SUPPORT RÉSEAU INTERNET POUR LES OBJETS INTELLIGENTS ET LE M2M

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OBJETS "INTELLIGENTS" ?

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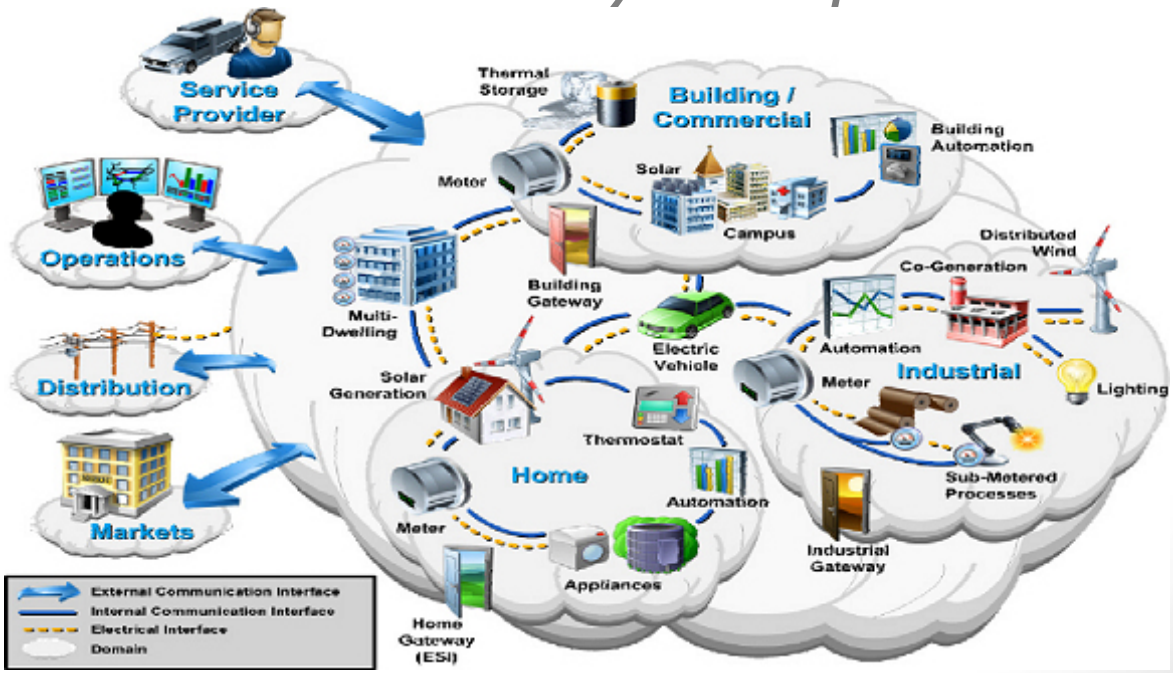
M2M NETWORKS ?

- Machine to Machine communication

- Includes: *sensors, smart phones, RFID, credit cards, PCs, servers, actuators, badges, meters …* ***objects with a networking capability***

- No-human in the communication system loop: *services*



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GLOBAL OUTLINE

1. (Context)

2. Applications

3. Hardware technology

4. Software support

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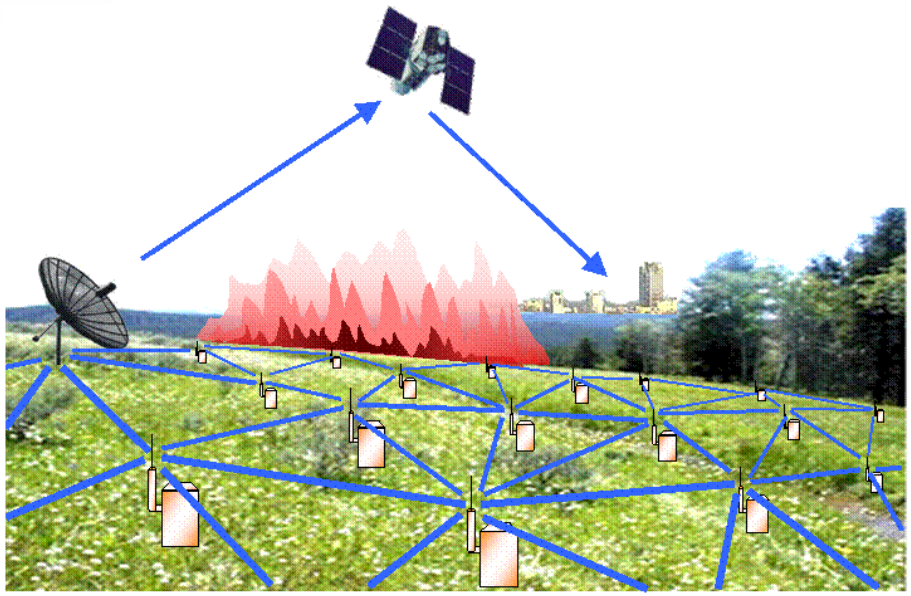
Military & disaster apps

- (4C's) Command, control, communications, computing
- Intelligence, surveillance, reconnaissance, management
- Targeting systems, Rescue, intrusion



