link is usually short-range and transmissions can often be disrupted
- Many of the current WSN deployments are application-centric
  - they are designed for one specific scenario, with defined *Quality of Service (QoS)* requirement
  - provided services are usually tightly-coupled



# Opportunities

- Sensor environments are driven by Data
  - think about the Data, Not How to Communicate
  - information regarding state of data is published and available to use in entire system
- Context information can improve and extend overall functionality of the data-centric system
  - more data available to users (e.g. location of sensors)
  - more holistic view of the physical environment
  - middleware layer can improve some aspects of its functionality

# Data-centric approach

- Distributed systems are getting more complex
  - Network-centric, dynamic, very large-scale “systems of systems”
  - Stringent simultaneous *Quality of Service (QoS)* demands
  - Highly diverse and complex problem domains



Sensor



Device

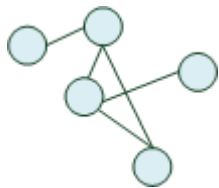


Internet of Things

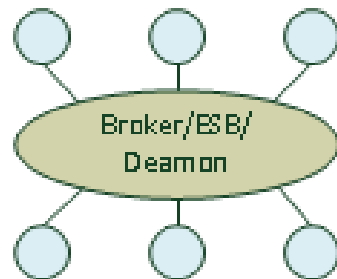
# Data-centric approach



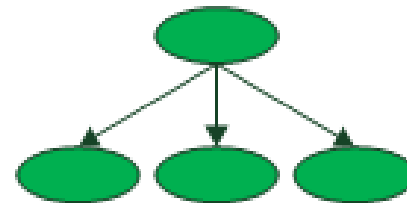
Point-to-Point



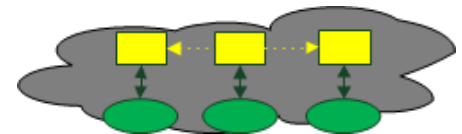
Client/Server



Publish/Subscribe  
Messaging



Data Centric  
Publish/Subscribe





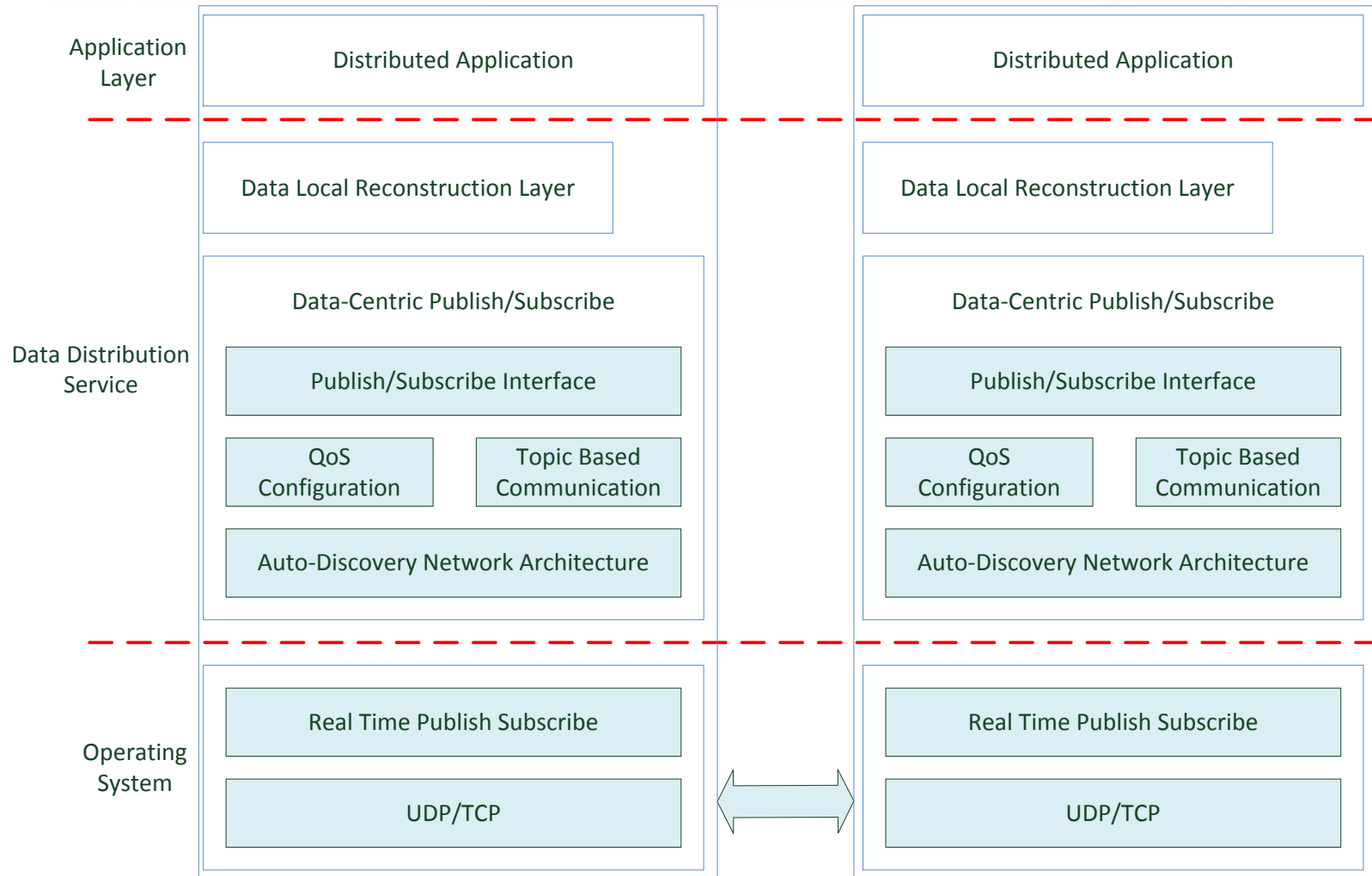


# Data-centric approach

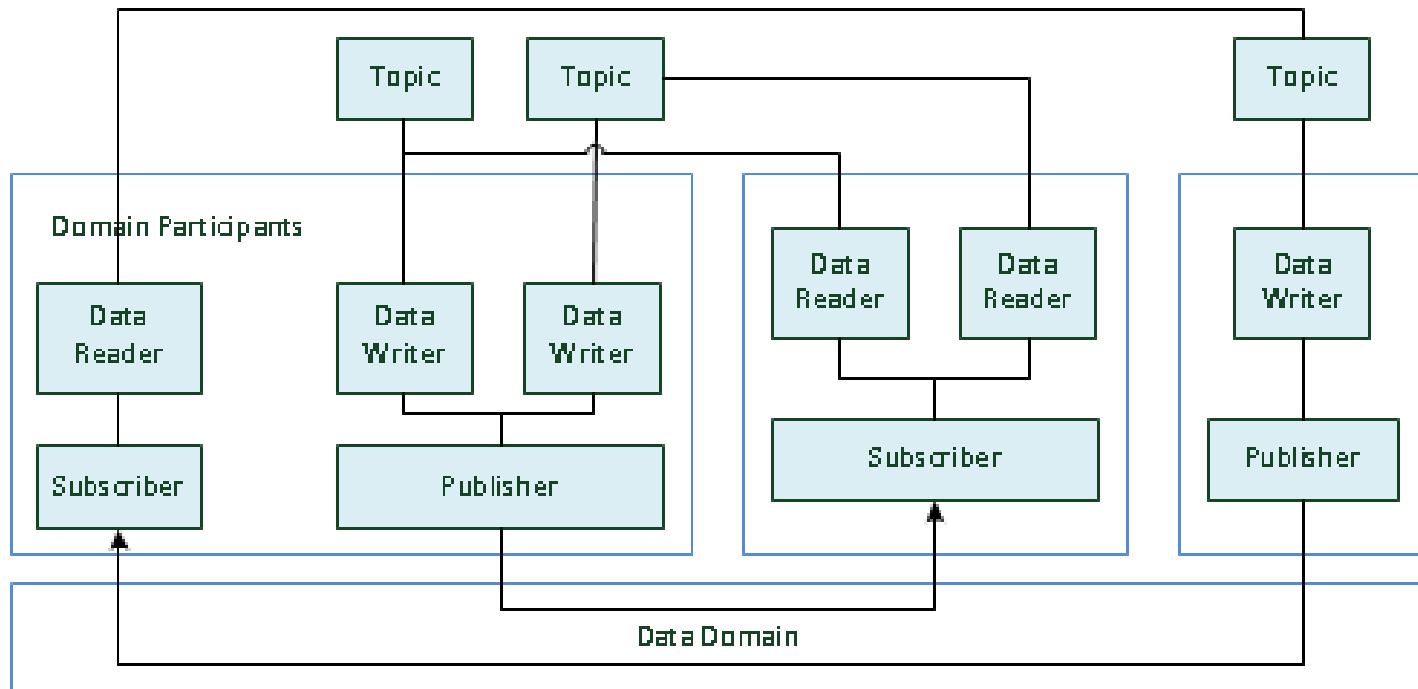
- Information is described by data and metadata - structure of data and access interface
- Data bus connects data producers to consumers, shared among participants and is responsible for data management and distribution.
- The behavior of system is hidden, infrastructure disseminates and manages state
- The data-handling contracts should describe data transfers among communication parties, the contracts should contain the *Quality of Service (QoS)* properties



