

The Internet of Things / Sensor Networks - May – 2009

EPRI



JP Vasseur (jpv@cisco.com)

Cisco Distinguished Engineer

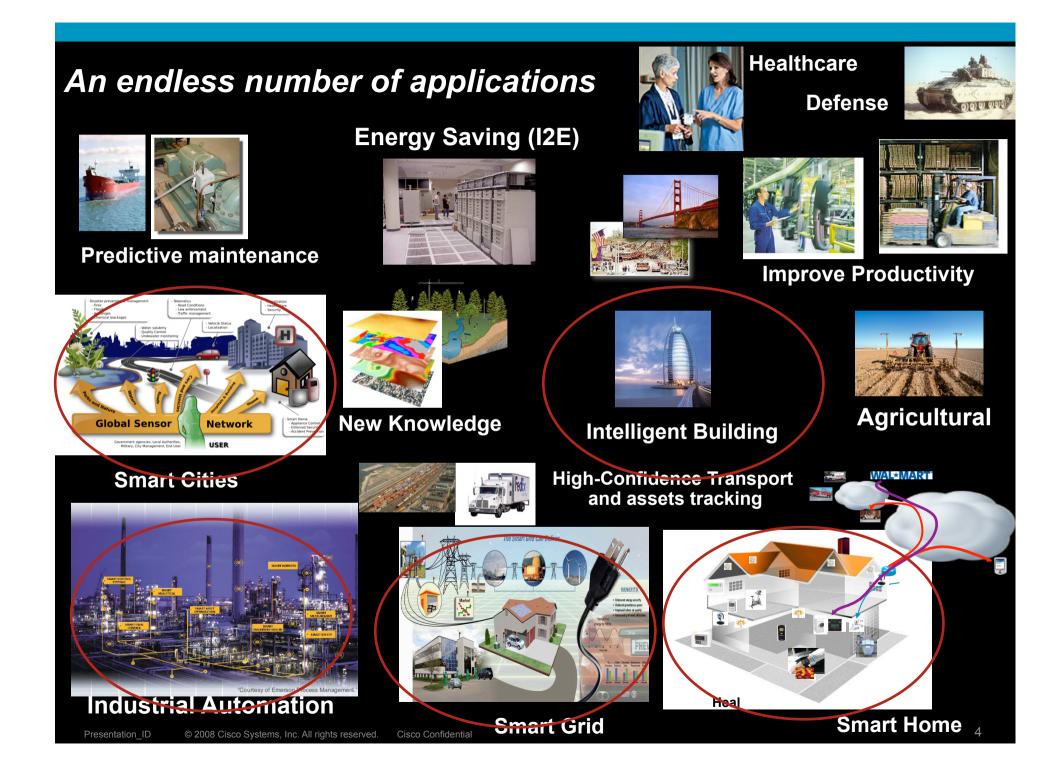
Co-Chair of the IETF Routing over Low power and lossy WG Chair of the Technology Advisory Board of the IPSO alliance

What is "The Internet Of Things ?"

- Before we start ... What do we mean mean by "The Internet of Things" ?
 - It is fundamentally the idea of connecting Smart Objects to enable a myriad of new applications !
 - It is in fact about connecting Smart Objects using IP: either via a (virtual) private network OR the Internet

What is a Smart Object? (cont)

- An intelligent tag (RFID),
- A sensor: device that measures a physical quantity and converts it to a analog or digital signal: power consumption and quality, vibration of an engine, pollution, temperature, CO, motion detection, temperature, ...
- An Actuator: device that controls a set of equipment (e.g. control and/or modulates the flow of a gas or liquid, control electricity distribution, perform a mechanical operation)
- Any combination of the above features to form a more complex entity.



Back to 2-3 years ago ...

- High number of proprietary or semi-closed solutions: Zigbee, Z-Wave, Xmesh, SmartMesh/TSMP, ... at many layers (physical, MAC, L3) and most chip vendor claim to be compatible with their own standard
- Many non-interoperable "solutions" addressing specific problems ("My application is specific" syndrome)
 - Different Architectures,
 - Different Protocols

... with ... The usual "My environment has specific requirements and requires a specific solution" syndrome => Local versus global optimum !!

CigBee® Alliance Wireless Control That Simply Works

=> Limited deployments in **scope** and **scale**,

IP end to end for the Smart Grid

Why not using protocol translation gateways ?

