The Internet of Things / Sensor Networks - May – 2009

EPRI

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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.

An endless number of applications

Healthcare

Defense

Energy Saving (I2E)

Predictive maintenance

Improve Productivity
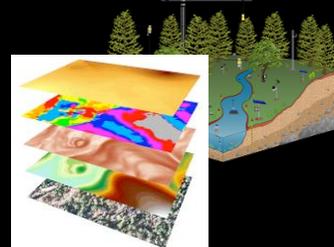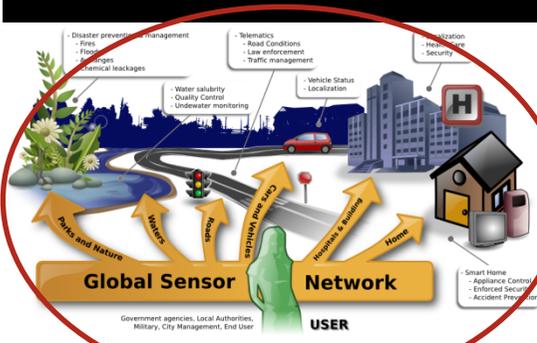
New Knowledge

Intelligent Building

Agricultural

Smart Cities

High-Confidence Transport and assets tracking

Industrial Automation

Smart Grid

Smart Home

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 !!

=> 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 ☹ - 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 ☹ - 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 real-time protocols"

- A very secure and well proven

- **Biliions of connected devices**

A question that we heard several times ...

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

Open source lightweight stack delivered ➜ uIPv6

- ☑ 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,

APS	GEN	OAM	INT	RTG	RAI	SEC	TSV

6lowpan   ROLL

Reuse

LLNs
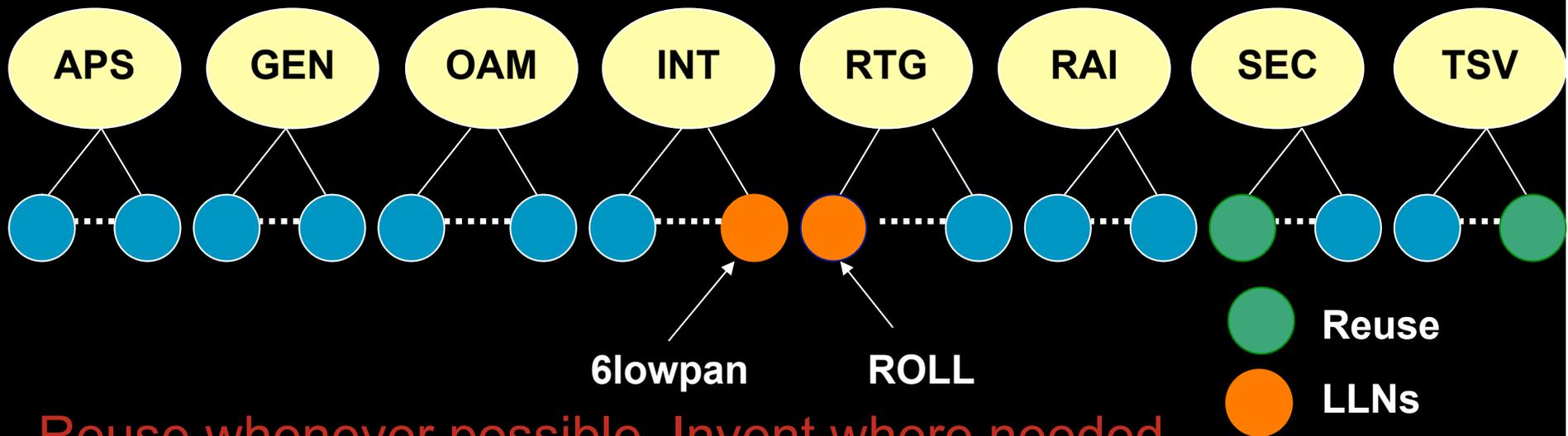
Reuse whenever possible, Invent where needed

