IoT Interoperablity at Bosch

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Adam Wynne (RTC3)

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What Does Bosch Do?

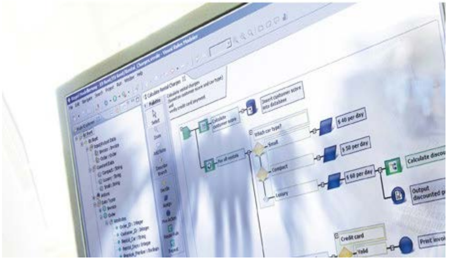
Automotive Technology

Household products

Industrial Systems

CLIMATEC
MERGING BUILDINGS & TECHNOLOGY

Building Management



Software Solutions

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Bosch in IoT

- ➔ Not traditionally a software business
- ➔ In the IoT of the future, everyone will be a software company!

- ➔ Acquired Software Innovations, 2008
  - Business process management
  - Cloud-based IoT solutions
- ➔ Acquiring Prosyst (announced February 2015)
  - Provider of dynamic gateway solutions based on OSGi
  - Leader in OSGi technology and standards development
- ➔ Corporate Research in IoTS
  - Middleware
  - Assistance services
  - Security & Privace
  - Partner with local universities

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Characteristics of IoT Applications

- Asynchronous communication
- Peer-to-peer communication
- Message- or event-based
- Must be resilient to loss of connectivity

- Current trend is towards cloud hosted web services, hub-and-spoke architectures, vertical integration
- In the future, IoT systems will:
  - Require sophisticated automation and assistance services
  - Exhibit systems-of-systems, decentralized architectures
  - Support for large range of platforms, data formats, protocols
  - Require interoperability between vendors

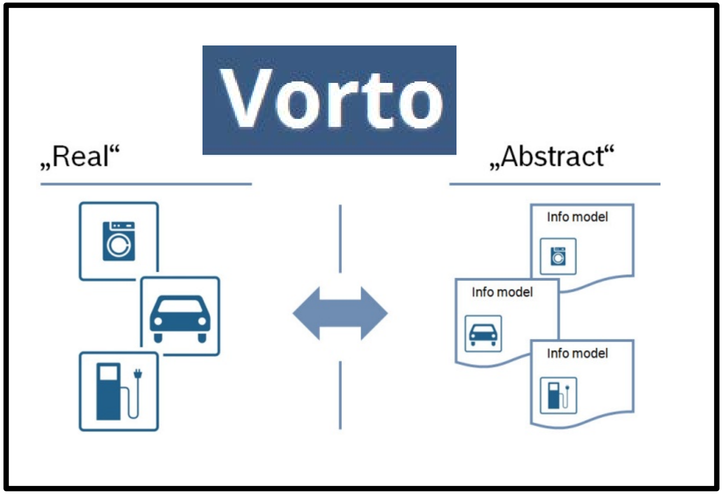
Bosch Approach

> *Bosch is committed to an open platform approach for IoT, since we know that "nobody can do it alone"*
>
> --Stefen Ferber, blog.bosch-si.com

Contributions to Open Source and Standards

Mortar.io

An Extensible Sensing and Control Platform for Building Energy Management



Semantic Sensor Network Ontology

Author

W3C Semantic Sensor Network Incubator Group

OSGi™ Alliance

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Protocols and Frameworks

- Great! We want to leverage open protocols and open source frameworks … how do we choose??
- A recent review of application level protocols found:
  - ~30 communication protocols
  - ~70 Java-based communication frameworks

- Most of these protocols are based on some traditional concepts…
  - Message oriented middleware
  - Publish-subscribe
  - Client-server
- BUT, they are lighter weight in terms of communication overhead
- SOME are looking towards a future of systems of systems

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A Sample of Protocols and Frameworks

- Service Orientation: CoAP (Constrained Application Protocol)
  - Proposed IETF standard (https://tools.ietf.org/html/rfc7252)
  - REST-ful protocol design, supports discovery (web linking)
  - Low header overhead and parsing complexity.
- Message Broker: MQTT (Message Queue for Transport Telem.)
  - Broker-based pub/sub system for constrained environments
  - OASIS Standard (MQTT v3.1) as of November 2014
- Advanced Message-Orientation: AMQP (Adv. Msg. Queue Protocol)
  - OASIS Standard, supports arbitrary topologies
  - Aims to standardize (binary) wire format for all types of MoM
  - First cross-platform MoM specification

How Will the IoT Evolve?

