Real-World G-Lab

Protocols, algorithms and services to integrate Wireless Sensor Networks with the Future Internet

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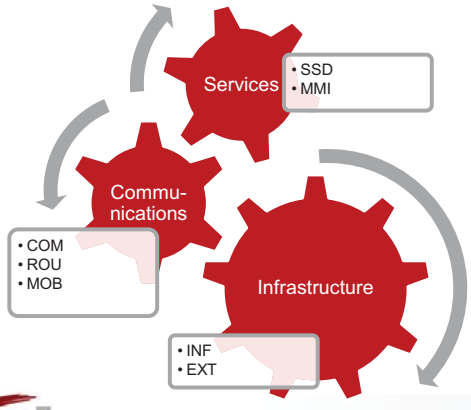
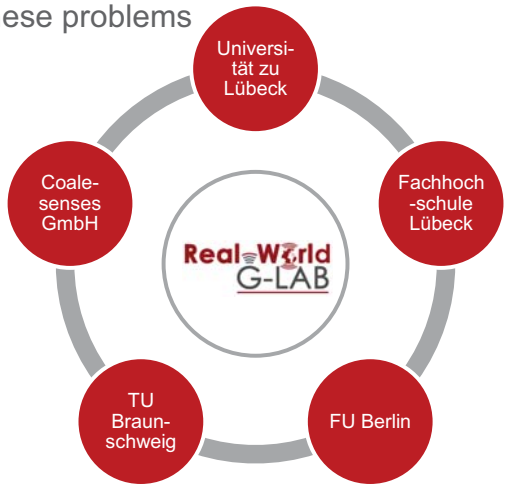
Real-World G-Lab

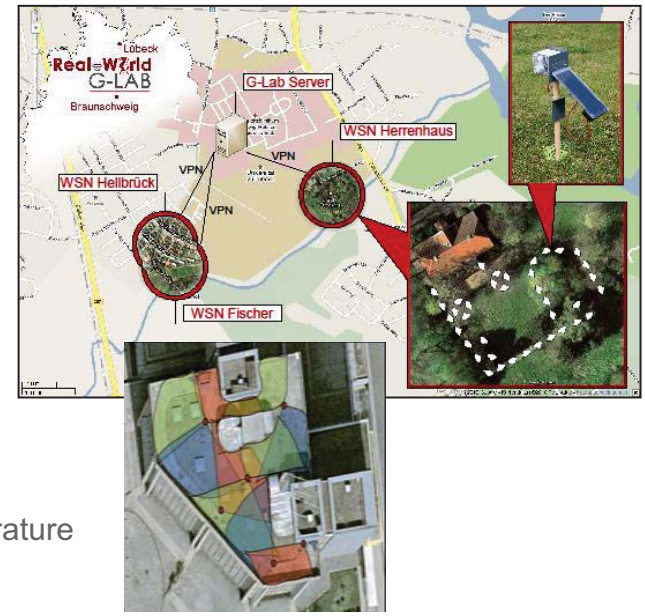
- 6 project members, 5 institutions, 3 cities
- Motivation
  - A plethora of sensor equipped embedded devices will be connected to the Future Internet
  - Several open questions like routing, energy efficiency, monitoring and searching
- Goal
  - Protocols, algorithms and services to overcome these problems
- Different work packages

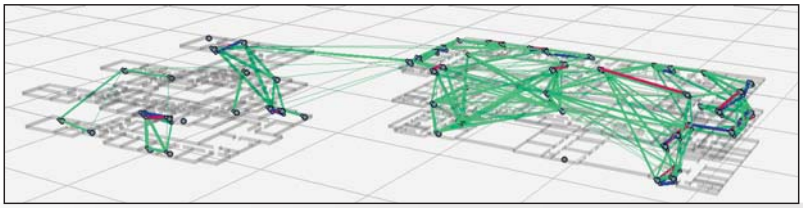




INF – Deploying outdoor WSNs

- University of Lübeck
  - 60 sensors @ 3 sites
  - Sensors: movement, acceleration, temperature
- TU Braunschweig
  - 10 solar powered Nodes on the roof
  - Sensors: movement, temperature, light, acceleration
- FU Berlin
  - 12 hybrid nodes in outdoor cases
  - Sensors: acceleration, humidity, temperature
- IPv6 in sensor networks
  - 6LowPAN + Dymo and DymoLow
- Server
  - Running G-Lab-Servers
  - Development of a special "Internet of Things"-image

