Interoperability in IoT

Why you should demand it…

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What Makes a Smart City?  
Multiple Applications Create Big Data

- **Connected Plane**: 40 TB per day (0.1% transmitted)
- **Connected Factory**: 1 PB per day (0.2% transmitted)
- **Public Safety**: 50 PB per day (<0.1% transmitted)
- **Weather Sensors**: 10 MB per day (5% transmitted)
- **Intelligent Building**: 275 GB per day (1% transmitted)
- **Smart Hospital**: 5 TB per day (0.1% transmitted)
- **Smart Car**: 70 GB per day (0.1% transmitted)
- **Smart Grid**: 5 GB per day (1% transmitted)

**A city of one million will generate 200 million gigabytes of data per day by 2020.**

Source: Cisco Global Cloud Index, 2015-2020
“Integrating multiple IoT systems enables 40 percent of potential value”

“We estimate a potential economic impact—including consumer surplus—of as much as $11.1 trillion per year in 2025 for IoT applications…”

McKinsey Global Institute, 2015
Many Devices, Many Applications, Many Protocols, So Little Time...
Vendor Lock in…

Body Cameras Quick Facts

- In the US, funding for 50,000 cameras, list price ~ $400
- 5 years archives
- Largest deployment to date: Oakland 600 cameras
- The market is in full expansion
Solution Overview
Not All Cameras are Created Equal…

- Buffer with or without sound?
- Camera with or without a monitor on it?
- Officers view the videos before writing the incident reports?
- Should there always be a blinking red light?
- Cameras' screens turned outward?
- Profound effect on how the cameras are used and who benefits from them
Option 1, Parallel Systems
Solution Overview (revisited)

Camera Vendor B

IoT Middleware

Video Mgt App1

Video Mgt App2
The Middle Ware Approach

- Analytics
- 3rd Party Integration
- Data Lake
- Dashboards

- GUI
- Device Provisioning
- Account Mgt

- Security
- Plugins Infra
- Client Binding
- Devices
- Physical World
Standards Landscape

**Application**
- ZigBee
  - ZAL (SE 2.0)
- REST / HTTPS
- CoAP
- XMPP
- SIP / SIMPLE
- DDS-RTPS
- MQTT
- IEEE 1888
- IEC 61968 CIM
- ANSI C12.19
- C12.22
- DLMS
- COSEM
- IEEE 60870
- IEC 61850
- DNP
- MODBUS
  ...

**Network**
- ZigBee
  - NWK

**Link**
- IEEE 802.15.4 MAC
  - 802.15.4e MAC enhancements
- IEEE 802.15.4 MAC
  - (including FHSS)
- IEEE P1901.2 MAC
- IEEE P1901.2 PHY

**PHY**
- IEEE 802.15.4 2.4GHz
  - DSSS
- IEEE 802.15.4g
  - (FSK, DSSS, OFDM)

**Lower Layers**
- 6LoWPAN (RFC 6282)
- TCP / UDP
- IPv6 / IPv4

**Control**
- 802.1x / EAP-TLS based Access Control

**Transport**
- RFC 2464
- RFC 5121
- RFC 5072

**Protocol**
- IEEE 802.3 Ethernet
- IEEE 802.16 WiMax
- 2G / 3G / LTE Mobile

**CoAP**
- XMPP
- DDS
- RTPS
- MQTT
- XMPP
- HTTPS
- SIP
- SIMPLE
- REST
- HTTPS

**IEEE Standards**
- 802.11 Wi-Fi
- 802.3 Ethernet
- 802.16 WiMax

**3GPP**
- 2G / 3G / LTE Mobile
A View into the Future

• No convergence may be reached for years
• Need pressure from users
• Need pressure from the top
• Creative solutions to make thing interoperate?