# OMG Data Distribution Service



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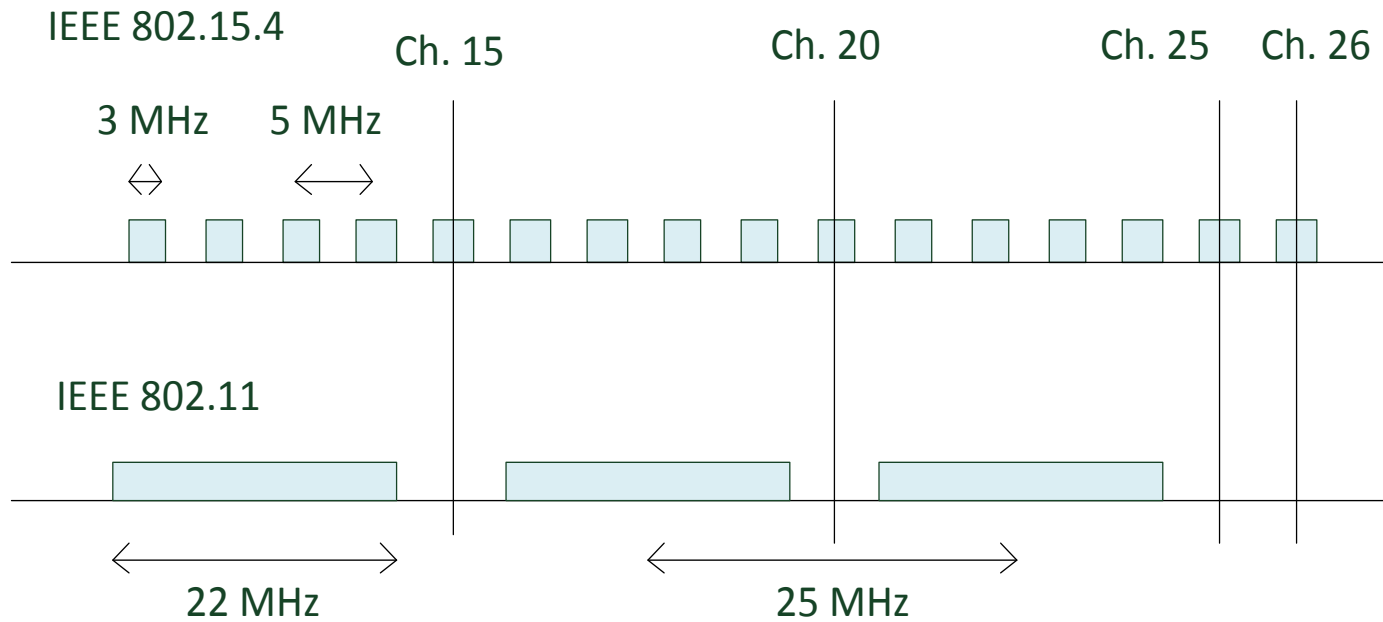




