Wireless Sensor Networks for Surveillance: Towards Standardized Protocols

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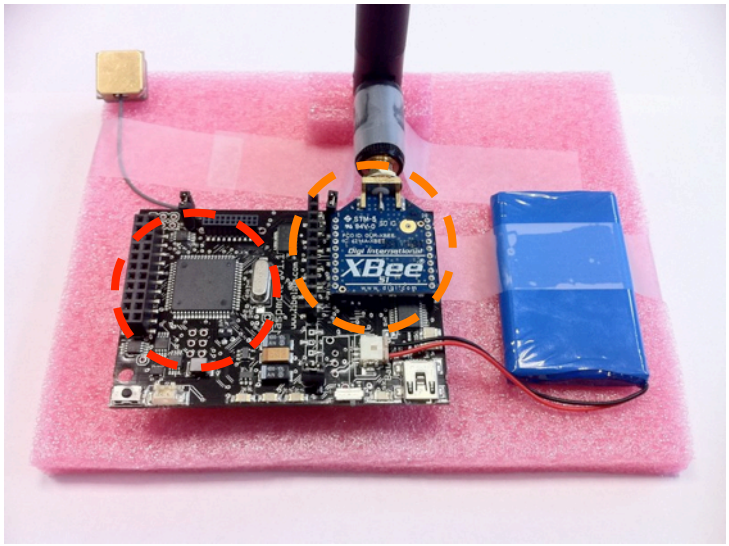
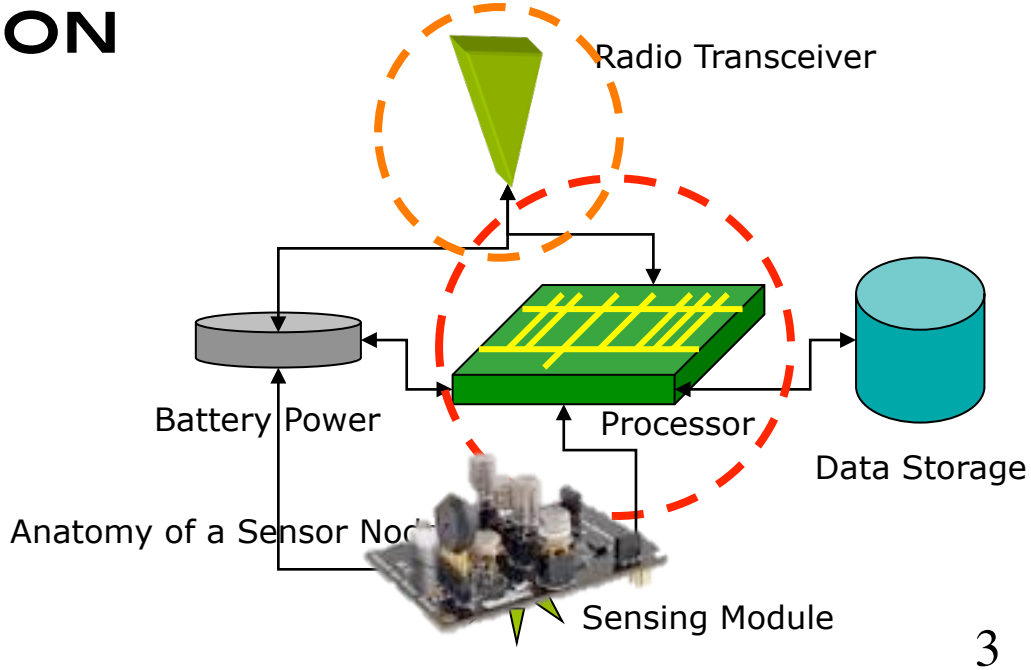
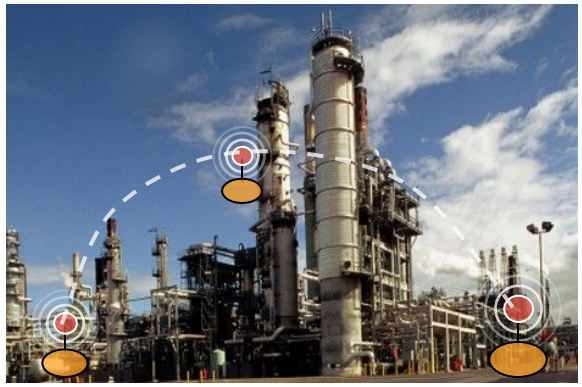
Wireless autonomous sensor

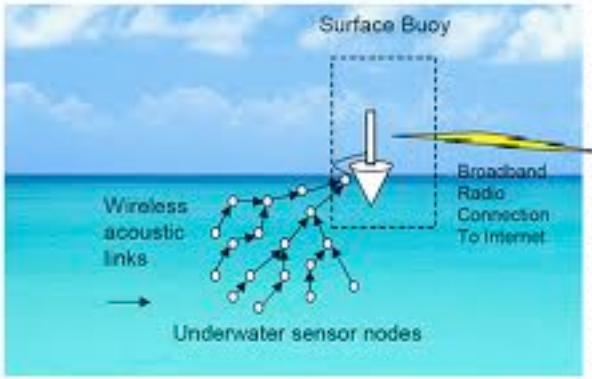
- In general: low cost, low power (the battery may not be replaceable), small size, prone to failure, possibly disposable
- Role: sensing, **data processing**, communication