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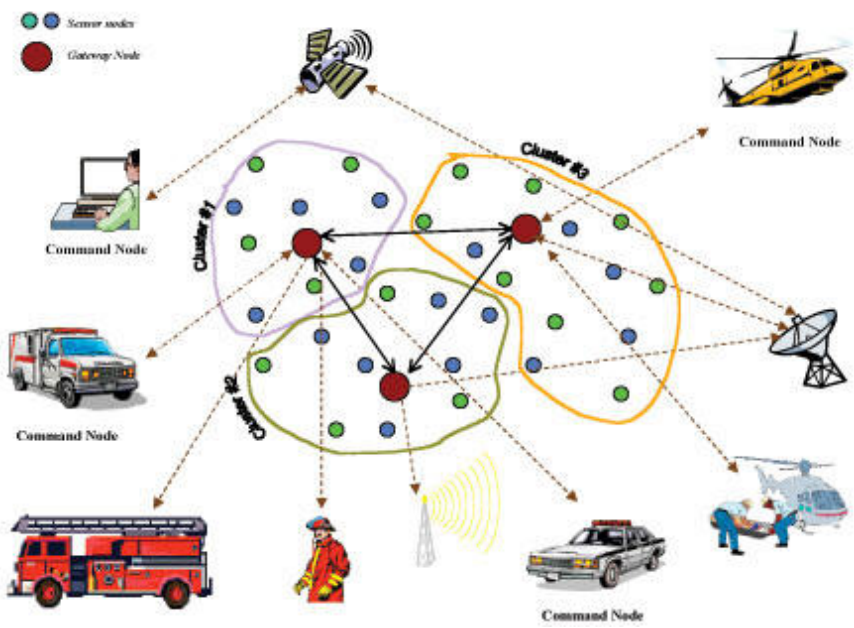
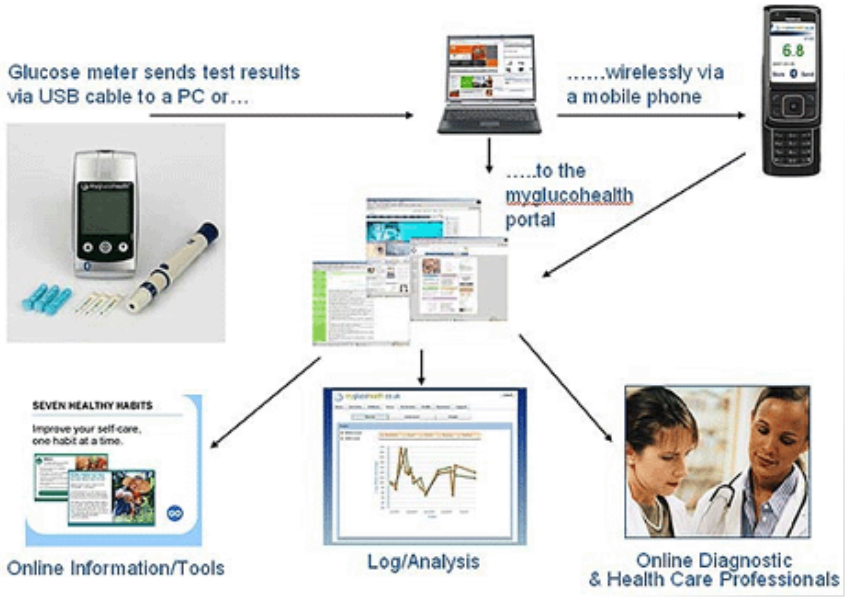
Human care apps

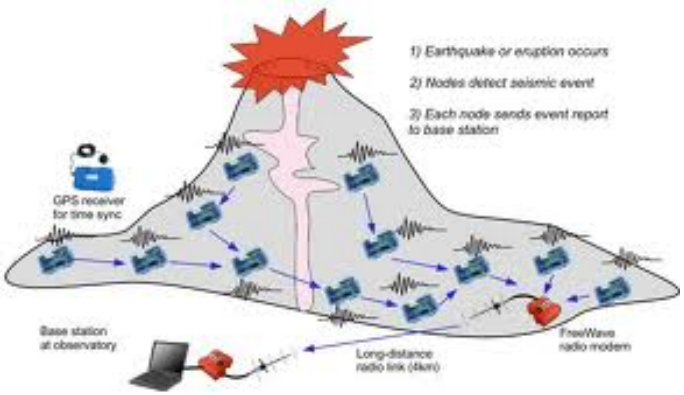
- Monitor patients, integrated biology
- Assist disabled patients, athletes
- Track contaminated tools
- Medical alarm





Environmental & structural apps

- Structure monitoring: stress, sliding, …
- Agriculture systems: weather, soil analysis, animal monitoring,
- Environment monitoring: crow, humidity, flood, habitat, ...



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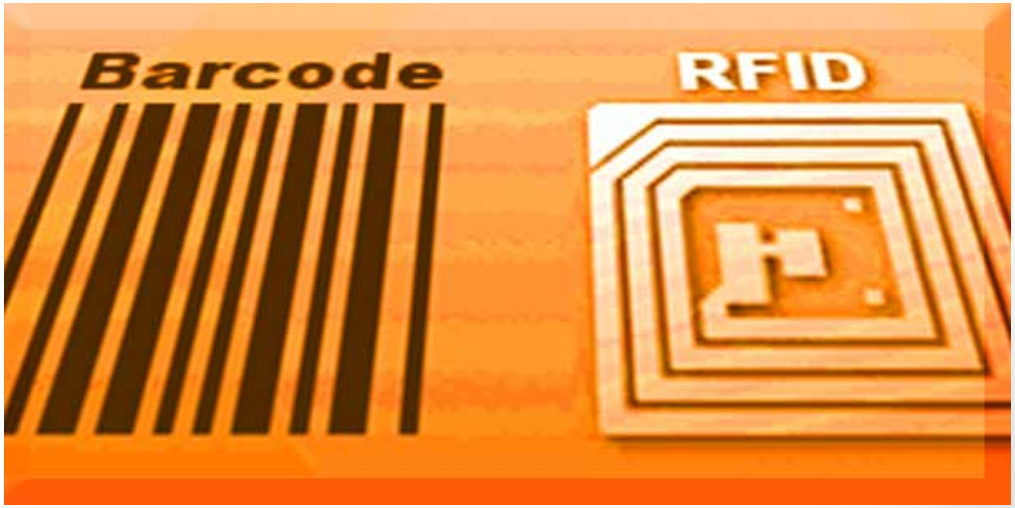
Industry & Commercial apps

- Logistics, supply-chain
- Inventory
- Product quality
- Product tracking
- Automation
- Cars
- Planes



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Building automation & metering apps