# Context information

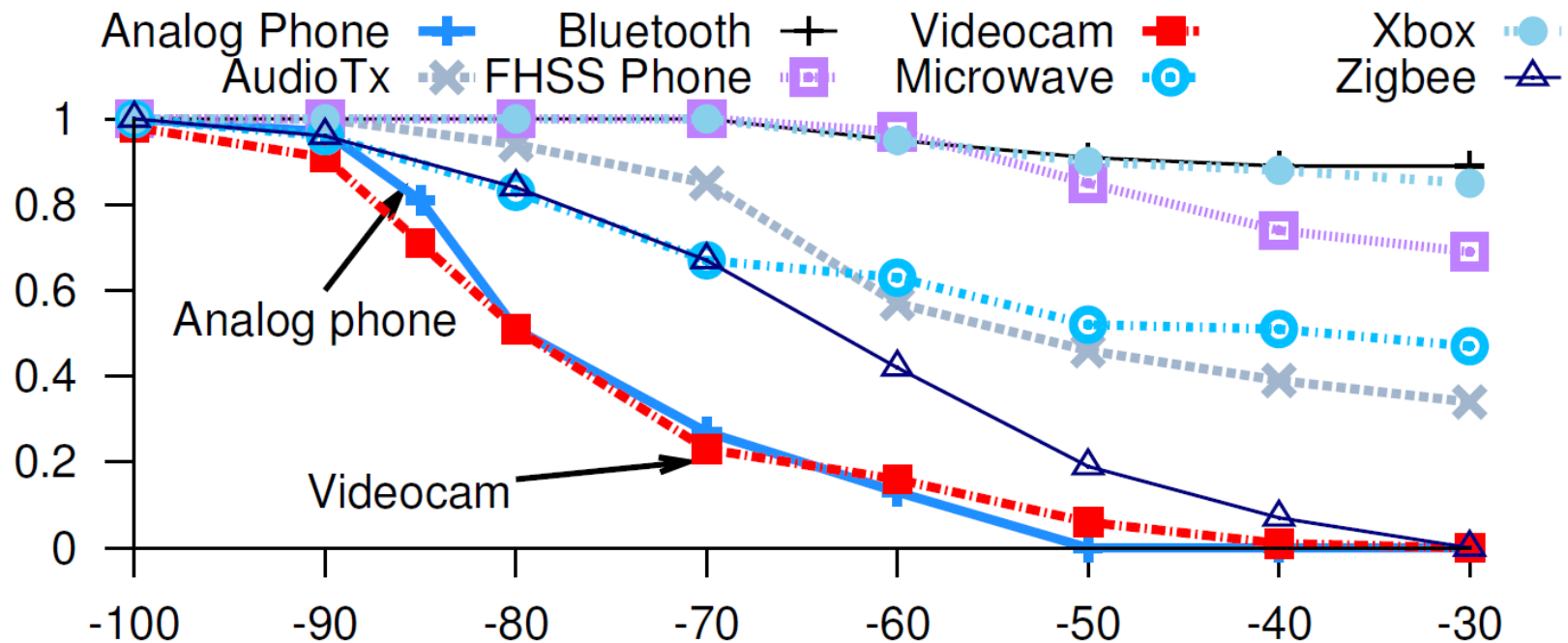
- Context in general can be described as the set of information that characterize situation of some entity
- Context can be categorized in four dimensions:
  - computing context
  - physical context
  - time context
  - user context
- Context data in data centric architecture
  - can extend metadata definition
  - can influence the *QoS* parameters

# Throughput optimization



# Throughput optimization

- Static configuration of network
  - often peaks in the radio bandwidth usage
  - there are other devices that uses the 2.4 GhZ ISM bandwidth