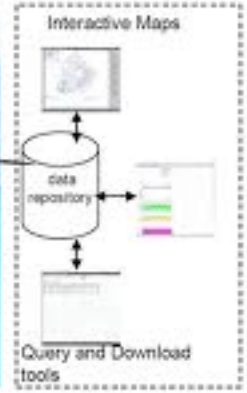


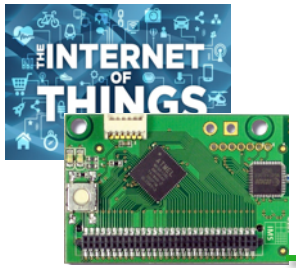


Monitoring/Surveillance





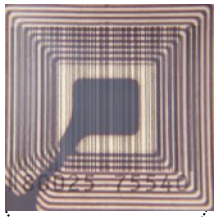


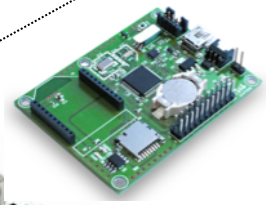


Digital devices ecosystem



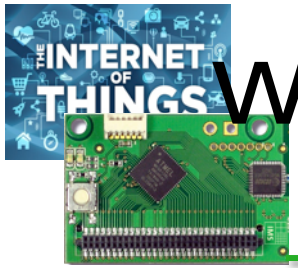




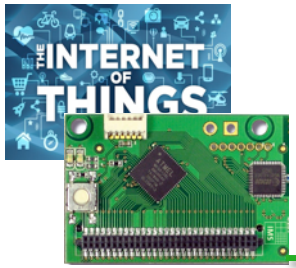




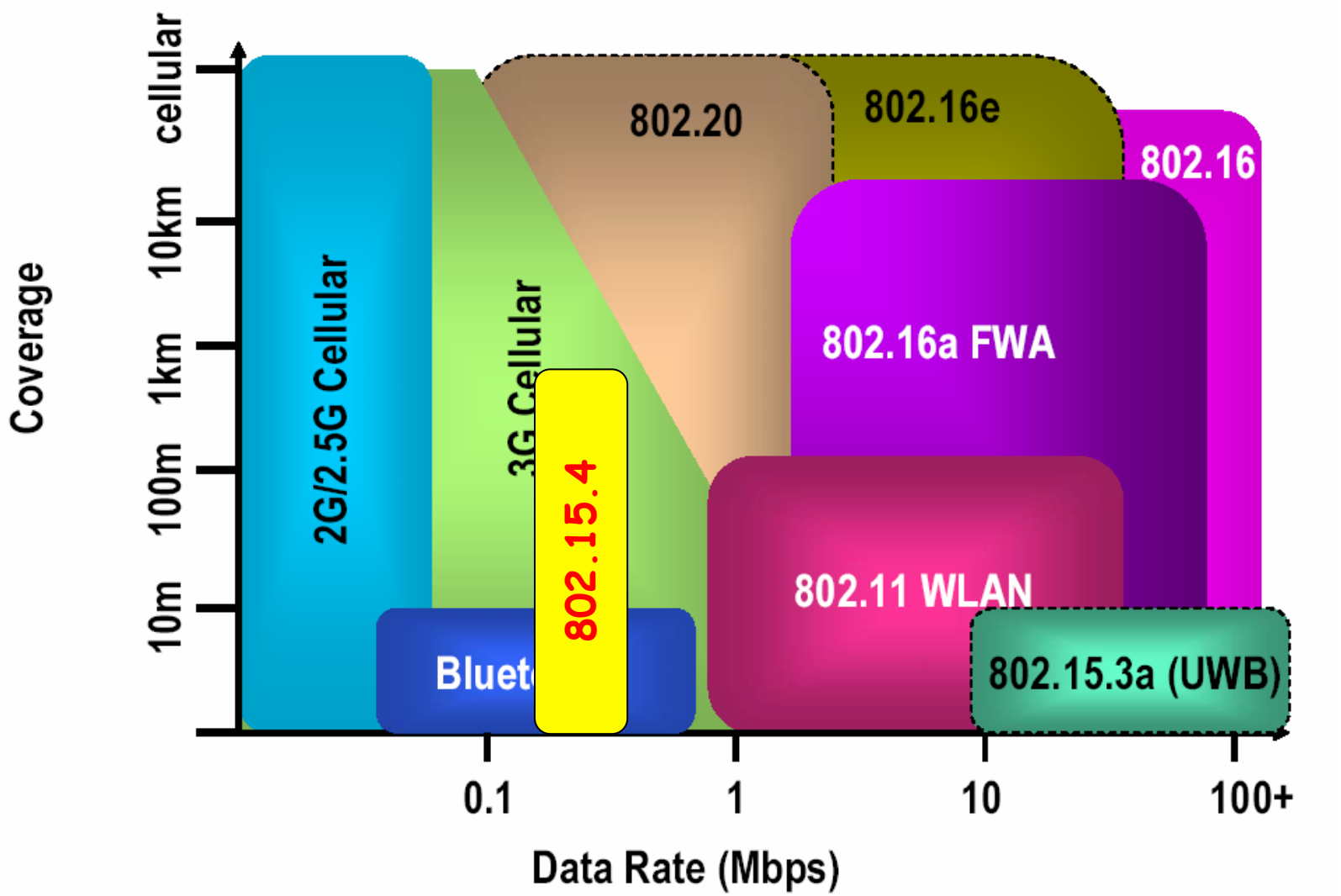


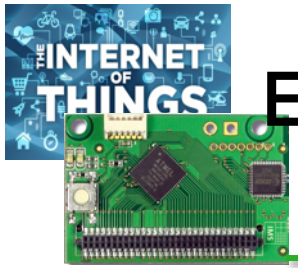


Wireless Communication made easy



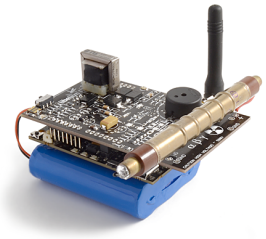
Wireless technologies





Beyond Sensor Networks: Communicating Objects!

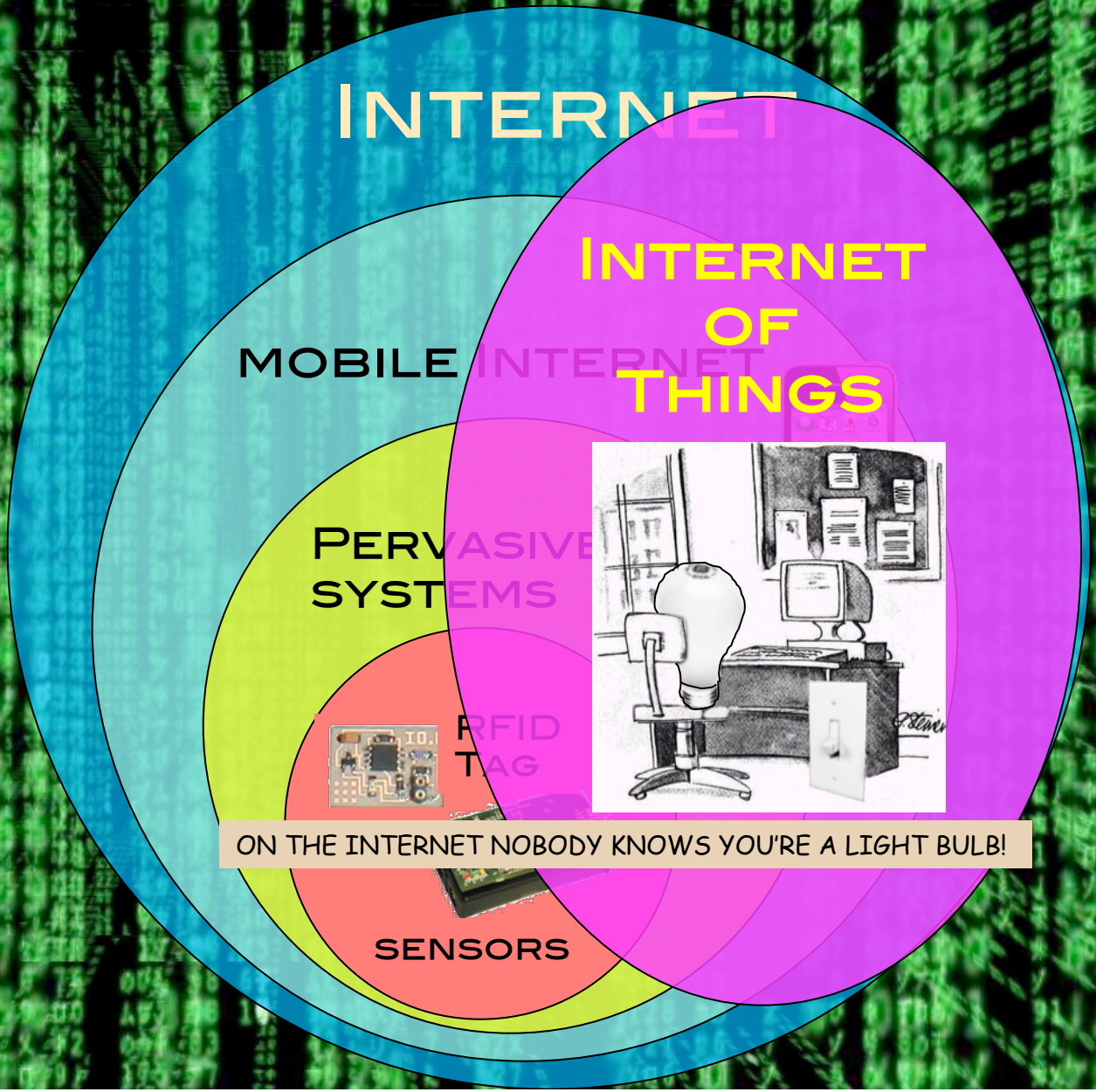
- Native communication:

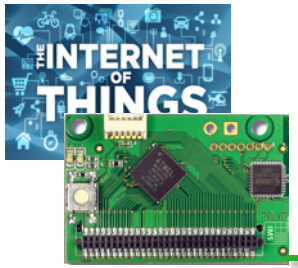


- Added communication
  - Active communication

- Passive communication

Digital Wireless World





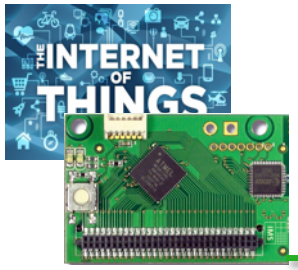
CONTROL, OPTIMIZE & INSTRUMENT !