If the Internet of Things is going to be successful it needs to be built on the principles that made the Internet successful – open standards and open source software.

--Ian Skerret, Eclipse IoT Working Group

The Smart Campus **Opportunity**

- ➔ Harnessing the Power of **Open Innovation** in the IoTS

What is the **Smart Campus** concept?

- **Smart Campus** is a vision for the future of smart commercial spaces
  - Current R+D efforts focus **on individual home / building automation**
  - **Medium-scale** (e.g. multi-building) spaces have **unique requirements**
  - Opportunity to create **connected campus environments** that enhance: *Productivity + Efficiency, Safety + Security, Social + Professional Interaction*

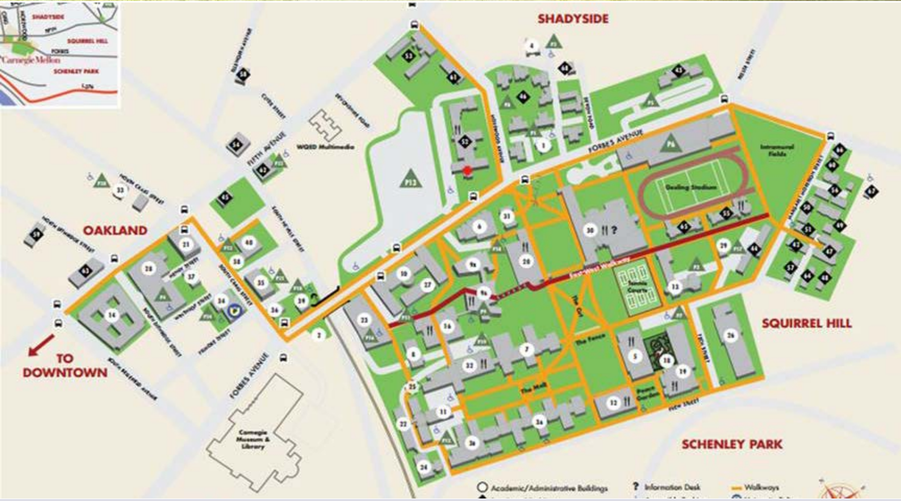
- **Challenges / Problems to be Solved**
  - **Identify high-potential business** opportunities in medium-, large-scale IoTS
  - **Address technical requirements** unique to segment: scalability, security, integration
  - Deliver **high-quality User Experiences (UX)** for both Web and Mobile

- **Approach**
  - Utilize CMU* campus as a "Living Lab" for **ideas, prototyping, validation**
  - Focus on **leveraging existing Bosch portfolio** to enter adjacent markets
  - Increase innovation **via direct engagement** of end users / domain experts

Opportunity to leverage current portfolio + university collaboration to drive innovation

* CMU: Carnegie Mellon University

Our Testbed Partner: Carnegie Mellon University



CMU **Statistics**[1]			
Population	15,507	Housing	4069 beds
Area	.6 km^2	Facilities (useable)	.6 km^2
Electricity	118K mWh	Input Energy*	522,759 mmBTUs
Buildings	109	Parking	3,309 units

[1] *Factbook 2014*, CMU Institutional Research and Analysis
* Natural Gas, of which ~73% converted to steam

M2M* Interfaces: Focus on Energy, Environment

EnFuse Panel Meters
Electricity usage
11 x 48 = 528 feeds

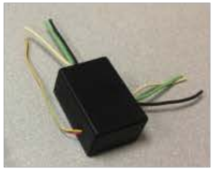
Lutron Lighting Controller
277 VAC lighting control

AutoMatrix PUP Controller
HVAC
30 x 6 (inter-building) x 24 = 4320 feeds

FireFly Environmental
Light, temp, humidity, sound, motion, vibration, pressure
120 feeds

Thermostat
802.15.4 Pneumatic thermostat with branch pressure monitoring
70 feeds

Chilled Water and Steam
Temperature and flow-rate
2 x 2 = 4 feeds



Fan Control Units
802.15.4 units for heat exchangers in each room
Control and power metering
170 feeds

Localization
ALPs + VLC Localization
Feed per person

* M2M: Machine-to-Machine communication

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Out of the Lab: Professional Install and Support