- Home
- City
- Campus
- Smart grid
- Energy efficiency

All the Remote Services apps

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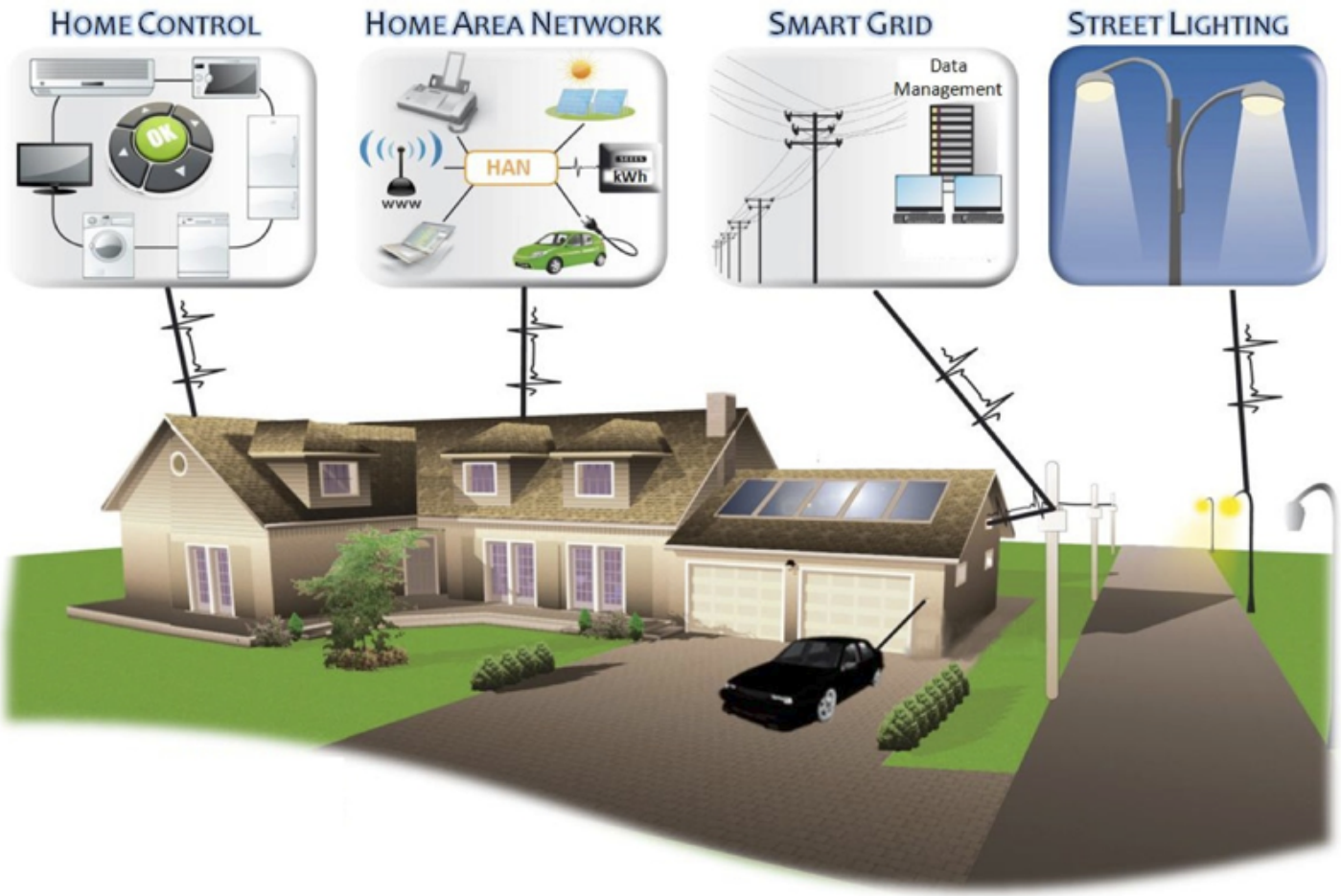

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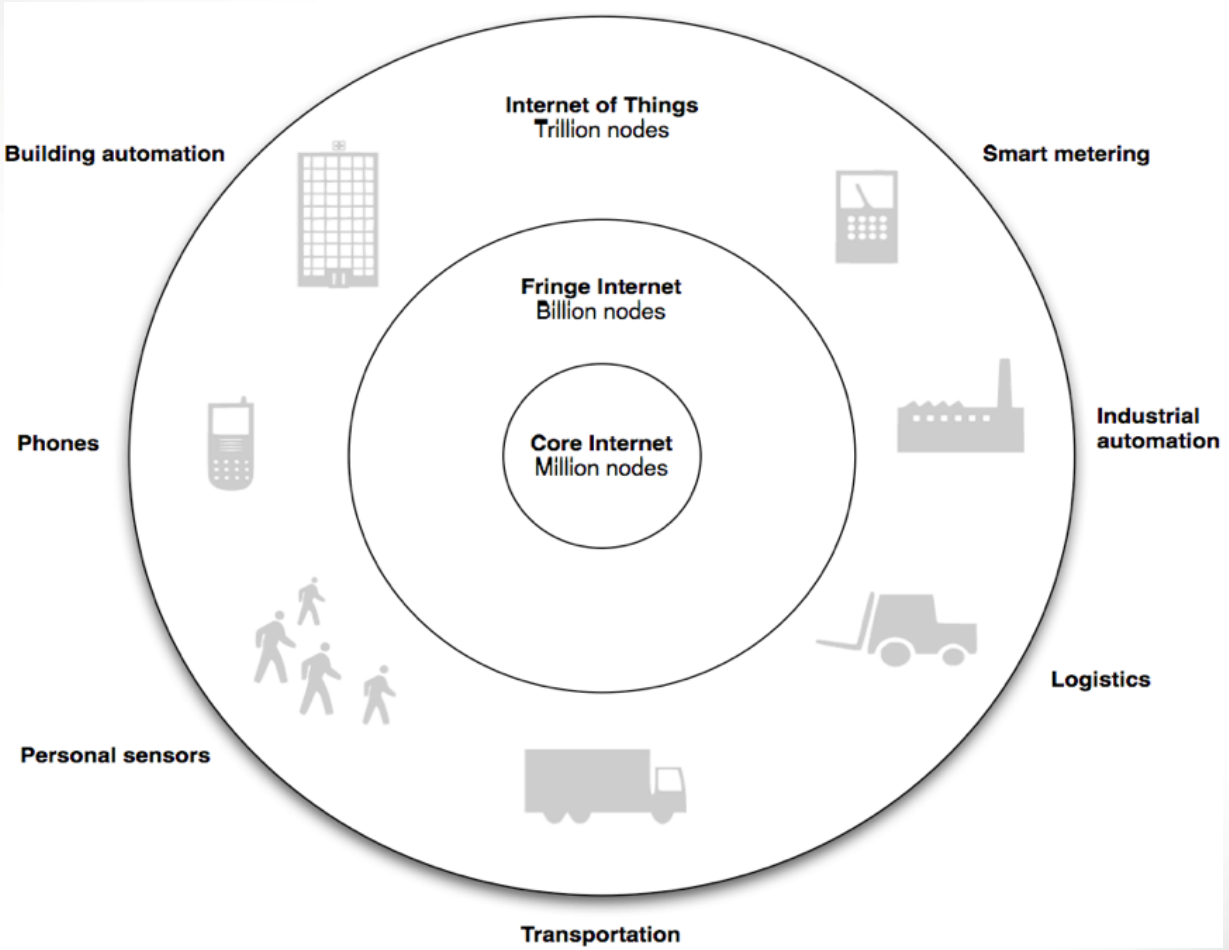
Internet scalability



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M2M Emerging characteristics

- **Long lifetime**, similar to embedding objects' lifetime
- **Autonomous**
- **Self-everything**: configuration, healing, organisation, ...
- **High-tech** but **low ressources**
- **Low IT performance** ? Second vs ns ? kb/s ?
- **New and Multiple Performance Metrics**: Lifetime, Robustness, Formfactor, Usage easiness, Power consumption, Scalability
- **Network Parameters**: Density, Mobility, Self-recovery, Dealy Tolerant, Autoconfigurable, Resilience, Connectivity, Fault-tolerant, Secure, ...
- **Application Parameters**: Sample rate, Precision, ...