DATA ANALYSIS, OPTIMIZATION & CONTROL

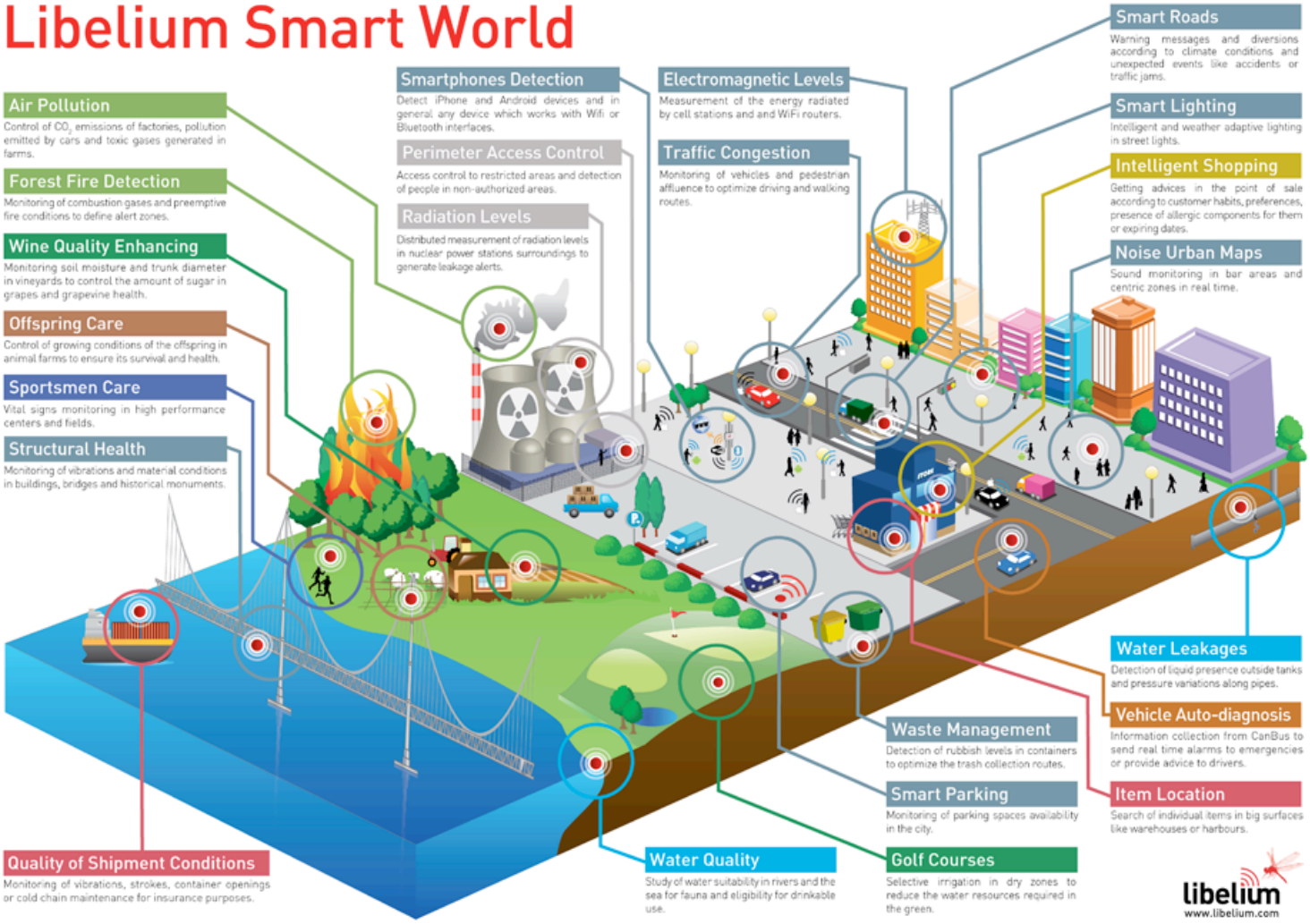
PERVASIVE SYSTEMS

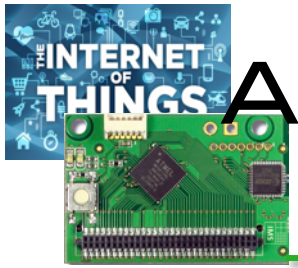
SENSING

PEOPLES, INFRASTRUCTURES, BUILDINGS, VEHICULES

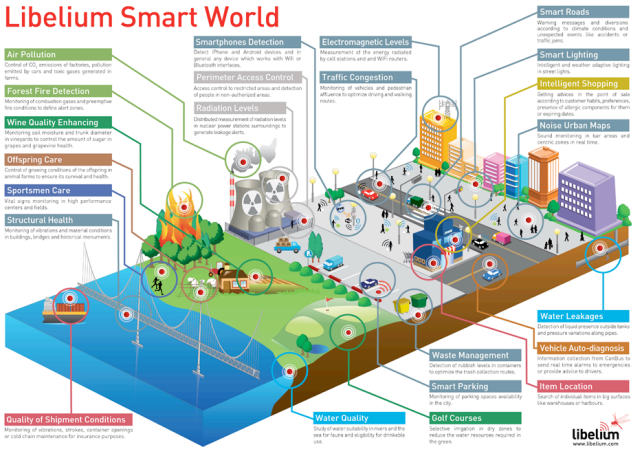


Smart Cities



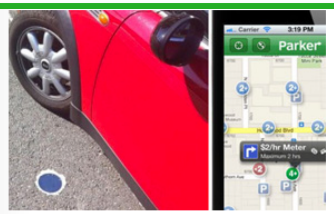


A REAL BUSINESS MODEL IN SMARTCITIES



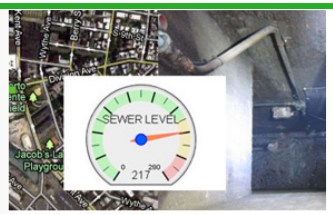
KEEP STREETS CLEAN

Products like the cellular communication enabled Smart Belly trash use real-time data collection and alerts to let municipal services know when a bin needs to be emptied. This information can drastically reduce the number of pick-ups required, and translates into fuel and financial savings for communities service departments. // Visit



STOP DRIVING IN CIRCLES

With the use of installed sensors, mobile apps, and real-time web applications like those provided in Streetline's ParkSight service, cities can optimize revenue, parking space availability and enable citizens to reduce their environmental impact by helping them quickly find an open spot for their cars. // Visit

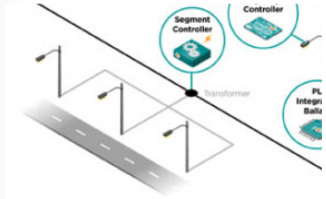


RECEIVE POLLUTION WARNINGS

The DontFlushMe project by Leif Percifield is an example that combines sensors installed in Combined Sewer Overflows (CSOs) with alerts to local residents so they can avoid polluting local waterways with raw sewage by not flushing their toilets during overflow events. // Visit

USE ELECTRICITY MORE EFFICIENTLY

The SenseNET system uses battery-powered clamp sensors to quickly measure current on a line, calculate consumption levels, and send that data to a hosted application for analysis. Significant financial and energy resources are saved as the clamps can easily identify meter tampering issues, general malfunctions, and any installation issues in the system. // Visit



LIGHT STREETS MORE EFFECTIVELY

This smart lighting system from Echelon allows a city to intelligently provide the right level of lighting needed by time of day, season, and weather conditions. Cities have shown a reduction in street lighting energy use by up to 30% using solutions like this. // Visit

SHARE YOUR FINDINGS

AirCasting is a platform for recording, mapping, and sharing health and environmental data using your smartphone. Each AirCasting session lets you capture real-world measurements (Sound levels recorded by their phone microphone; Temperature, humidity, carbon monoxide (CO) and nitrogen dioxide (NO2) gas concentrations), and share it via the CrowdMap with your community. // Visit