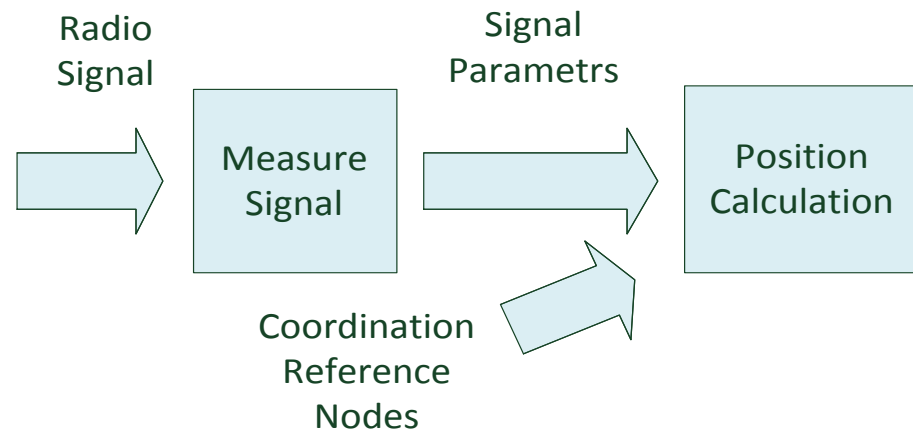


# Throughput optimization

- Sensors should dynamically adapt to changes in radio quality
  - use mechanism based on the *Carrier Sense Multiple Access-Collision Avoidance (CSMA-CA)* algorithms
  - use external systems that can provide information about radio quality

# Location estimation

- Location is very important for sensors
  - raising an alarm by sensors
  - mobility of nodes
  - privacy of data