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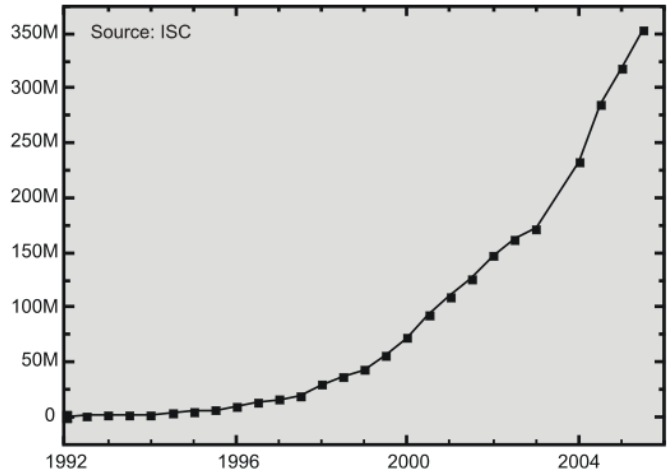
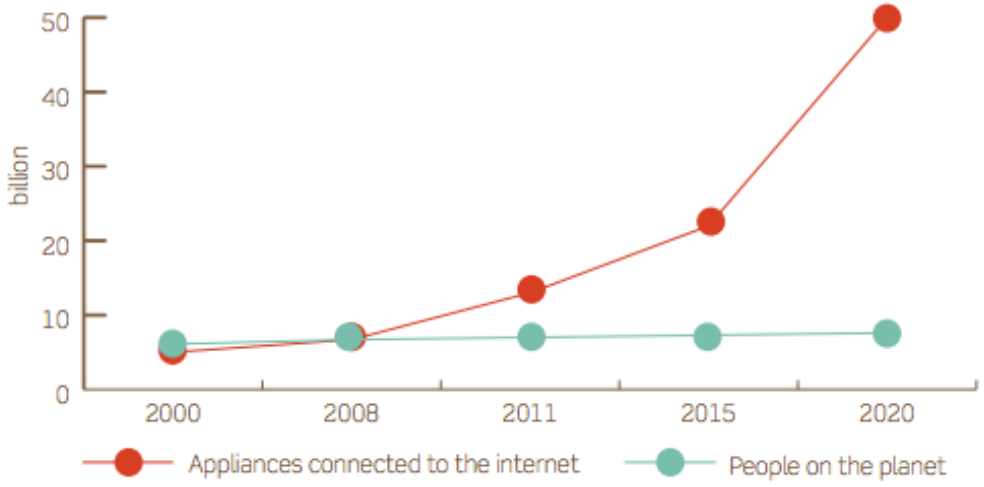
History at the Internet Pace

- 1980 DARPA DSN
  - Arpanet with 200 nodes
  - Mobile means in a truck
- 2000 DARPA SensIT
  - Internet Billion nodes
  - SoC fits in mm^2



Source: The Alexandra Institute 2011: Tegneserien om Tingenes Internet



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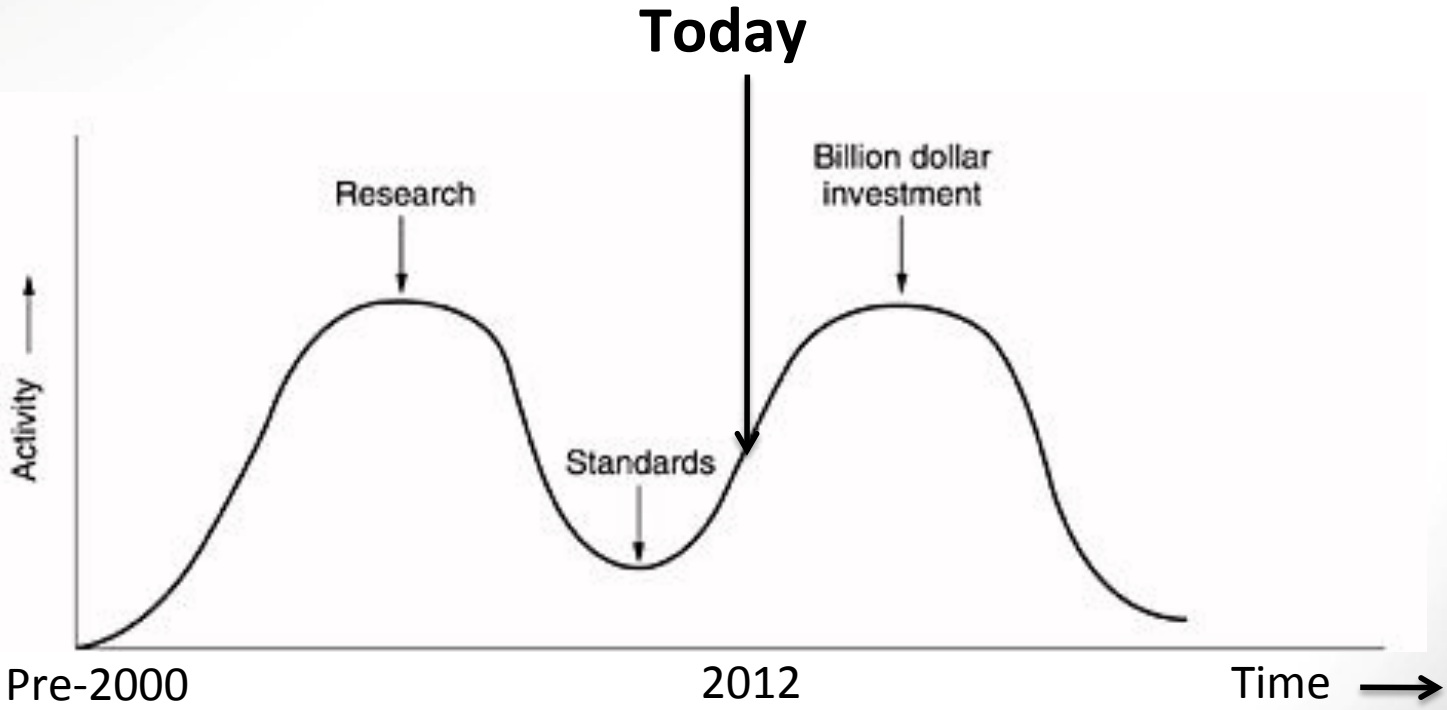
Moore+Bell's laws revisited

IoT : Where are we Today ?