http://www.postscapes.com/internet-of-things-examples/

GLOBAL SENSING SCENARIO

Activating

Intelligent Agent

Sending

Activating

Intelligent Agent

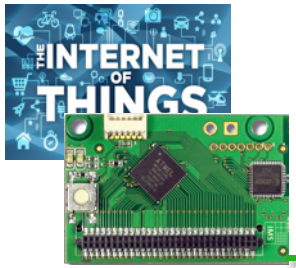
Sending

Activating

Intelligent Agent

Sensor Net

Sending

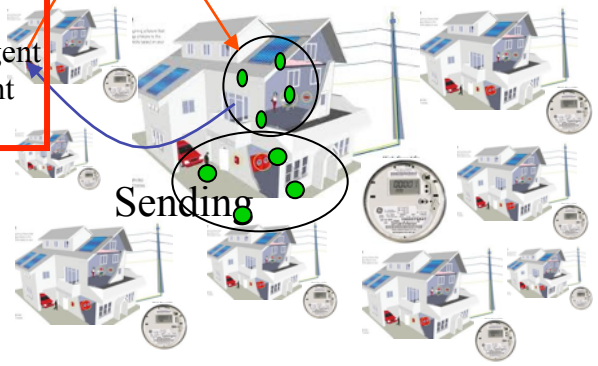


The Rise of Big Data

Activating

Intelligent Agent

Activating



Intelligent Agent

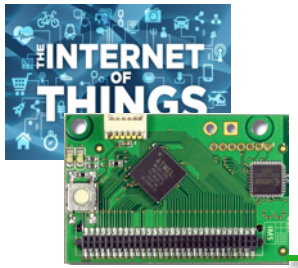
Sending

Activating

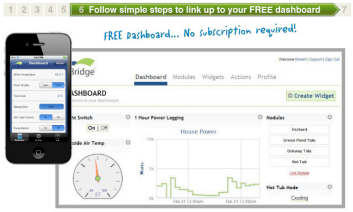
Intelligent Agent

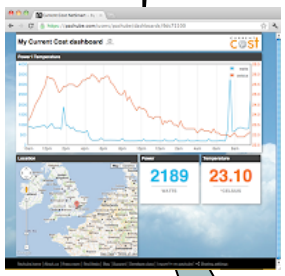
Sensor Net

Sending



Control, optimize & Instrument

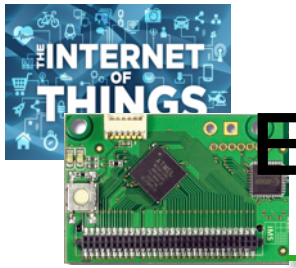




Pervasive Systems

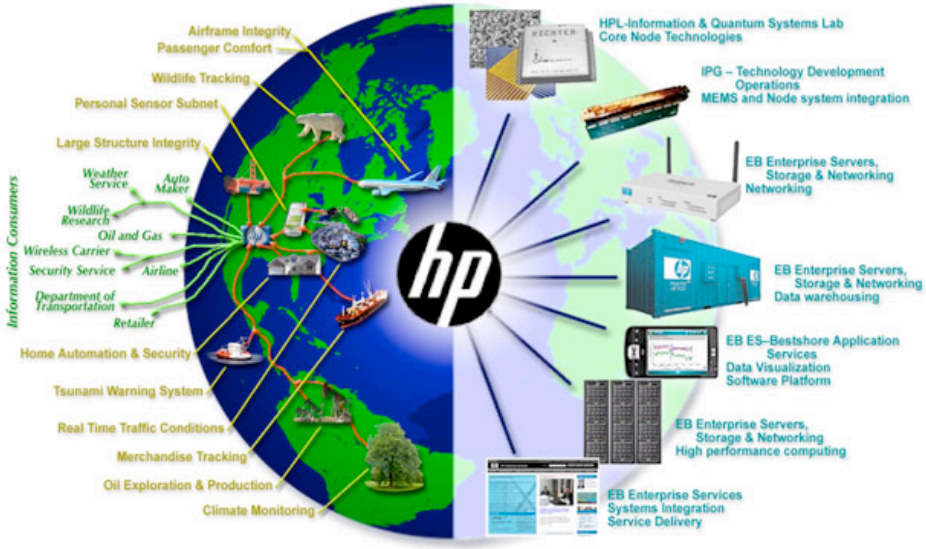
Sensing

Peoples, Infrastructures, Buildings, Vehicules

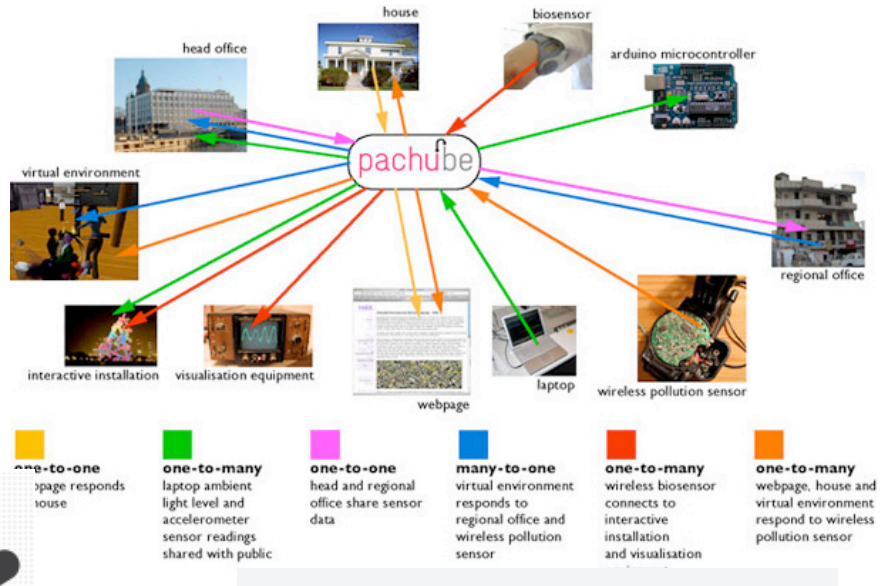


Big actors for big data

HP CeNSE



Pachube/Cosm



IBM Smarter Planet

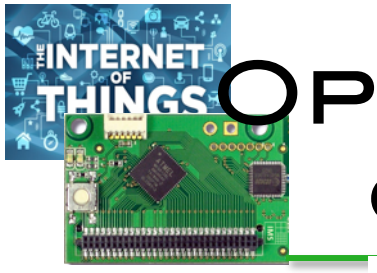
IBM

cosm™ BETA

Connect to your world

http://readwrite.com/2010/12/15/top_10_internet_of_things_developments_of_2010

Opportunities for Telco operators & more...



Transmission rate

Wi Fi

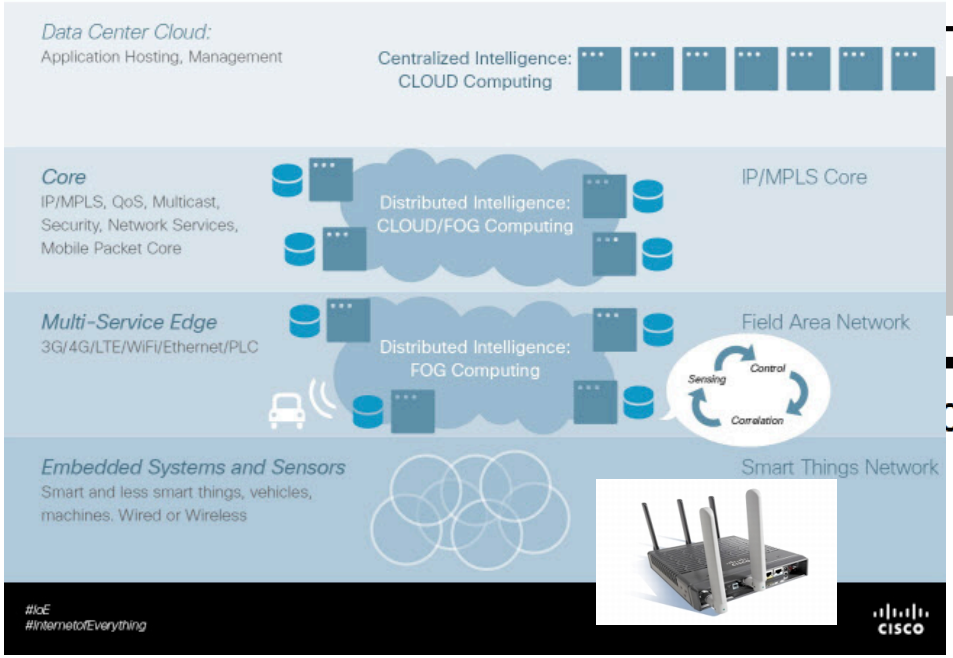
Roving Networks, a leading provider of wireless solutions announced the RN-XVee, its new ultra-low power, through hole 802.11 b/g module that is drop in compatible with existing 802.15.4 modules. 2011

SIGFOX

UMTS, HDPA, LTE, LTE-A

Opportunity for M2M

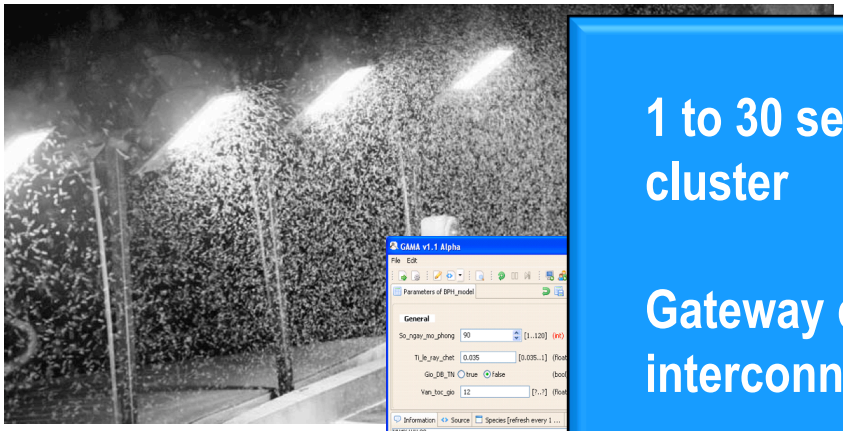
The "Common" Cisco IoT Platform Architecture General Functionality