- Very different situation than 15 years ago with SNA, IPX, ... (few exception but we have a strategy)
- Protocol translation gateways is the wrong approach for the "Internet of Things":
 - Expensive and difficult to manage (CAPEX and OPEX)
 - Number of technical issues: end to end lack of QoS, routing and fast recovery consistency
 - Force down the path of the least common denominator
 - Clearly not an enabler for innovation
 - Different scale !
 - Security holes ...

So ... which protocol and architecture ?

- The architecture and protocol MUST have a specific properties:
- Based on open standards: for interoperability, cost reduction and innovation ... almost all proprietary protocols died ...
- Flexibility in many dimensions:
 - Support a wide range of media
 - Support a wide range of devices
- Always favor global than local optimum: all protocols solving very specific issues never survived ⁽²⁾ - We live in a fast changing world
- Highly secure
- Plug & Play
- Scalable

A plethora of emerging new low power media for Smart Object

- Things are fast changing since the historical serial connection with RS485 …
- Then wide adoption of IEEE 802.15.4 as the low power RF technology (2.4 GHz and 900 MHz)
- As expected (and this is the good news) several other low power technologies have emerged:

Power Line Communication (PLC): key for the home and the Smart Grid

Low power Wifi

New RF technologies

Smart Objects networks are made of a variety of links

IP: The perfect fit !

- Based on open standards: for interoperability, cost reduction and innovation ... almost all proprietary protocols died ...
- Flexibility in many dimensions:
 - Support a wide range of media
 - Support a wide range of devices
- Always favor global than local optimum: all protocols solving very specific issues never survived ⁽²⁾ -We live in a fast changing world
- Highly secure
- Plug & Play
- Scalable

 Open standard: The Internet Engineering Task Force

- Flexibility in many dimensions:
 - Serial, SDH, FR, ATM, Ethernet, Wireless, Optical ...
 - From cell phone to high speed routers
- Always favor global than local optimum: "IP if good enough for everything: from email to video to realtime protocols"
- A very secure and well proven

© 2008 Cisco Systems, Inc. All rights reserved. Cisco Confid

A question that we heard several times

Isn't IP too greedy to run on highly constrained device ?

Open source lightweight stack delivered →ulPv6

ahaha				orldwide [change]	ge] Log In Register About Cisco		
cisco			Search				Go
Solutions	Products & Services	Ordering	Support	Training & Events	Partner C	entral	
News@Cisco > Press Release	se						
Share, Email	, SMS 🖶 Print 🔊 Subscribe					News@Cisco Cisco News	
a Future Wh	el and the Swedish Institut here Any Device Can Be C	onnected to	the Internet			Events Press Releases Feature Stories	
One of the World's Smallest Open-Source, IPv6-Ready Protocol Stack Enables Cost-Effective Deployment of Sensor- Based 'Smart' Objects						Corporate Information Press Resources	
SAN JOSE, Calif., and BANGALORE, India, October 14, 2008 - Cisco, Atmel and the Swedish Institute of Computer Science (SICS) today announced the availability of uIPv6, one of the world's smallest open-source, IPv6-ready protocol stack, which could enable every device, no matter how limited by power or memory to have an Internet Protocol address.						World Wide News Sit	es
This collaborative project builds on Cisco's expertise in IP networking, Atmel's innovative low-power wireless hardware and SICS' knowledge in embedded operating systems design. "uIPv6 has the potential to impact a wide range of market verticals where automation is key, just as voice over IP did in enterprise telephony," said Rob Adams, senior director of Cisco's Corporate Development technology group.						Select a country	
"Smart" objects powered by a wide range of sensors and actuators are poised to enable a wide range of next-generation applications in building automation, industrial monitoring, smart cities and energy management, among many other areas. These applications help transmit information in the physical world about conditions or the environment (for example, temperature, light, motion, health status) to locations where the information can be analyzed, correlated with other data and acted upon.						Media Podcasts Videos Blogs SMS	
The proliferation of such applications has however been held back by the large number of proprietary or semi-closed systems, and the cost associated with translating information before it can be effectively shared with other devices and systems. The use of IP as networking technology has long been recognized as the solution to this interoperability issue. Now, thanks to unique lower-layer energy management mechanisms and limited memory capacity, uIPv6 is highly power-efficient and ideal for most constrained devices.							
Open-source uIPv6 includes standard IP applications and can be easily customized for specific requirements. It is integrated in the Contiki operating system developed by SICS, which provides all the necessary functionalities for networked smart objects. In addition, uIPv6's small footprint and memory usage allows it to run on the most constrained platforms. In particular, it was tested on Atmel's Raven wireless platform, chosen for its outstanding low-power performance.						Other Resources Select a link My News@Cisco	
performance," s Cisco and SICS	ower wireless systems require ul said Magnus Pedersen, Atmel's d S chose the Atmel AVR Raven pic confirms Atmel's leading edge in	irector of product oPower wireless	marketing, MCU platform as the I	Wireless Solutions. "The basis for their ulPv6 and 6	a fact that	Stay on top of	your
uIPv6 is released under a permissive open-source license, and as a result can be used for both commercial and noncommercial applications.						News@Cisco. Sign up now for the I news and media con	
sensor network Wetterwald, pre	e, standard-compliant, small-foot applications," said Adam Dunkel sident of the IP for Smart Objects becomes as easy as operating a	s, senior scientis Alliance (IPSO)	st at SICS and Co said, "By runnin	ontiki project leader. Patri g an IPv6 stack, operating	ck	Subscribe Now—It's → Feedback → Su	