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
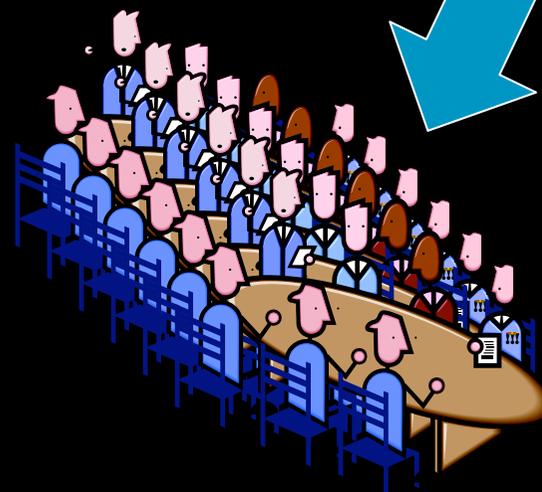
Arch Rock	SAP
Atmel	Sensinode
Bosch	SICS
Cisco	Sun Microsystems
Duke Energy	Tridium
Dust Networks	Watteco
EDF	Zensys
ECE	Centria
Eka Systems	Cimetrics
Ericsson	ELIKO
Freescale	Emerson Climate Technologies
Gainspan	IAR Systems
Jennic	IP Infusion - An ACCESS Company
Jonhson Control	Kitworks
Intel	Landis & Gyr (Cellnet)
INRIA	Lulea University of Technology
Kinney Consulting	Mocana
National Instruments	ROAM / Acuity
Nivis	SilverSpring Networks
PicosNet	SmartSynch
Primex Wireless	Tampere University of Technology
Proto6, LLC	Texas Instruments
	TZ

April 2008: 3 persons
Patrick, JP and Roland

Power Management
Smart Grid
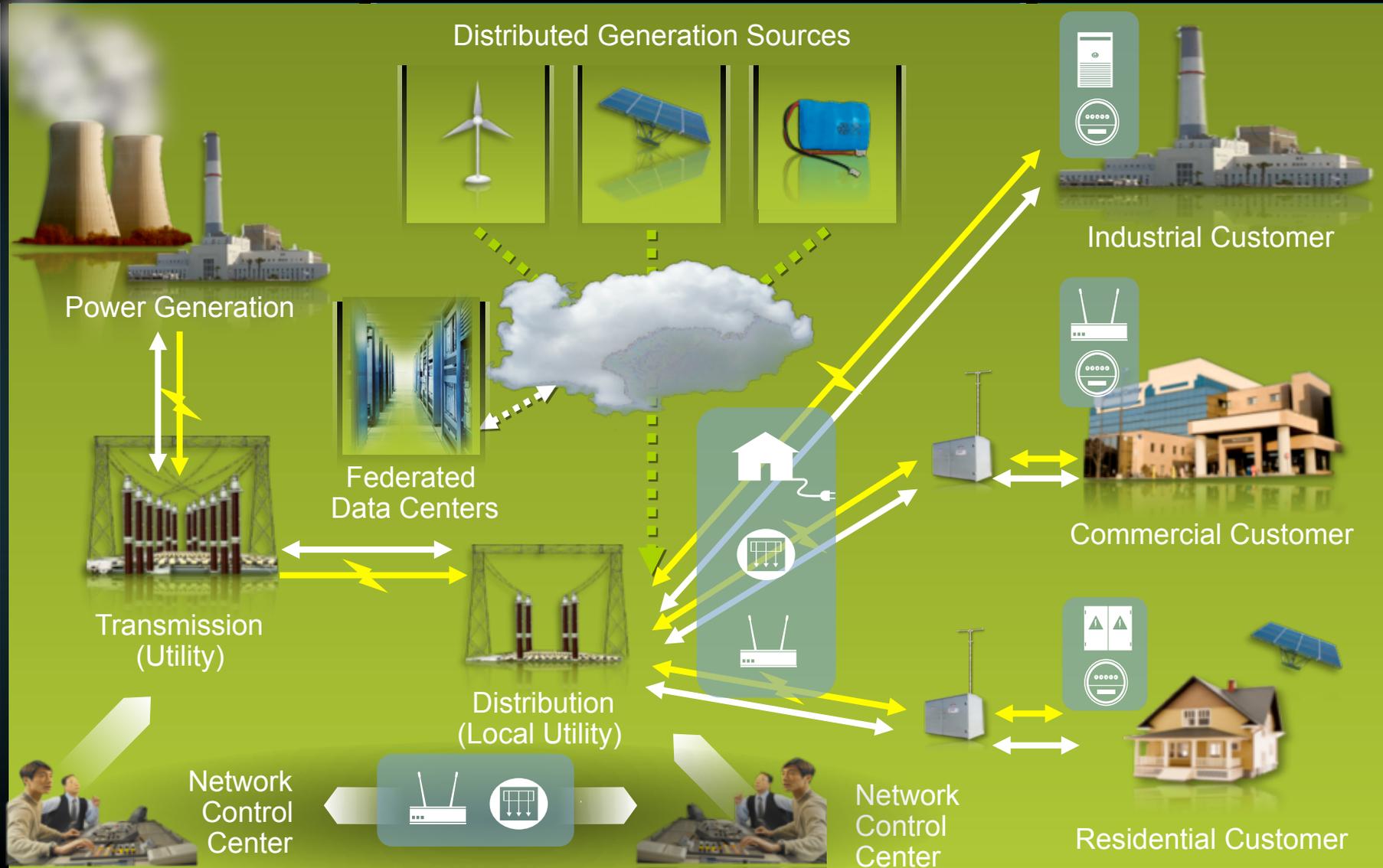
Why IP end to end: the example of the Current Grid