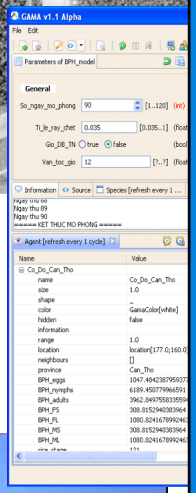


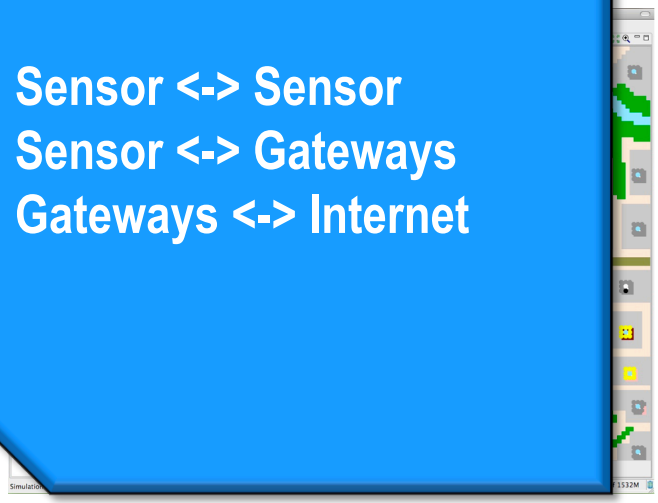
00 m 1 Km 10 Km

in SmartCities"

Typical application







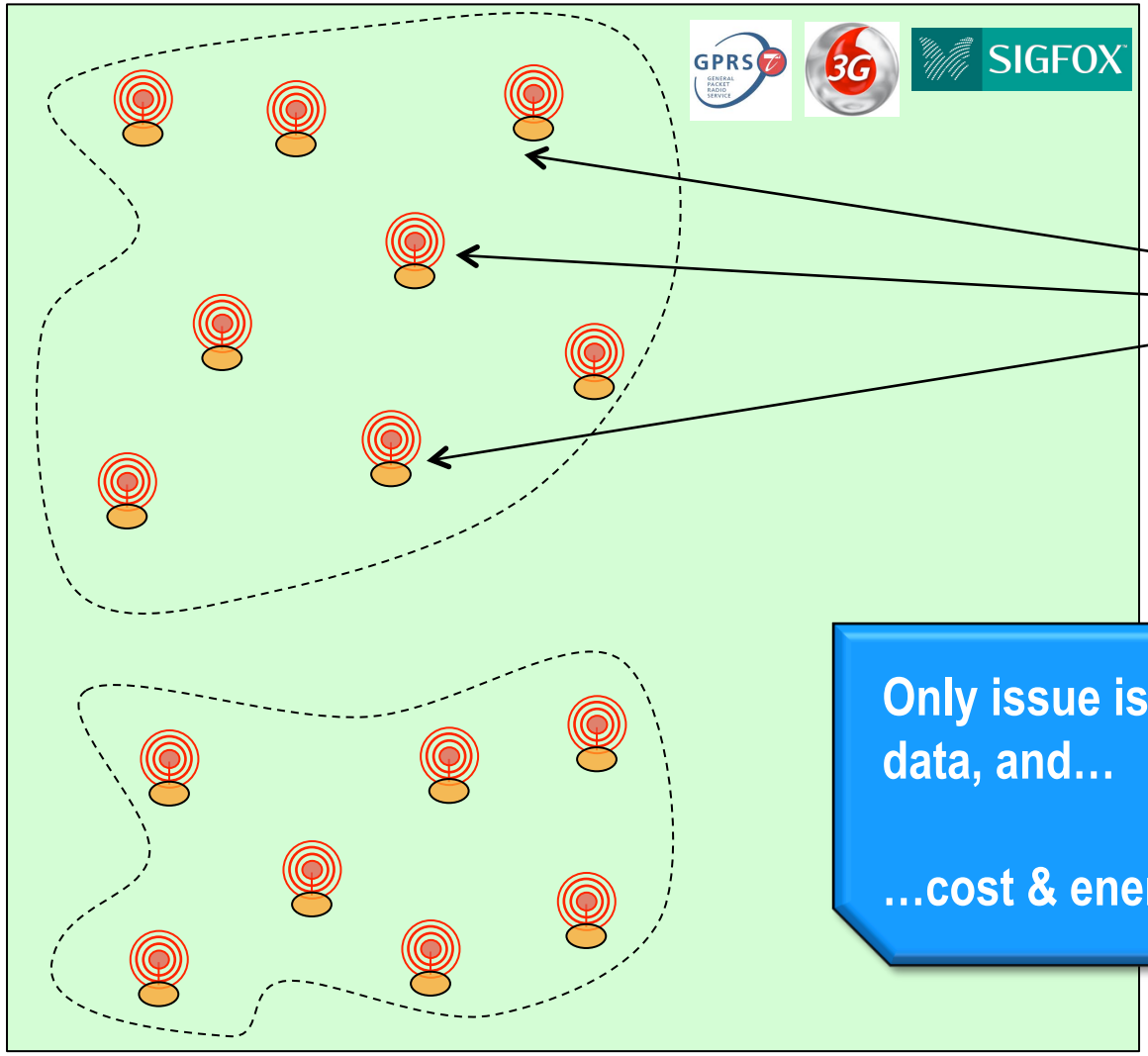
1 to 30 sensor nodes per cluster

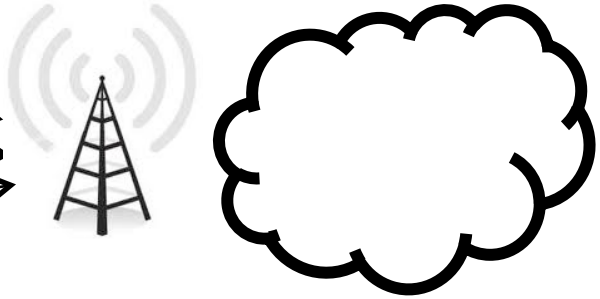
Gateway can interconnect clusters

Communication needs:

Sensor <-> Sensor
Sensor <-> Gateways
Gateways <-> Internet

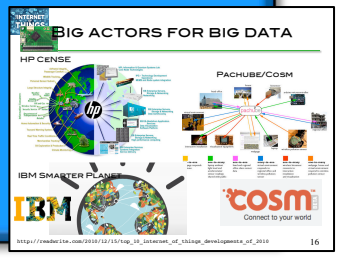
WITHOUT GATEWAYS



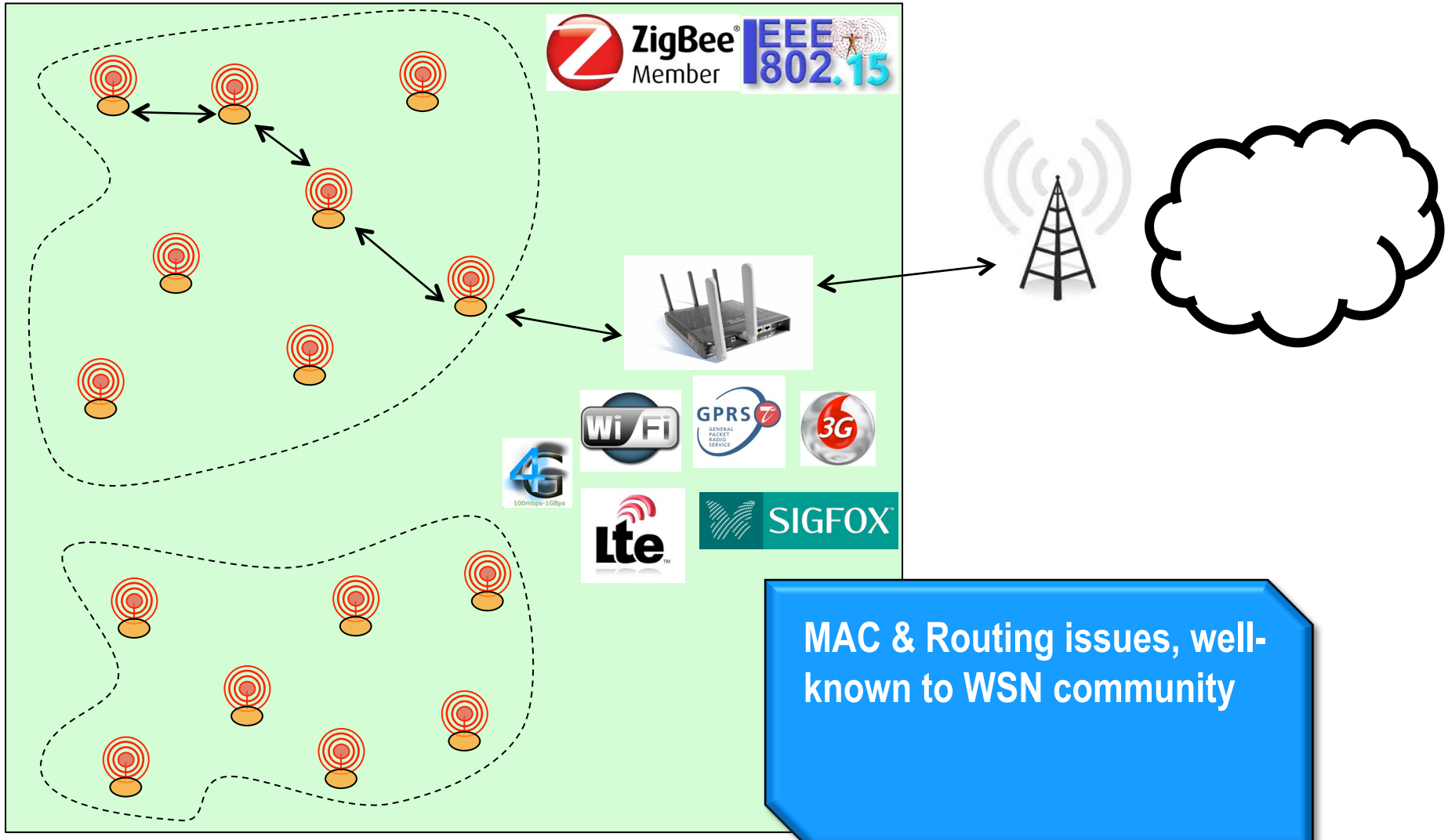


Only issue is to process data, and…

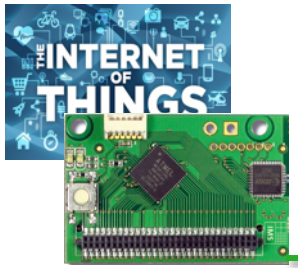
…cost & energy



WITH GATEWAYS



MAC & Routing issues, well-known to WSN community



Are you I-o-T or WSN?

- IP integration, WWW
- IPv6
- Inter-operability
- Interactions (all kind)
- Semantic, Ontology
- Data representation
- Data logging
- WebServices

- Organization
- Programmability
- Energy saving
- Scheduling
- Efficient MAC, routing
- Congestion control
- Data transmission

Digital Wireless World

Wi Fi

wimax

ZigBee® Member

3G

4G 100mbps-1GBps

Lte™

WiMedia ALLIANCE

Internet

In 2025

MOBILE INTERNET

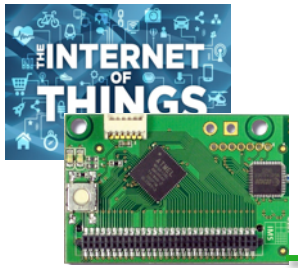
Internet of Things

PERVASIVE SYSTEMS

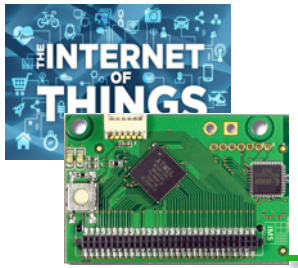
RFID TAG

SENSORS

Machine-to-Machine Communications

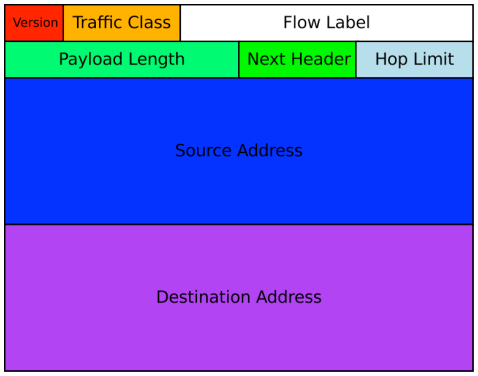


IP protocols will be the standard for IoT!

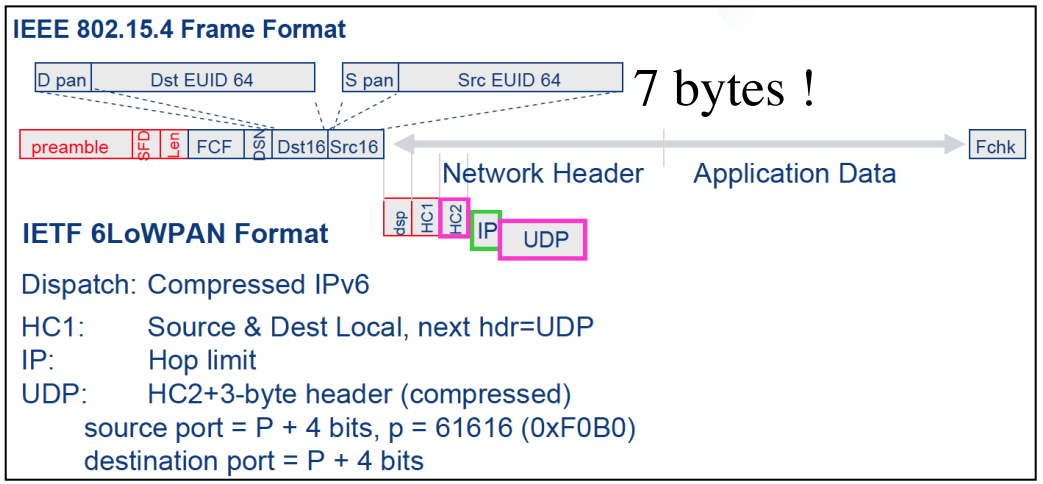


IP need IP addresses!

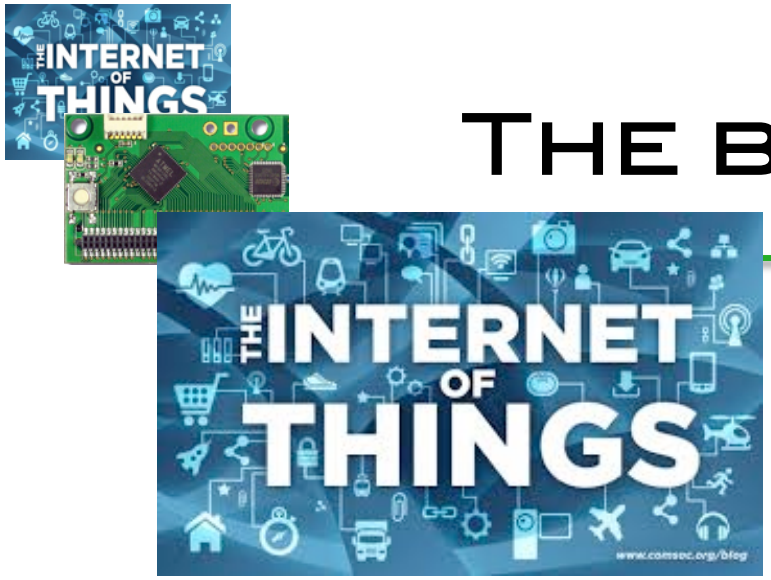
- IPv4 has no more addresses!
- IPv6 gives plenty of addresses
  - 128bit address=16bytes!
- 6LowPAN adapts IPv6 to resource-constrained devices
  - Compressed IPv6 header



40 bytes



The benefit of IP



Don't reinvent the wheel!

RFC 768	UDP - User Datagram Protocol	[1980]
RFC 791	IPv4 – Internet Protocol	[1981]
RFC 792	ICMPv4 – Internet Control Message Protocol	[1981]
RFC 793	TCP – Transmission Control Protocol	[1981]
RFC 862	Echo Protocol	[1983]
RFC 1101	DNS Encoding of Network Names and Other Types	[1989]
RFC 1191	IPv4 Path MTU Discovery	[1990]
RFC 1981	IPv6 Path MTU Discovery	[1996]
RFC 2131	DHCPv4 - Dynamic Host Configuration Protocol	[1997]
RFC 2375	IPv6 Multicast Address Assignments	[1998]
RFC 2460	IPv6	[1998]
RFC 2765	Stateless IP/ICMP Translation Algorithm (SIIT)	[2000]
RFC 3068	An Anycast Prefix for 6to4 Relay Routers	[2001]
RFC 3307	Allocation Guidelines for IPv6 Multicast Addresses	[2002]
RFC 3315	DHCPv6 - Dynamic Host Configuration Protocol for IPv6	[2003]
RFC 3484	Default Address Selection for IPv6	[2003]
RFC 3587	IPv6 Global Unicast Address Format	[2003]
RFC 3819	Advice for Internet Subnetwork Designers	[2004]
RFC 4007	IPv6 Scoped Address Architecture	[2005]
RFC 4193	Unique Local IPv6 Unicast Addresses	[2005]
RFC 4291	IPv6 Addressing Architecture	[2006]
RFC 4443	ICMPv6 - Internet Control Message Protocol for IPv6	[2006]
RFC 4861	Neighbor Discovery for IP version 6	[2007]
RFC 4944	Transmission of IPv6 Packets over IEEE 802.15.4 Networks	[2007]