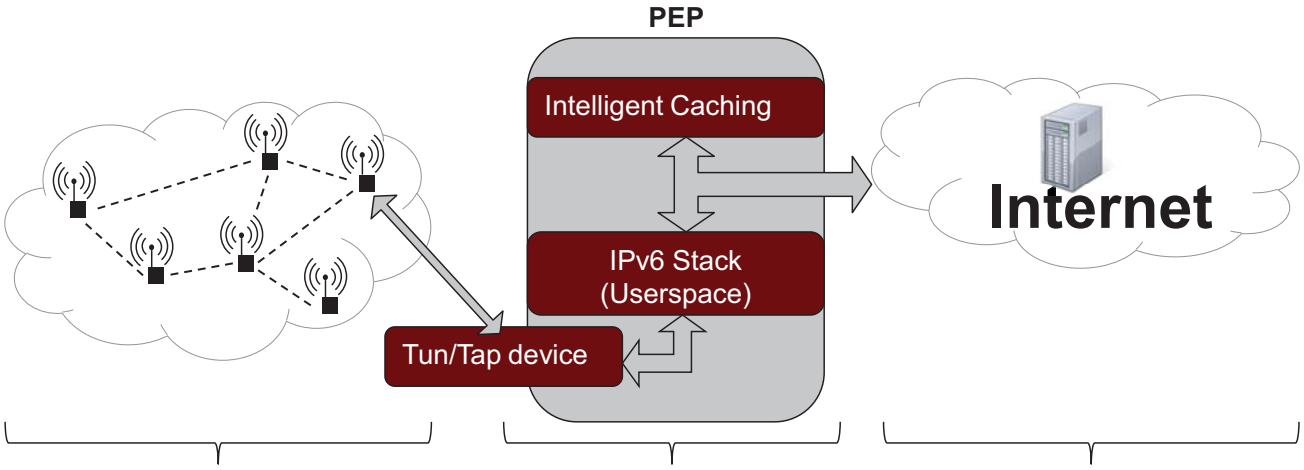




MOB – Mobility Support for the Future Internet

- Goal: Enable **mobile devices** to be part of **wireless multi-hop** networks
- Current work:
  - Extend the DES-Testbed with mobile nodes
  - Extend the testbed management framework with support for mobile nodes
  - Specify effects and requirements of client and infrastructure mobility
- Future work:
  - Implementation of interfaces for the distribution of mobility information for addressing and routing purposes
  - Design and implementation of a cross-layer service for mobility information

COM – Connecting WSNs to the Internet



- **IP** requirements
  - Constantly available links
  - Low latency
  - Bursty traffic
- **WSN** requirements
  - Low power
  - Low duty-cycle
  - Limited data rate
- Mediation required on PHY/MAC/LL level

- Performance Enhancing Proxy
  - Improve routing by using global gateway information
  - Minimize communication inside the WSN through caching

- IPv4/IPv6 Internet
- Export expensive operations to the Internet if possible

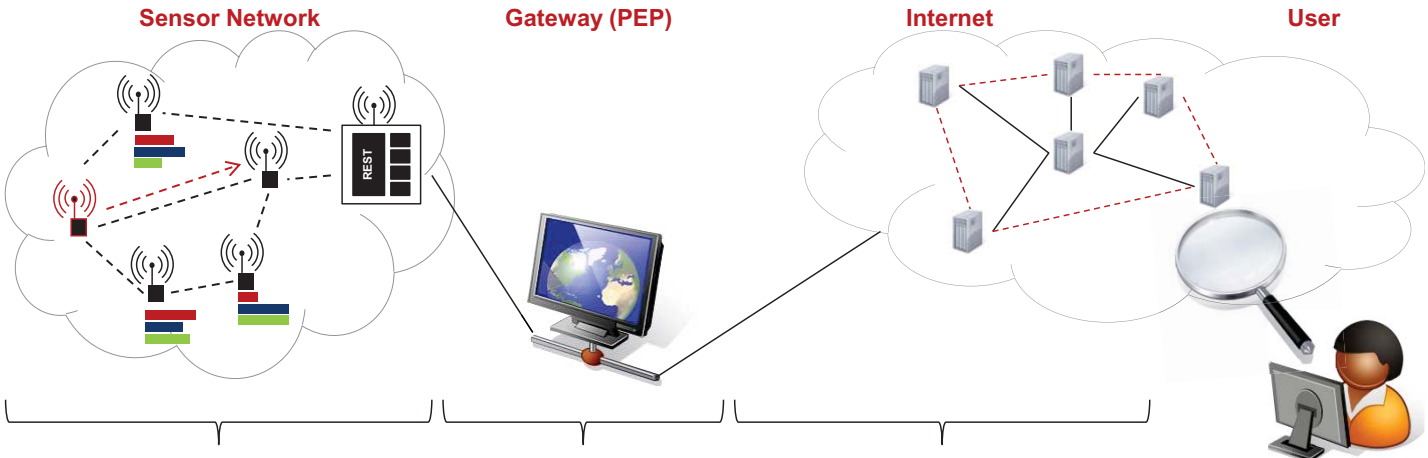
MMI – Monitoring of the Internet of Things

