Internet of Things and Services
Guido Stephan
From the Internet to a Web of Things thesis

Internet

Research Networks

ARPANET  TCP/IP  http  VoIP  Mobile Web  Social Media  M2M  Smart Grid  Smart City


Web2.0

Internet / Web of Things

Guido Stephan
Vertical communication using Internet Protocol/Web down to field level

**Market Pull**
- Global megatrends require smart solutions based on seamless **cross-domain integration** e.g. multi-modal energy systems)
- Efficient information sourcing for **big data** and process optimization
- New **business models** require horizontal eco-systems and vice versa

**Technology Push**
- Powerful system on chip below $1 enables **internet / web-technology** and allows **ubiquitous web access** even to smallest field devices
- **Internet of Things / web of things** based machine-to-machine (**M2M**) for flexible integration
- Networked embedded systems supporting **distributed control**
Vertical communication using Internet Protocol/Web down to field level

**Today: Hierarchical Communication**
(diverse, specific)

- Separated tiers
- Dedicated and domain specific communication
- Heterogeneous and low-level data representation
- Non-uniform access to devices and information
- Difficult cross domain integration

**Tomorrow: Vertical Communication**
(unified, IP/Web based)

- **Seamless communication** within and across domains
- **Unified access** to all functional units including field devices
- **Service oriented architecture**

Building Automation
Plant Automation
Energy Automation

- Diverse, specific communication protocols
- Separated tiers
Vertical communication is key to integration and control of complex distributed systems

Example: Smart Grid

110kV

Communication

10-50kV med voltage

Distribution Grid Control

0,4kV low voltage

Power flow

Communication:  
- Task specific, diverse
- Seamless, unified, IP/Web based

Vertical Communication from Power Grid to Smart Grid
Vertical communication is key to integration and control of complex distributed systems

Example: Smart Grid

Vertical Communication from Power Grid to Smart Grid

<table>
<thead>
<tr>
<th>Communication</th>
<th>Number of entities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution Grid Control</td>
<td>$10^3$</td>
</tr>
<tr>
<td>Energy Marketplace</td>
<td>$10^4$</td>
</tr>
<tr>
<td>Virtual Power Plant</td>
<td>$10^7$</td>
</tr>
<tr>
<td>Low Voltage Grid Control</td>
<td>$10^9$</td>
</tr>
<tr>
<td>Smart Building</td>
<td></td>
</tr>
</tbody>
</table>

Power flow

Smart meter
What are possible developments? Two approaches

Data Centric Approach

Cloud Services + Internet of Things = Big Data

Information Centric Approach

Smart Things + Internet = Web of Things

- Trust
- Proof
- Logic
- Rules / Query
- Ontology
- RDF Model & Syntax
- XML Query
- XML Schema
- XML
- Namespaces
- URI / IRI
- Unicode

Smart „Thing“

<table>
<thead>
<tr>
<th>Algorithms</th>
<th>Ontology</th>
</tr>
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<tbody>
<tr>
<td>Data</td>
<td>Web Service</td>
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</tbody>
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Research fields at Siemens for IoT

**Web of Things**
Web-based integration and interaction of smart distributed systems

**Massive Distributed Systems**
Plug and automate for massively distributed systems

**Embedded Networks**
Standard IT technologies for networked embedded systems

**Industrial Communication**
Reliable communication with guaranteed quality for industrial applications
Scope:
• Today, many IoT architectures are used in many different contexts (e.g. sensor networks, logistics)
• Many future solutions, applications, as well as their lasting realization will rely on a consistent IoT approach

Results, Deliverables, Impact:
• Identification, collection, and classification of IoT requirements
• Development of an open architectural reference model for interoperable IoT-systems based on key building blocks; manual for how to use the model
• Validation of the architectural reference model against requirements and implementation of real-life use cases

Project Details:
Duration: Sep. 2010 – Aug. 2013

Related Technologies:
• Internet of Things: Concepts and technologies
• Communication protocols
• Embedded networks
ICeWater

Scope:
- Real-time monitoring of water infrastructure and smart metering
- Optimize water network operations to reduce energy requirement and water waste
- Address the "water-energy" nexus
- Detect and localize leaks in real-time
- Exploit Internet of Things paradigms to overcome shortcomings of traditional architectures

Results, Deliverables, Impact:
- Input to roadmap development to
  - Innovations for products
  - Urban data research and development center
  - Testing of technologies in two live pilots (Milan, Italy, Timisoara, Romania)

Project Details:
Duration: Oct. 12 – Sep. 15

Related Technologies:
- IT platforms for smart cities
- Internet of Things and service architectures
- Energy efficient communication
- Smart apps, smart metering
Many thanks for your attention!

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