- « Apocalypse of the two elephants » (D. Clarke – MIT)



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Academic Hardware Platforms

WeC 99
"Smart Rock"

Small microcontroller
8 kB code
512 B data

Simple, low-power radio
10 kbps ASK

EEPROM (32 KB)

Simple sensors

Rene 11/00

Designed for experimentation

-sensor boards

-power boards

Dot 9/01

Demonstrate scale

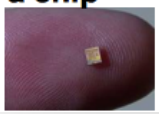
Mica 1/02

NEST open exp. Platform
128 kB code, 4 kB data
40kbps OOK/ASK radio
512 kB Flash

Telos 4/04
Robust
Low Power
250kbps
Easy to use

Mica2 12/02
38.4kbps radio

Spec 6/03
"Mote on a chip"



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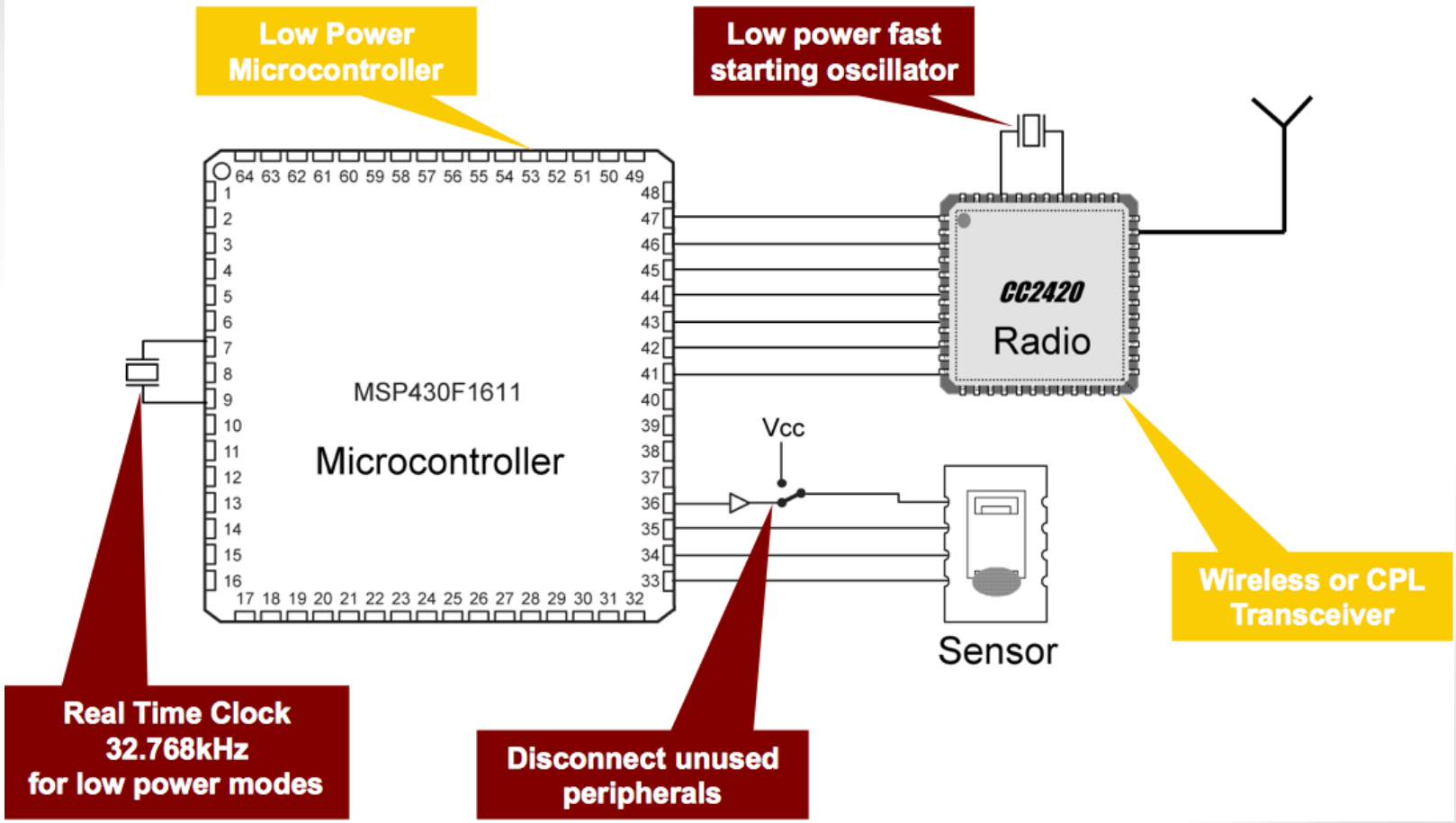
SoC type Architecture



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Standards for the Internet of Things

APP

– ETSI M2M

NET

– CORE (CoAP)
– ROLL (RPL)
– IP (v6)
– 6LoWPAN (HC + ND)

MAC
PHY

– P1901.2
– 802.15.4
  • 2006-2011 / E / G

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Industry alliances

enocean alliance
No Wires. No Batteries. No Limits.

IPSO Alliance

wave 2M
open low power wireless standard

Z-WAVE ALLIANCE™

DASH7™ ALLIANCE

HOMEPLUG®
POWERLINE ALLIANCE

PRIME ALLIANCE

G3-PLC™ Alliance

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Historic crossover

- Microcontroller, Wireless & PLC tranceivers designed for embedded
- Low cost SoC
- Ubiquitous Internet
- Power supply ?
- Operating system ?
- Ipv6 stack ?

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Battery Technology: no Moore's Law

Battery	Rechargeable	Gravimetric Density (Wh/lb)	Volumetric Density (Wh/l)
Alkaline MnO2	No	65,8	347
Silver Oxide	No	60	500
Li/MnO2	No	105	550
Zinc Air	No	140	1150
NiCd	Yes	23	125
Li-Polymer	Yes	65-90	300-415

- Technology improves very slow !
  - NiCd improved by x2 over 30 years!
  - Require breakthroughs in chemistry ;-)

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Key issue I: Energy-awareness

- Typical consumption: 1xRF = 1000xCPU
- Low power
  - Circuits, architectures, operating system, protocols
- Power management
  - Right power at the right place at the right time
  - Seldom communication
  - Sleep, sleep, sleep
- Energy system
  - Battery, scavenging, supercapacitor

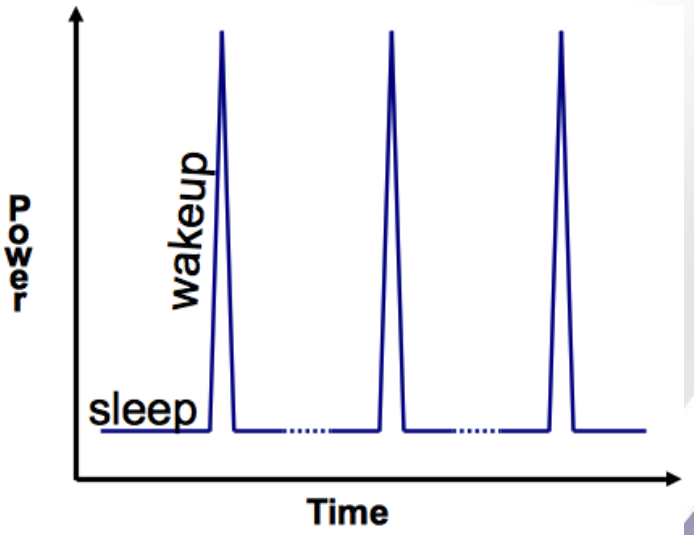
Power Budget : Watteco IPSensor Example

- Sleep
  - Majority of the time (>99,9 %)
  - µC + RF: 1.4 µA (with low power low frequ. oscillator)