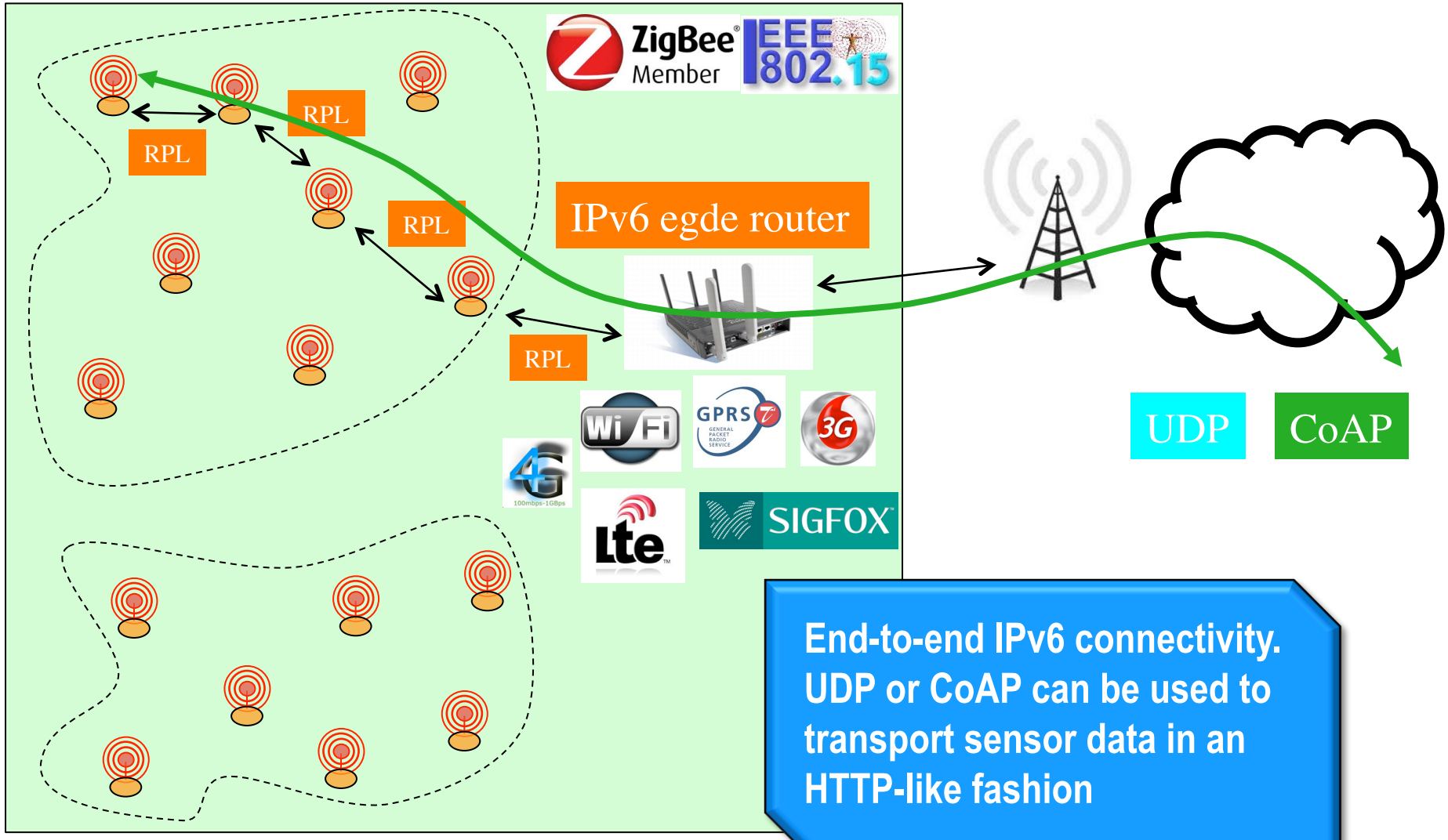
From ArchRock "6LowPan tutorial"

CoAP
Constrained Application Protocol

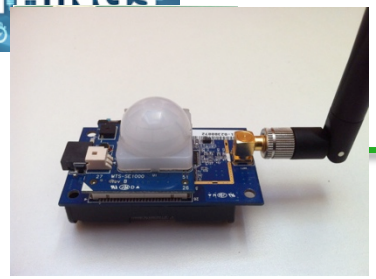
RPL
Routing Protocol for LLN
LLN: Low power & Lossy Networks

6LowPan
802.15.4

Using IP protocols

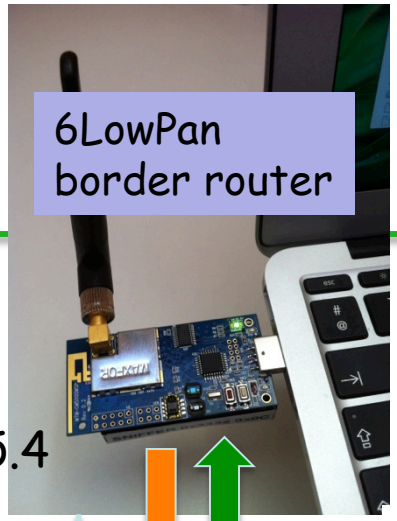


End-to-end IPv6 connectivity. UDP or CoAP can be used to transport sensor data in an HTTP-like fashion



get

ack



CoAP/6LowPan/IEEE 802.15.4
RPL routing

IPv6

ack

get

Wi Fi

Client/User-
initiated scenario
(e.g. temp. sensor)

INTERNET

ack

IPv6

get

112	106.575520000	fe80::212:6d45:50b7:6a0f	fe80::212:6d45:5026:34cc	ICMPv6	94	RPL Control (Destination Advertisement Object),
113	106.576064000			IEEE 802.15.4	5	Ack, Bad FCS
114	106.576608000			IEEE 802.15.4	5	Ack, Bad FCS
115	113.692576000	fe80::212:6d45:50b7:7575	fe80::212:6d45:5026:34cc	ICMPv6	94	RPL Control (Destination Advertisement Object),
116	114.080416000	fe80::212:6d45:50b7:7575	[illegible]	ICMPv6	94	RPL Control (Destination Advertisement Object),
117	114.[illegible]			IEEE 802.15.4	5	Ack, Bad FCS
118	116.008352000	2001:620:607:5b10::a	::ff:fe00:28	COAP	60	Confirmable, GET, End of Block #15, Bad FCS
119	116.008896000			IEEE 802.15.4	5	Ack, Bad FCS
120	116.292576000	::ff:fe00:28	2001:620:607:5b10::a	COAP	65	Acknowledgement, 2.05 Content, End of Block #[illegible]
121	116.[illegible]			IEEE 802.15.4	5	Ack, Bad FCS
122	116.544800000	fe80::212:6d45:50b7:[illegible]	[illegible]	[illegible]	94	RPL Control (Destination Advertisement Object),
123	116.545344000			IEEE 802.15.4	5	Ack, Bad FCS
124	116.545888000			IEEE 802.15.4	5	Ack, Bad FCS
125	116.546432000			IEEE 802.15.4	5	Ack, Bad FCS
126	121.702624000	fe80::212:6d45:50b7:7e21	fe80::212:6d45:5026:34cc	ICMPv6	94	RPL Control (Destination Advertisement Object),
127	121.703168000			IEEE 802.15.4	5	Ack, Bad FCS
128	123.968480000	fe80::212:6d45:50b7:7575	fe80::212:6d45:5026:34cc	ICMPv6	94	RPL Control (Destination Advertisement Object),
129	123.969024000			IEEE 802.15.4	5	Ack, Bad FCS
130	127.058048000	fe80::212:6d45:50b7:69b3	fe80::212:6d45:50b7:6a0f	ICMPv6	94	RPL Control (Destination Advertisement Object),
131	127.058592000			IEEE 802.15.4	5	Ack, Bad FCS
132	127.344416000	fe80::212:6d45:50b7:6a0f	fe80::212:6d45:5026:34cc	ICMPv6	94	RPL Control (Destination Advertisement Object),

to actuators

RPL and CoAP exchanges

Browse and run installed applications

k 1.7.2 (SVN Rev 42506 from /trunk)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