- Motivation: Future Internet will include large numbers of embedded nodes (sensors, actuators) networked with unreliable low-power wireless links
  - Typical performance problems:
    - Low yield (only a fraction of expected data is delivered)
    - High latency (delivery of data with long delay)
  - Challenge: hard to debug such problems
    - Large scale networks
    - Heterogeneous nodes and networking technologies
    - Problems often result from subtle interactions of many nodes
    - Limited node and network resources
- Goal: Performance Monitoring of the Embedded Internet
  - Parameters that are influenced by interplay of nodes: yield, latency
  - Different scales (sensor node, sensor network, federation of networks)
  - Resource budgets (adjustable tradeoff between detail and resource consumption)

MMI – Monitoring of the Internet of Things

- Work done
  - Development and test of a monitoring service for sensor networks (latency, yield, routing topology)
- Current work
  - Deployment of monitoring service on WSN outdoor testbed
  - Gathering monitoring data over a longer period of time
- Future Work
  - Examine collected data traces to identify typical behavior and problems
  - Develop algorithms for detection, classification, and localization of performance problems

SSD – Overview



- RESTful sensor nodes
- Proactive sending
- Generation of prediction models (PM)

- Indexing of PMs
- Common representation of sensor information
- Caching
- Responses in the name of the WSN

- P2P-Overlay networks for distribution of queries and indices
- Queries are forwarded to responsible peers
- Structure of queries is used to enhance search results
- Pseudo-sensors: Dynamic web content is used, too

- Queries for high-level state (in a certain region)

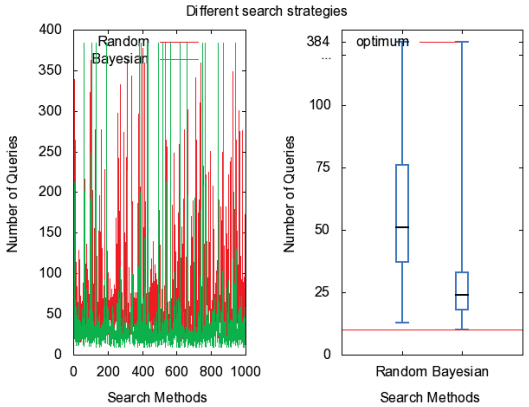
SSD – Searching the Future Internet

- Motivation: Internet of Things offers online access to the state of the real world
  - Search for real-world entities and sensors is a key service
    - Static meta data: sensors of certain types at a certain location
    - Dynamic output: sensors that currently output a certain value
  - Challenges
    - Huge search space (expect orders of magnitude more sensors than current Internet nodes)
    - Highly dynamic search space (sensor output and locations change frequently)
- Goal: Search engine for real-time states of real-world entities
  - Efficient heuristics to identify sensors that are likely to match a query
  - Distributed overlay networks to support scalable search
  - RESTful interfaces to sensors
  - Exploit existing online sensors (webcams, weather stations, bicycle rental systems, …)

SSD – Searching the Future Internet

- Current work
  - Exploit correlations between output of different sensors (knowing sensor output and correlations, the expected output of other sensors can be inferred)
  - Use of Bayesian networks to model correlation structure
  - Experiments with a large data set (400 sensors over several months) from bicycle rental system

- Future work
  - Continue work on correlation
  - Explore search strategies (e.g., pub/sub) for uncorrelated / unpredictable sensors
  - Distributed search algorithms using P2P techniques
  - Build and deploy a prototype of the search engine



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