- Wakeup
  - As quickly as possible to process and communicate then return to sleep
  - Time : 290ns typical, 5µs max

- Active
  - Get your work done and get back to sleep
  - µC = 1,84 mA (at 8 MHz)
  - Radio sending 1 byte: 2.55µJ (868 MHz – 20 kbps)
  - Radio receiving 1 byte: 1,38µJ (868 MHz – 20 kbps)

- Lifetime
  - Average consumption < 10 µA (10 min Reports)
  - >10 Years on a 1000 mAh battery



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Key issue II: MCU memory (kbytes)

How to fit **numerous** softwares, from drivers to service oriented middleware, in very constrained devices ?

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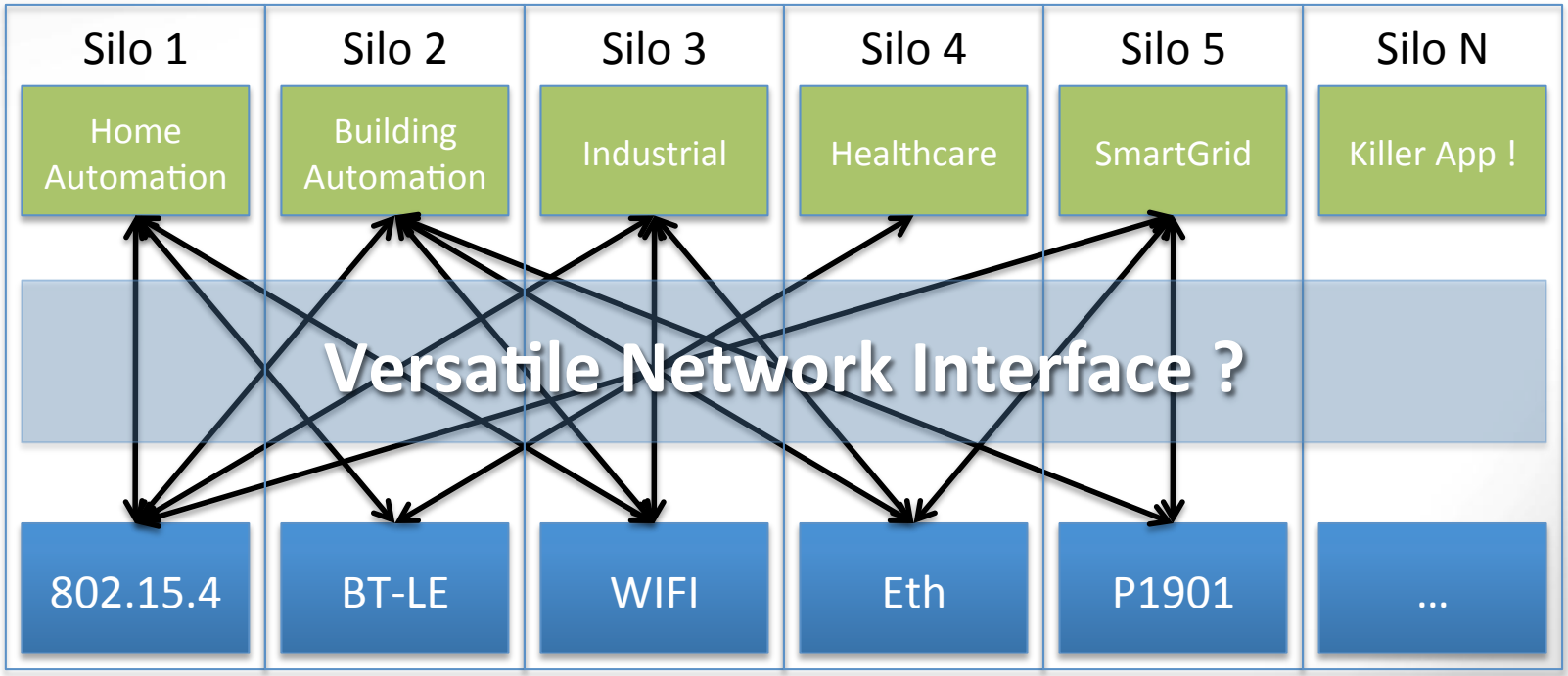
Break Silos !

Knowledge silo
Knowledge silos create borders between people, which prevent knowledge sharing and collaboration

Avoid NxN complexity : Think Horizontal

Collaborative knowledge
Bringing down the knowledge silos enables the stakeholders to recognise their shared interests



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IPv6 for Smart Objects

Think Horizontal = Use IP(v6)

Why IP ?

- **Open and Flexible Standard** (Multiple physical interfaces)
- **Lightweight** (through 6LoWPAN)
- **Versatile** (Multiple applications & use cases)
- **Ubiquitous** (Most widely used network protocol)
- **Scalable** & **Manageable** (Already connects thousands of devices)
- **Stable** (Leverages on years of deployments)
- **End to End** (No gateway through the IP backbone)

Core set of network Protocols :

- **CoAP** : RESTfull access (GET/PUT/POST/DELETE) over constrained devices
- **RPL** : Multi-Hop routing protocol for low power and lossy networks
- **IPv6** : Core network protocol. Neighbor discovery, unique @, auto-configuration
- **6LoWPAN** : Header compression & fragmentation of IPv6 packets over 802.15.4

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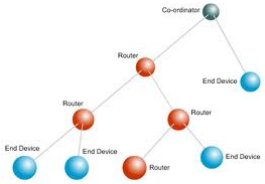
OS Footprint Optimization (bytes)

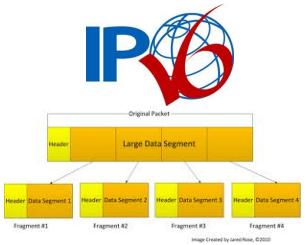
How much Lighweight can be IPv6 ?