SCADA

HomePlug

Zigbee

ZWave

101-104-DNP3-Modbus over LL/Frame Relay/ MPLS/Fiber

101-104 over GRPS

Residential

Power Generation

Transmission

PLC (PLAN, …) or Proprietary L2 mesh

Transmission Substation

Secondary Distribution
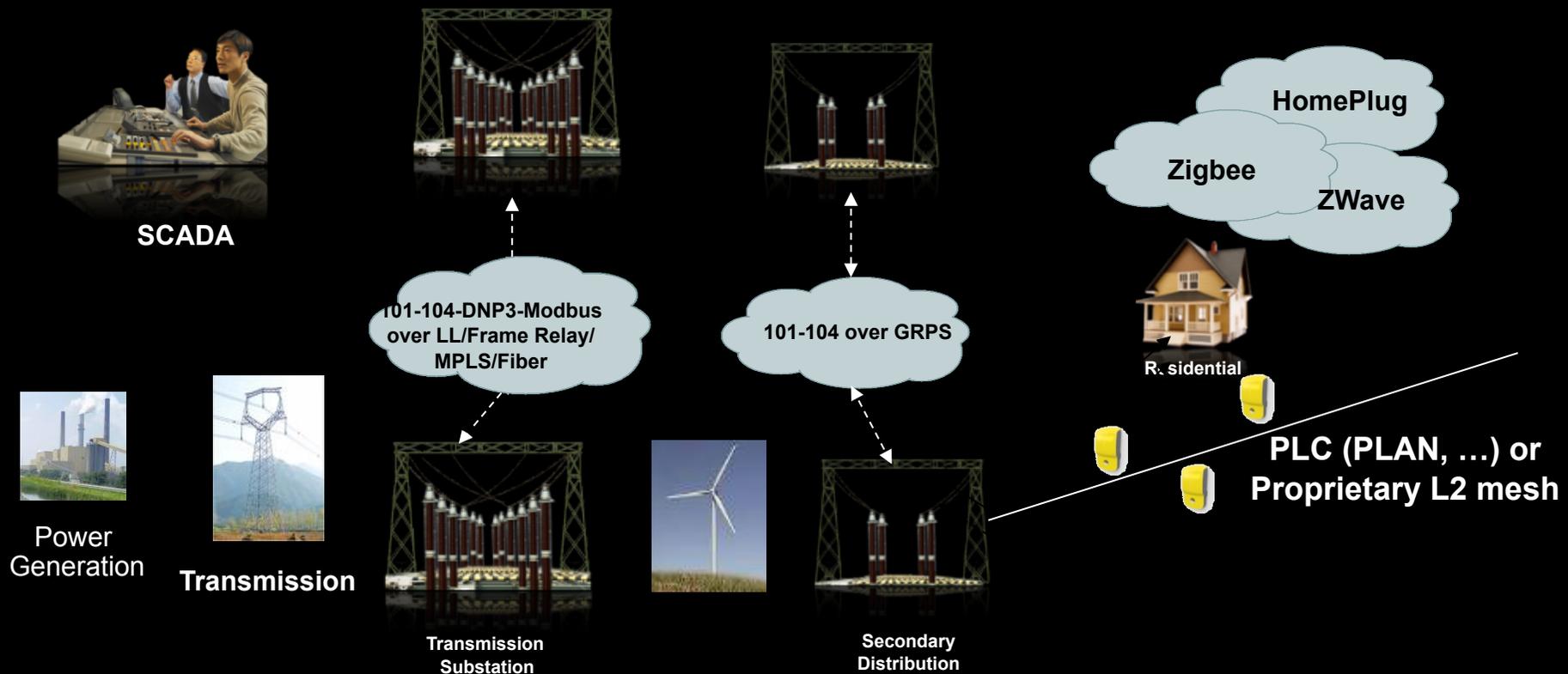
- Increasing demand for end-to-end energy management (telecontrol, telemetry, load shedding…), Smart metering, … in support of Demand-Response, DSM, …