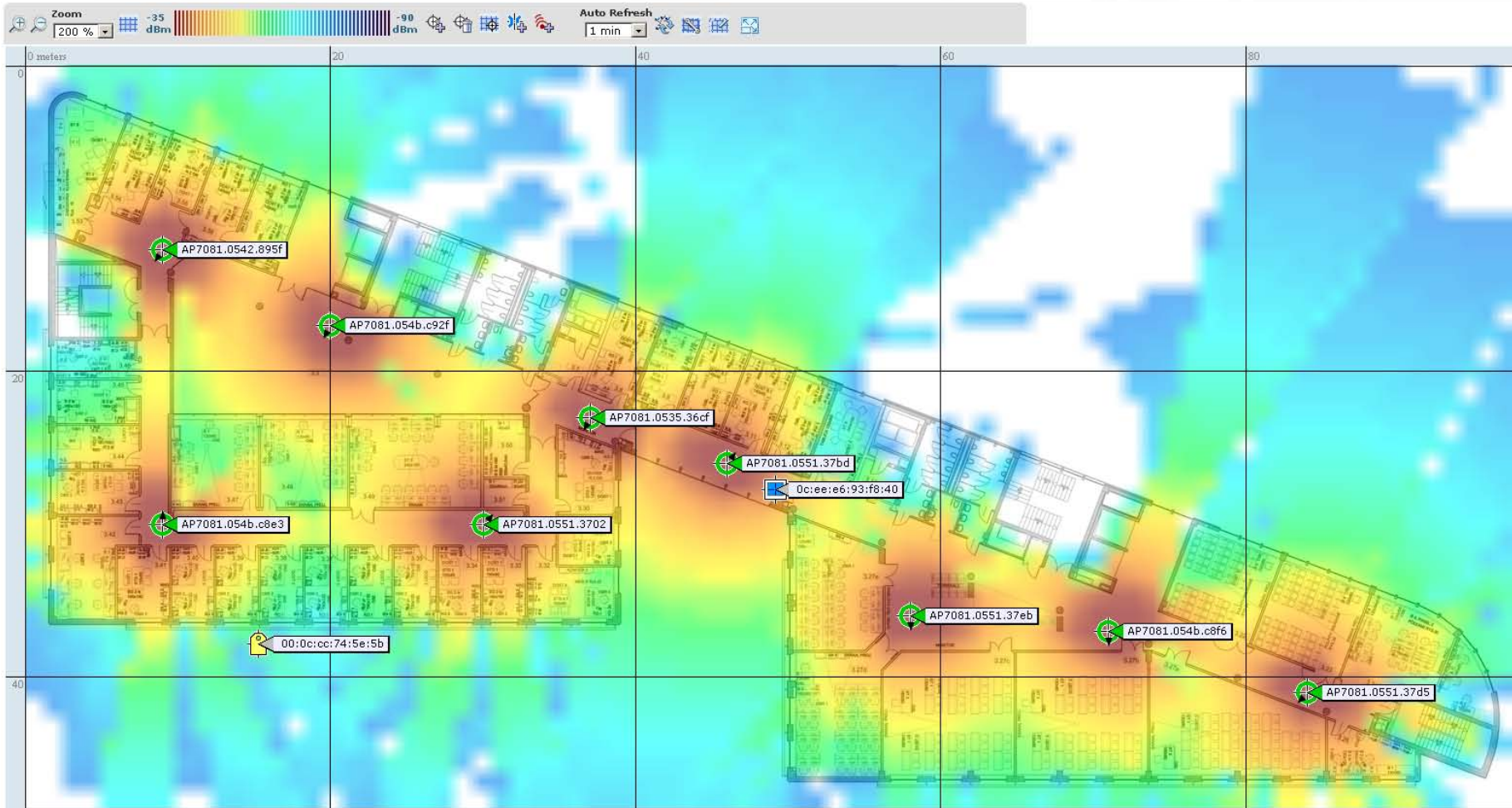
# External sources of context

- Cisco Context-aware services
  - *Aironet AP*
  - *Wireless Control Server*
  - *Wireless LAN Controller*
  - *Mobility Service Engine*





# External sources of context



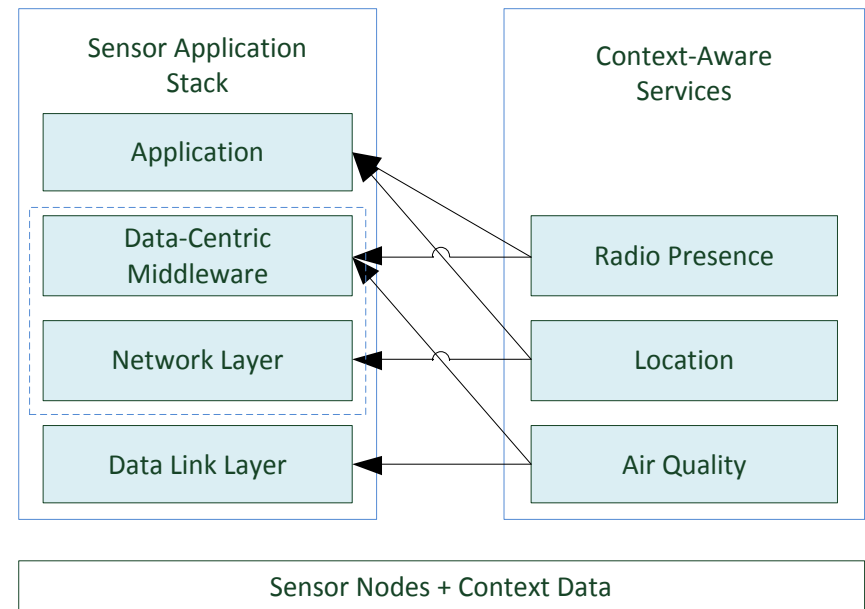


# Middleware architecture

- Main function of middleware in WSN
  - handle heterogeneity of environment (also external sources of data)
  - provide abstraction for software developers
  - responsible for handling context and data distribution (e.g. *flooding-based, direct access, selection-based and gossip-based*)
- Context in middleware
  - representation of context
  - *Quality of Context (QoC)*

# Challenges and future work

- Presented concepts requires changes in entire sensor application stack
- We are currently in simulation and prototyping phase





**Thank you**