Contiki Module	MSP430	AVR
Kernel	810	1044
Program loader	658	-
Multi-threading lib.	582	678
Timer lib.	60	90
Memory manager	170	226
Event lib.	1656	1934
IP stack	4146	5218

IPv6 for Smart Objects

Software Stack example





APP	IPSO Application Framework : Flexible & Simple Profile	
	CoAP: RESTful primitives for Constrained Objects	
NET	RPL: Multi-Hop Topology over Low Power Networks	
	IPv6 : Core Internet Protocol	
Adapt.	6LoWPAN : Fragmentation & Header Compression	
MAC PHY	802.15.4 : Low Power, Short Range Radio standard	

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WATTECO IP SENSORS

Standard based stack :

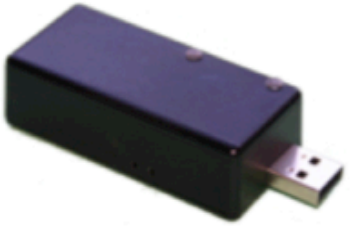
IEEE : **802.15.4** (2.4GHz / sub GHz)
IETF : **6LoWPAN** / **IPv6** / **RPL** / **CoAP**

Easy to use :

- Self organization
- Auto-reporting configuration
- Simple interactions : LEDs & Buttons

CO2

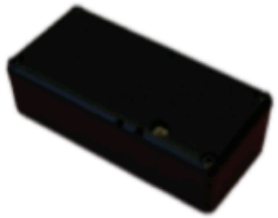
Temperature / Humidity



RF Dongle

Motion Closure

Surface Temperature



Illuminance

Occupancy

DIN Rail Smartplug

WATTECO IP SENSORS

METERING IP SENSOR

Features:

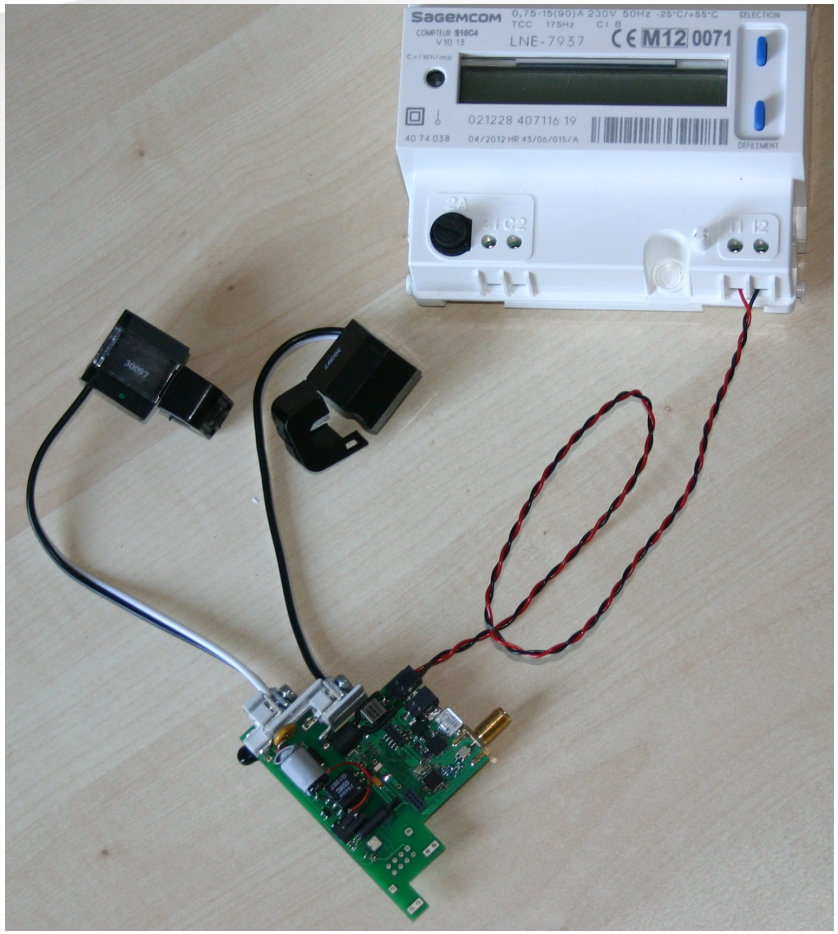
- **Self-Powered** through “TIC” meter output
- **No Battery – No Wires – No Gateway (Native IP)**
- 1 minute data reporting with TIC harvesting
- **RailDin** 2U Form Factor
- Security (AES128)
- SMA connector for external antenna

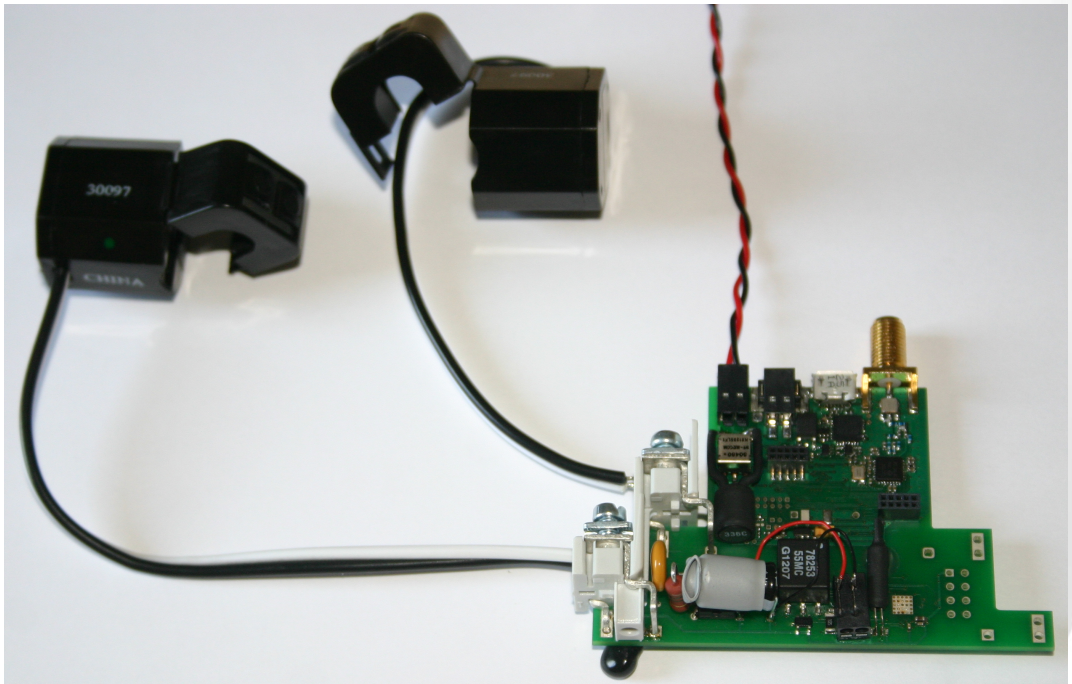
I/Os :

- “TIC” reading : *“Bleu”/”Jaune” / “Emeraude” / “Linky”*
- 2 external power measurements
- 4 configurable inputs (48V max)
- 4 opto-triac outputs
- 1 “TIC” replay output