- Code base: Contiki OS/UIP stack + KAME stack
- All IPv6 features (except MLD) are implemented

Code size ≈ 11.5 KByte

RAM usage ≈ 0.2+**1.6** =1.8KByte

- Obtained IPv6 ready phase 1 logo
- Open source release October 14th, 2008

http://www.sics.se/contiki

Other implementations: Archrock, Sensinode, PicosNet, Dust Networks, Gainspan, ZeroG, etc...



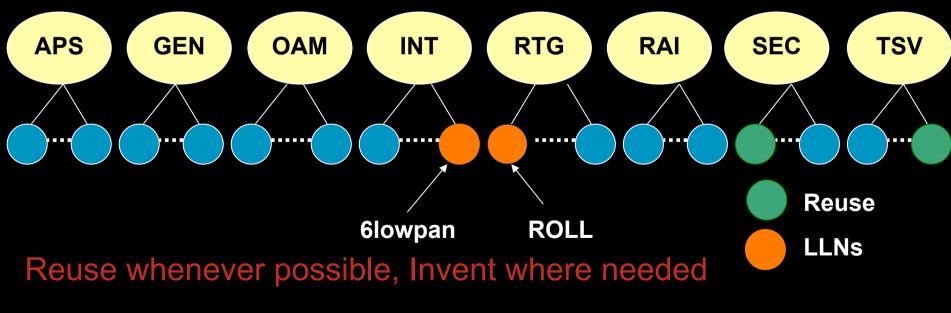
Why is this technology discussion so important ?

No, this is not a religious debate: it is technical *and* economical (CAPEX) and OPEX)

Standardization

IETF Update

- IETF formed in 1986,
- Not considered as important for some time :-)
- Not government approved :-)
- Involving people not companies
- Motto: "We reject kings, presidents and voting. We believe in rough consensus and running code" Dave Clark (1992)
- Organized in areas made of WGs,



Building an eco-system is a crucial ... this is how the IPSO alliance came to birth

IPSO IP for Smart Object alliance



September 2008: Alliance launch 27 founding companies



May 2009: 50 members

Arch Rock Atmel Bosch Cisco Duke Energy Dust Networks EDF ECE Eka Systems Ericsson Freescale Gainspan Jennic Jonhson Control Intel INRIA Kinney Consulting National Instruments Nivis PicosNet Primex Wireless Proto6, LLC

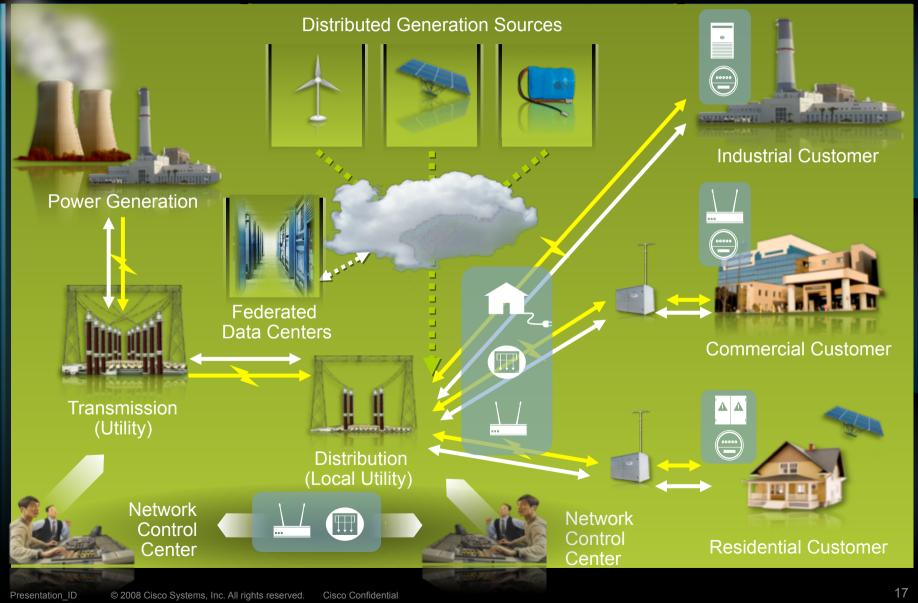
SAP Sensinode SICS Sun Microsystems Tridium Watteco Zensys Centria Cimetrics ELIKO **Emerson Climate Technologies** IAR Systems IP Infusion - An ACCESS Company Kitworks Landis & Gyr (Cellnet) Lulea University of Technology Mocana ROAM / Acuity SilverSpring Networks SmartSynch Tampere University of Technology Texas Instruments ΤŻ 16



