The IoT, IPv6, and the Cloud

Simon Duquennoy

simonduq@sics.se

Groupe de Discussion

Internet des Objets – Perspectives et Opportunités pour les Entreprise

Mercredi 6 Juin 2012

CETIC, Charleroi









- Independent, non-profit research institute, since 1985
- Bridging the gap between academia and industry
- Leading Swedish IT
- Owned by the Swedish government (60%)
- And companies (40%): Ericsson, TeliaSonera, SaabTech, FMV, Green Cargo, ABB, Bombardier
- Research in Internet of Things, mobile systems, language processing, constraint programming, industrial processes





Message of this Talk

1 The Internet of Things is happening, now

2 **IPv6** for an open, innovative, scalable, reliable IoT

3 The Cloud is the new center of gravity of the IoT



Io T

What is the

all about?



Defining the Internet of Things

1999: Birth of the term, mostly referring to RFID

- Addressing of physical objects
- 20xx: Machine to machine
 - Interaction between objects

2012: RFID is commonplace, smartphones are everywhere, cloud computing has taken off...

Junction of the physical and digital worlds,



Ericsson's Vision

MORE THAN 50 BILLION CONNECTED DEVICES "The visit

"The vision of more than 50 billion connected devices by 2020 may seem ambitious today, but with the right approach, it is within reach"

Source: Ericsson white paper, February 2011



CISCO's Vision

"Size doubling every 5.32 years. The IoT was born between 2008 and 2009."





A Variety of Applications



8

The Smart Grid

- Towards a more clever eletrcicity management
 - Generation, distribution, consumption
 - Green, efficient, secured



- More dynamic pricing
- Better anticipation of needs

MINISTRA MINISTRA MINISTRA

Smart Cities

- Support to safety/emergency services
- Resource management
- Transport management
- Zoom on Smart Parking
 - Fast Park in Barcelona, SF Park in San Francisco







Smart Buildings

- Instrumented buildings
- Automate & monitor
 - Resource adaptation
 - Flexibility
 - (bulbs, switches)
 - Power visualization
 - Safety
- Part of Smart Cities





Zoom on Smart Buildings

- Challenges at different levels
 - Hardware, nerwork architecture, applications
- Heterogeneous hardware
 - Communication via PLC, WiFi, ZigBee (802.15.4), ..
 - From 8 to 32-bit MCU, strong memory limitations
 - Often battery-operated



IP

Towards an

-based Internet of Things



Why IP?

- Provides interoperability
 ⇒ plug anything with anything (no gateway!)
- Favors innovation
 - \Rightarrow focus on applications (finally!)
- Eases adoption

 \Rightarrow experts are already there (aren't you?)

IPv6 for scalability (remember, 50 billion devices...)



The Contiki OS

- An Operating System for the IoT
 - Runs on small devices, sensor networks, etc
 - Low power, low memory
 - Certified IPv6 stack
 - Supports a variety of hardware









Open-source, contributors from

 SICS, Cisco, Redwire LLC, SAP, and others



The IPv6 Embedded Stack, 2012

- Traditional stack
- A couple of new IETF standards
- IPv6 as the "narrow waist"



Runs in system with a few kB memory



The IPv6 Embedded Stack, 2012

- Academia has put a lot of effort
 - Reaching low power
 - OS design, programming, network protocols
- Industry has invested a lot
 - Standardization, implementation, deployments
- There are still many challenges to be addressed

But let's take a step back...



Cloud

The

is the key



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Cloud Computing

- Storage and applications as a service
- Took off insanely quickly

















The IoT, IPv6, and the Cloud



A Cloud-centric IoT







SICS



Cosm, an online platform for the IoT

- Stores and shows sensing data
- Allows users to set triggers
- Supports applications
- Visualize from your

Computer, phone, tablet

-M- Testfeed (Contiki OS + 6LoWPAN + RPL + HTTP + JSON)







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Participatory Sensing

- An initiative of Deborah Estrin at UCLA
- Smartphone-based sensing
- Data posted to the cloud by users
- Feedback helps user
- Ex: Noisetub, in Paris
 - Monitoring noise pollution







How to plug it all?

- Adopt a RESTful architecture
 - For simple, well-defined interaction
 - Done with HTTP/TCP or CoAP/UDP
 - GET /sensors/temperature
 - POST /light?intensity=40
 - An API for the world!
- Let the magic happen in the cloud
 - Applications will fit the devices
 - Crowdsourcing is fantastic
 - Standard profiles may also be helpful



The EU FP7 CALIPSO Project

SCVI520

- Towards truly low-power IPv6
- Sensor networks, IPv6+RPL+CoAP
- Partners: Thales, Univ. Parma, Disney Research, SICS, CISCO, WorldSensing, CNRS
- Application-driven approach





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Conclusion

- Exciting stuff going on right now!
- Lots of new apps to be designed
- Many new challenges
 - Scalability (of applications and networks)
 - Energy (in network and globally)
 - Programmability (new space of applications)
- Thanks!





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