WATTECO IP SENSORS

METERING IP SENSOR





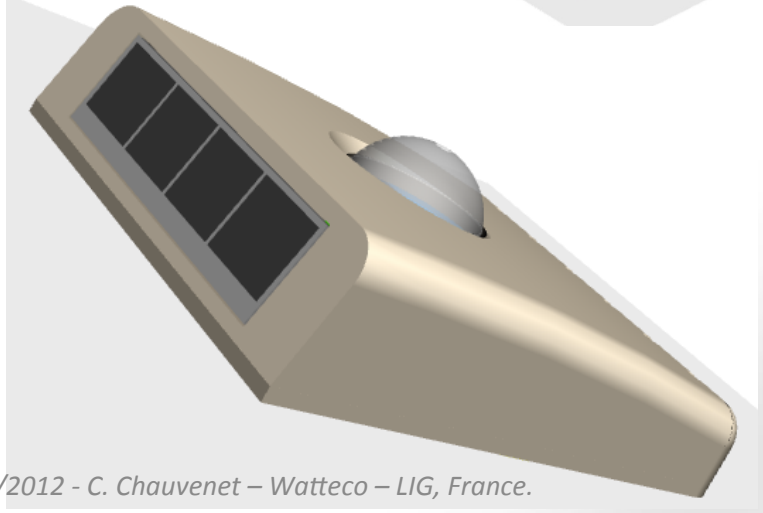
INSTALLATION EXAMPLE

WATTECO IP SENSORS

HARVESTING IP SENSORS

Additional Features:

- **Self-Powered** through solar panel
- 10 minutes data reporting **under 200 lux***
- **No Battery – No Wires – No Gateway (Native IP)**
- **100 days energy buffer** with no light source
- More than **10 years lifetime** without light with optional battery**
- Home friendly design
- **Security** (AES128 + PANA key exchange)
- **IEEE 802.15.4G** standard



•Average light over a day
** With 2 AAA 1000 mAH batteries

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-Multiple protocol aggregator :
- **6LoWPAN**
- **Zigbee**
- **ETSI M2M**
- KNX / LON / Bacnet / Wireless M-bus/ EnOcean … *

-Multiple Physical interfaces :
- 802.15.4-2006/G (Sub GHz – 2.4 GHz) / RS485 / Bluetooth
- Wifi / 2 x Ethernet / POE / 3G
- 2 x USB 2.0

- Cortex A8 – Up to 256 Mo RAM / 2 Go Flash
- **Android** or **Linux** OS
- 7” multi-touch display

*Development upon request

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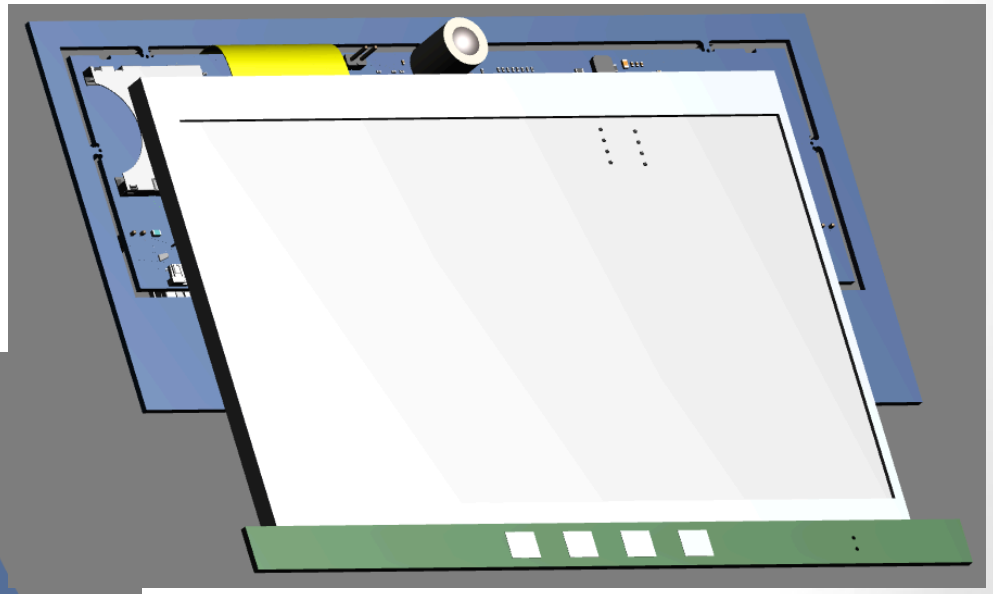
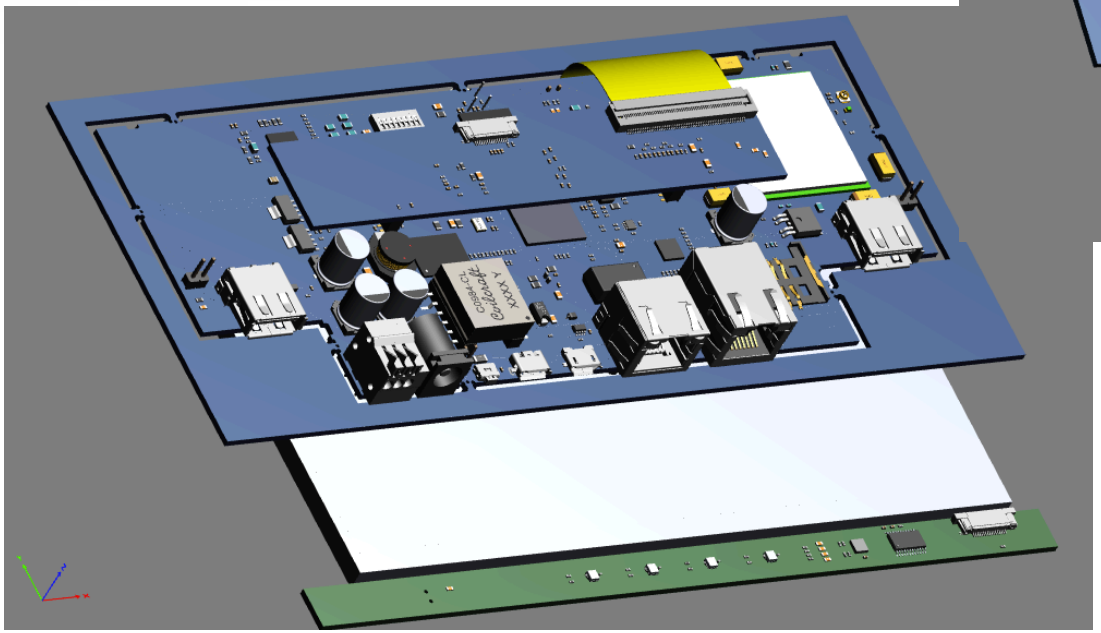
PAN ROUTER



USER FRIENDLY HOME AUTOMATION GATEWAY



HETEROGENEOUS SENSOR AGGREGATOR (6LOWPAN)

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Merci pour votre attention