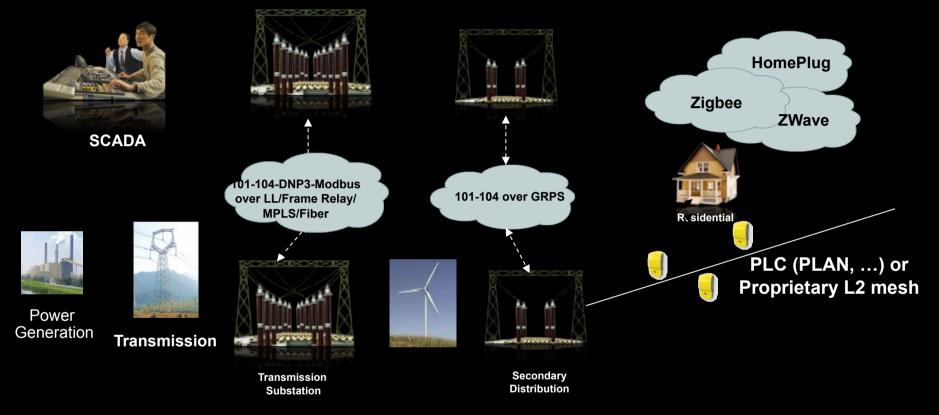
April 2008: 3 persons Patrick, JP and Roland

Power Management Smart Grid



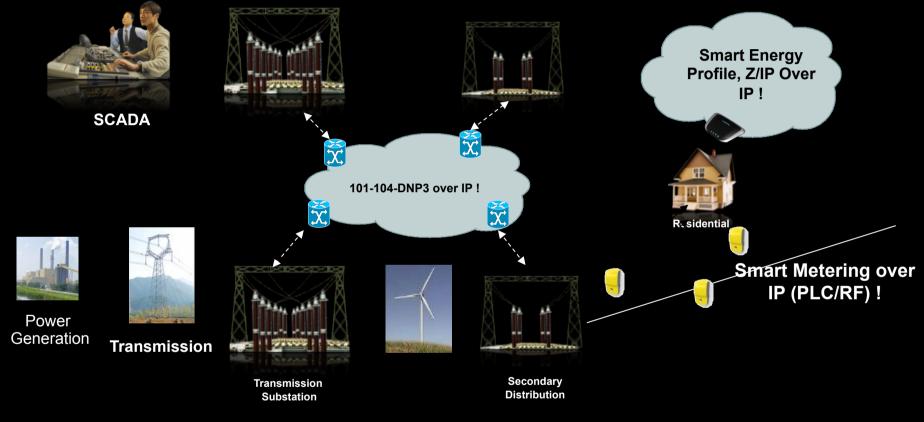


Why IP end to end: the example of the Current Grid



- Increasing demand for end-to-end energy management (telecontrol, telemetry, load shedding...), Smart metering, ... in support of Demand-Response, DSM, ...
- This implies a number of protocol translation !!!

Proposed end to end IP based architecture for the Smart Grid



IP end to end !!

Conclusion

- The vision of an "Internet of Thing" is now a reality
- Emergence of several "killer" applications with high business revenue opportunities: Smart Grid !
- Smart Objects running IP are available today
- IPSO a new Industrial alliance promoting the use of IP on Smart Objects (IPSO) is growing at an impressive pace
- Lot of work in many Standardization bodies: IETF, ISA, ETSI
- Solutions exist TODAY and are being deployed and this is just the beginning !

##