- **This implies a number of protocol translation !!!**

Proposed end to end IP based architecture for the Smart Grid

SCADA

Power Generation

Transmission

101-104-DNP3 over IP !

Smart Energy Profile, Z/IP Over IP !

Residential

Transmission Substation

Secondary Distribution

Smart Metering over IP (PLC/RF) !
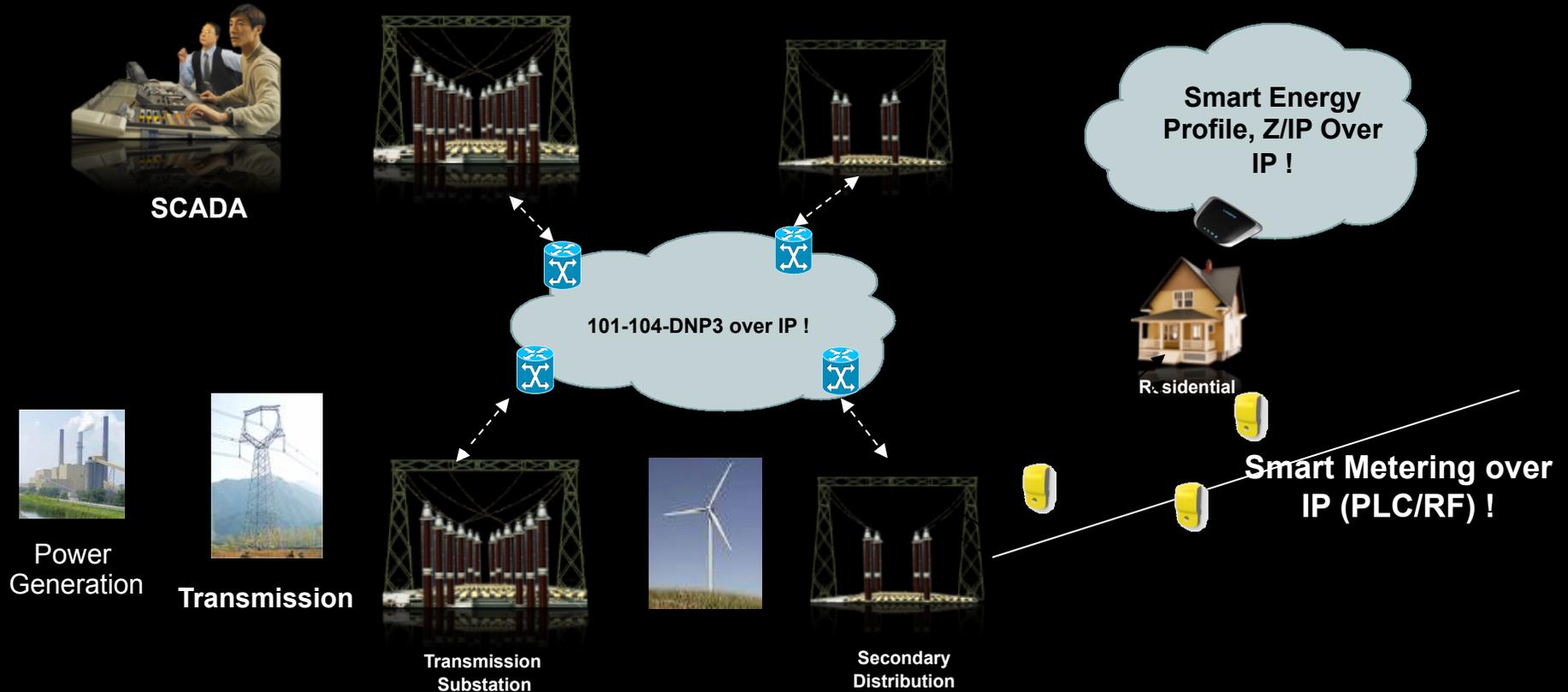
- IP end to end **!!**

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 !