Panel Electrical Metering

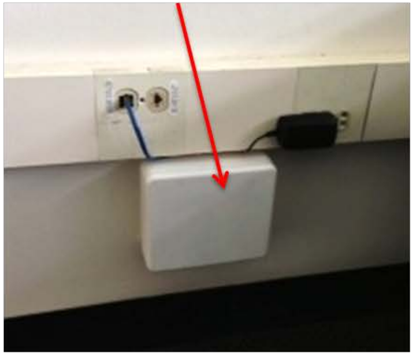
Fan Blower Control

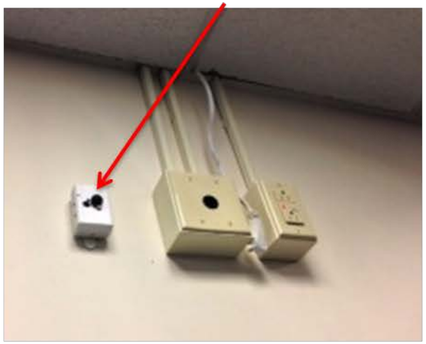
Wireless Thermostat

Beaglebone Gateway

Environmental Sensing

Lutron Lighting Control



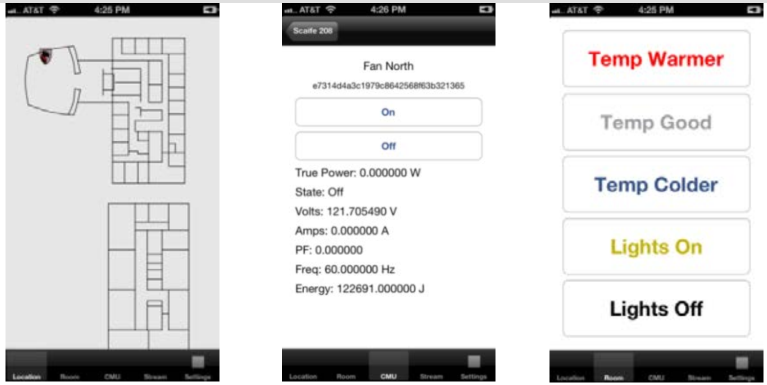


Big Data Target: 270K source points, 40B records, 1.5TB data, ~500 writes/sec

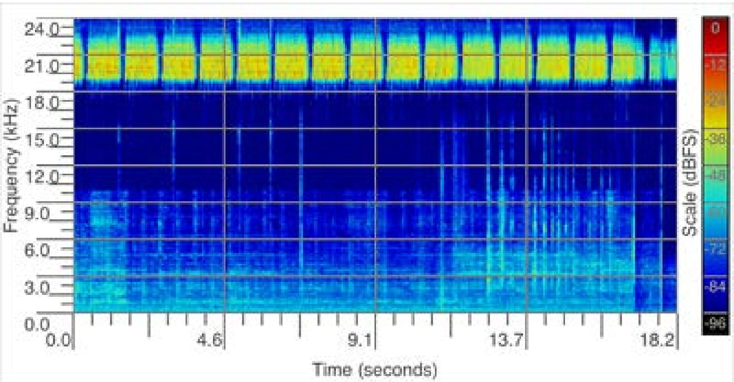
Sensor Andrew: Powerful End-User Features

Explicit Privacy Handling

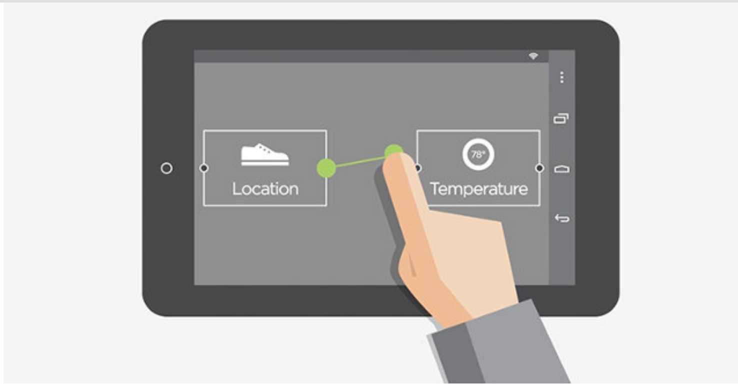
Mobile Application Framework



Infrastructure-based Localization



Application Authoring Environment[1]



[1] *MakerSwarm*, Maya Design, *www.makerswarm.com*