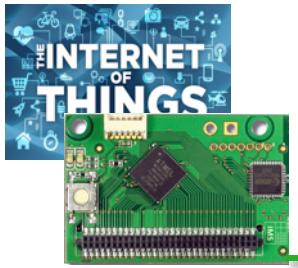
No.	Time	Source	Destination	Protocol	Length	Info	SN	Time
1	0.000000000	0x0078	0x0000	IEEE 802.15.4	35	Data, Dst: 0x0000, Src: 0x0078, Bad FC	1	0.000000000
2	3.253408000	fe80::212:6d45:50cc:16b4	fe80::ff:fe00:1	ICMPv6	88	RPL Control (Destination Advertisement	55	3.253408000
3	3.253952000			IEEE 802.15.4	5	Ack, Bad FCS	55	0.000544000
4	13.642912000	fe80::212:6d45:50cc:16b4	fe80::ff:fe00:1	ICMPv6	88	RPL Control (Destination Advertisement	56	10.388960000
5	13.643456000			IEEE 802.15.4	5	Ack, Bad FCS	56	0.000544000
6	24.023584000	fe80::212:6d45:50cc:16b4	fe80::ff:fe00:1	ICMPv6	88	RPL Control (Destination Advertisement	57	10.380128000
7	24.024128000			IEEE 802.15.4	5	Ack, Bad FCS	57	0.000544000
8	25.457824000	::ff:fe00:100	::ff:fe00:3	COAP	39	Confirmable, PUT (text/plain), Bad FCS	12	1.433696000
9	25.458368000			IEEE 802.15.4	5	Ack, Bad FCS	12	0.000544000
10	25.479296000	::ff:fe00:3	::ff:fe00:100	COAP	41	Acknowledgement, 2.04 Changed (text/pl	58	0.020928000
11	25.479840000			IEEE 802.15.4	5	Ack, Bad FCS	58	0.000544000
12	34.462976000	fe80::212:6d45:50cc:16b4	fe80::ff:fe00:1	ICMPv6	88	RPL Control (Destination Advertisement	59	8.983136000
13	34.463520000			IEEE 802.15.4	5	Ack, Bad FCS	59	0.000544000
14	45.451072000	fe80::212:6d45:50cc:16b4	fe80::ff:fe00:1	ICMPv6	88	RPL Control (Destination Advertisement	60	10.987552000
15	45.451616000			IEEE 802.15.4	5	Ack, Bad FCS	60	0.000544000
16	56.289696000	fe80::212:6d45:50cc:16b4	fe80::ff:fe00:1	ICMPv6	88	RPL Control (Destination Advertisement	61	10.838080000
17	56.290240000			IEEE 802.15.4	5	Ack, Bad FCS	61	0.000544000
18	64.688096000	::ff:fe00:100	::ff:fe00:3	COAP	37	Confirmable, PUT (text/plain), Bad FCS	13	8.397856000
19	64.688640000			IEEE 802.15.4	5	Ack, Bad FCS	13	0.000544000
20	64.707744000	::ff:fe00:3	::ff:fe00:100	COAP	39	Acknowledgement, 2.04 Changed (text/pl	62	0.019104000
21	64.708288000			IEEE 802.15.4	5	Ack, Bad FCS	62	0.000544000
22	66.698080000	fe80::212:6d45:50cc:16b4	fe80::ff:fe00:1	ICMPv6	88	RPL Control (Destination Advertisement	63	1.989792000

▸ Frame 1: 35 bytes on wire (280 bits), 35 bytes captured (280 bits) on interface 0
▸ IEEE 802.15.4 Data, Dst: 0x0000, Src: 0x0078, Bad FCS
▸ Data (24 bytes)

```
0000  41 88 01 34 12 00 00 78  00 3f 00 77 69 72 65 73   A..4...x .?.wires
0010  68 61 72 6b 20 66 6f 6e  63 74 69 6f 6e 6e 65 20   hark fon ctionne
0020  21 ab 00                                          !..
```

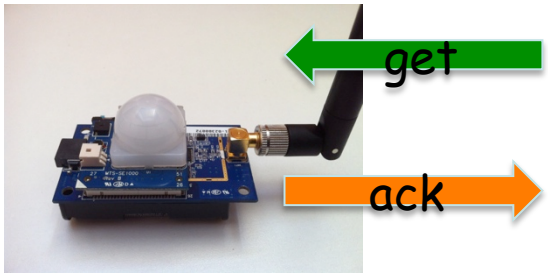
File: "/tmp/wireshark_-_20140327... ... Profile: Default

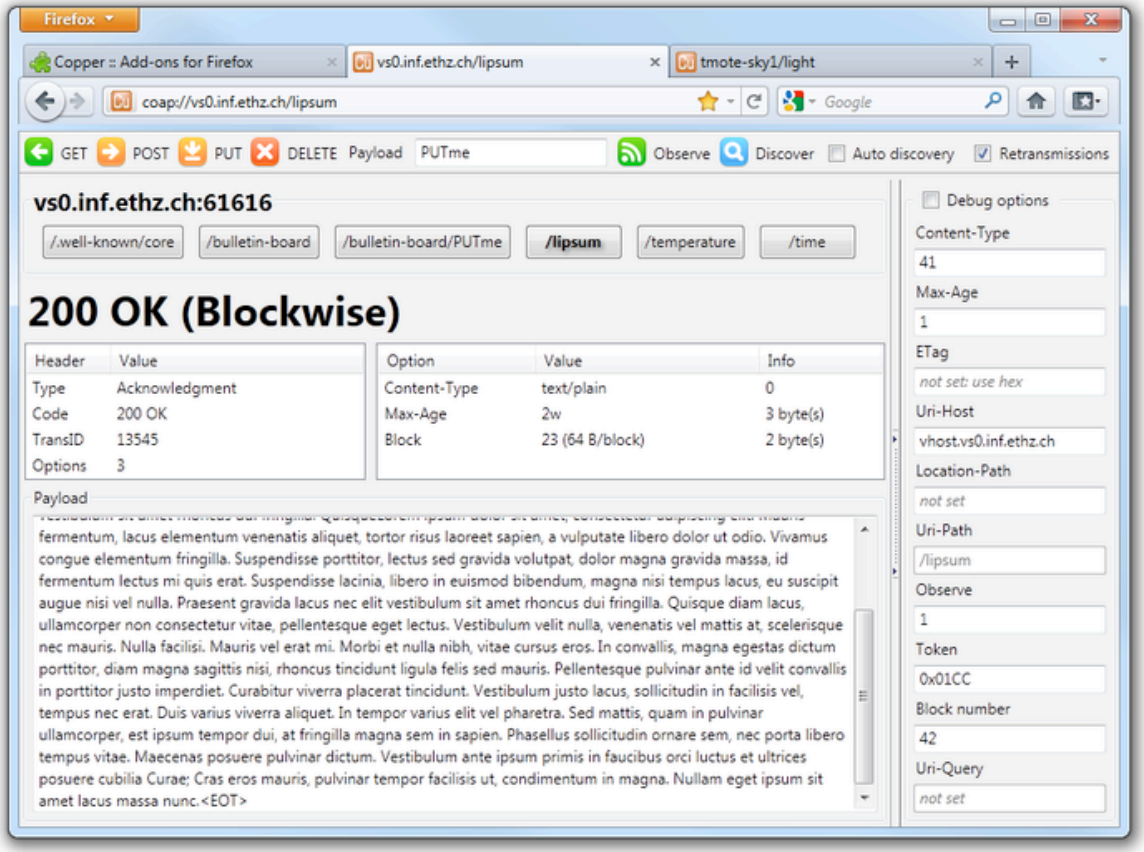
user@instant-contiki: ... Standard input [Wire...

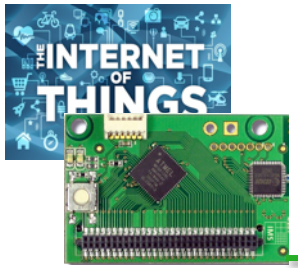


Copper for Firefox

- CoAP pluggin to query CoAP nodes in an HTTP-like fashion







What do you need?

CoAP
Constrained Application Protocol

→ **Need a CoAP implementation**

RPL
Routing Protocol for LLN
LLN: Low power & Lossy Networks

→ **Need an RPL implementation**

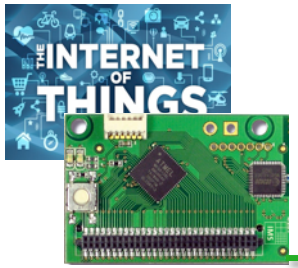
6LowPan
802.15.4

→ **Not difficult, just formatting of packets**

TinyOS

Contiki

Arduino (Telecom Bretagne)



Conclusions

- The Internet-of-Thing is becoming a reality with huge mass-market potential
- A lot of money will be invested in these technologies and elaborated products will be available
- IP protocols are de-facto standard and everything's ready for full IoT IP connectivity
- WSN will become part of IoT and IP will make the infrastructure a lot easier to deploy and manage…
- …then scientists could focus on how to exploit the data