The Internet of Things
## P2P RG – IRTF – Prague
March 2011

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What is a Smart Object?

- 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)
- An Embedded Device: a purpose built connected device that performs a specific function (e.g. a factory robotic arm, vending machine, smart grid analyzer)
- Any combination of the above features to form a more complex entity.

Microcontroller Example

- 20 MIPS at 20MHz
- 128KB Flash, 16KB SRAM, 4KB EEPROM
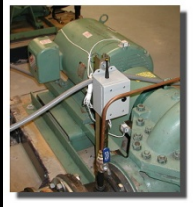- 6 sleep modes: 0.1µA -> 200 µA
- 32 programmable I/Os
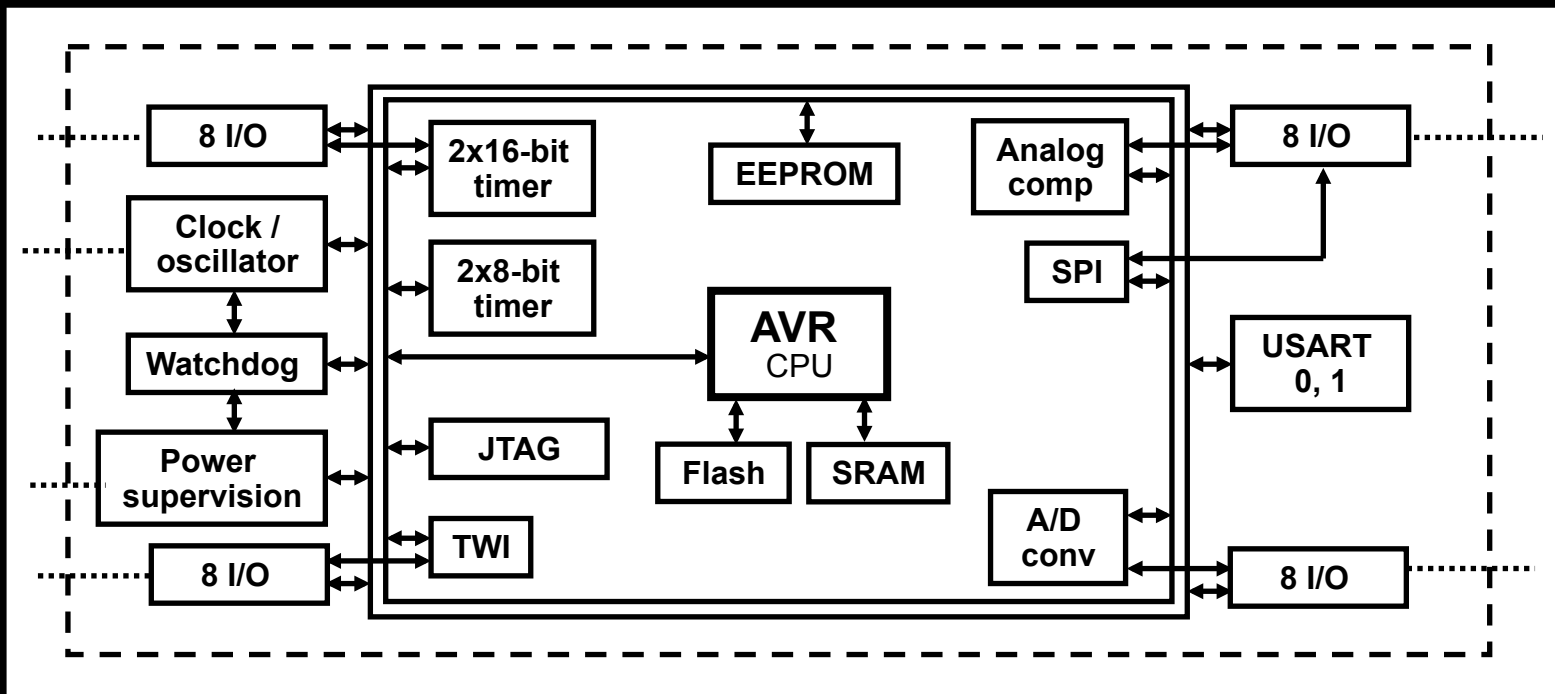
Several major applications are now there

Healthcare

Defense

Energy Saving (I2E)
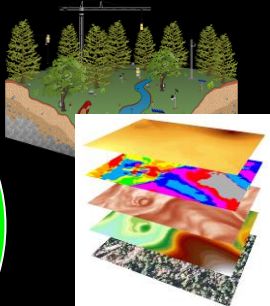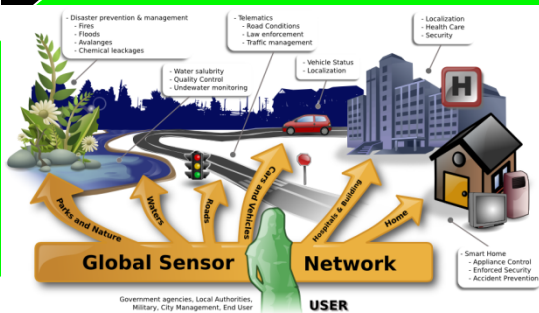
High-Confidence Transport and assets tracking

Predictive maintenance

Improve Productivity

Smart Cities

New Knowledge

Intelligent Building

Agricultural

Industrial Automation

Smart Grid

Smart Home

Smart Grid: A network of Smart Objects

→ Energy ← Information

Distributed Generation Sources

Power Generation

Federated Data Centers

Transmission (Utility)

Distribution (Local Utility)

Network Control Center

Industrial Customer

Commercial Customer

Residential Customer

Network Control Center
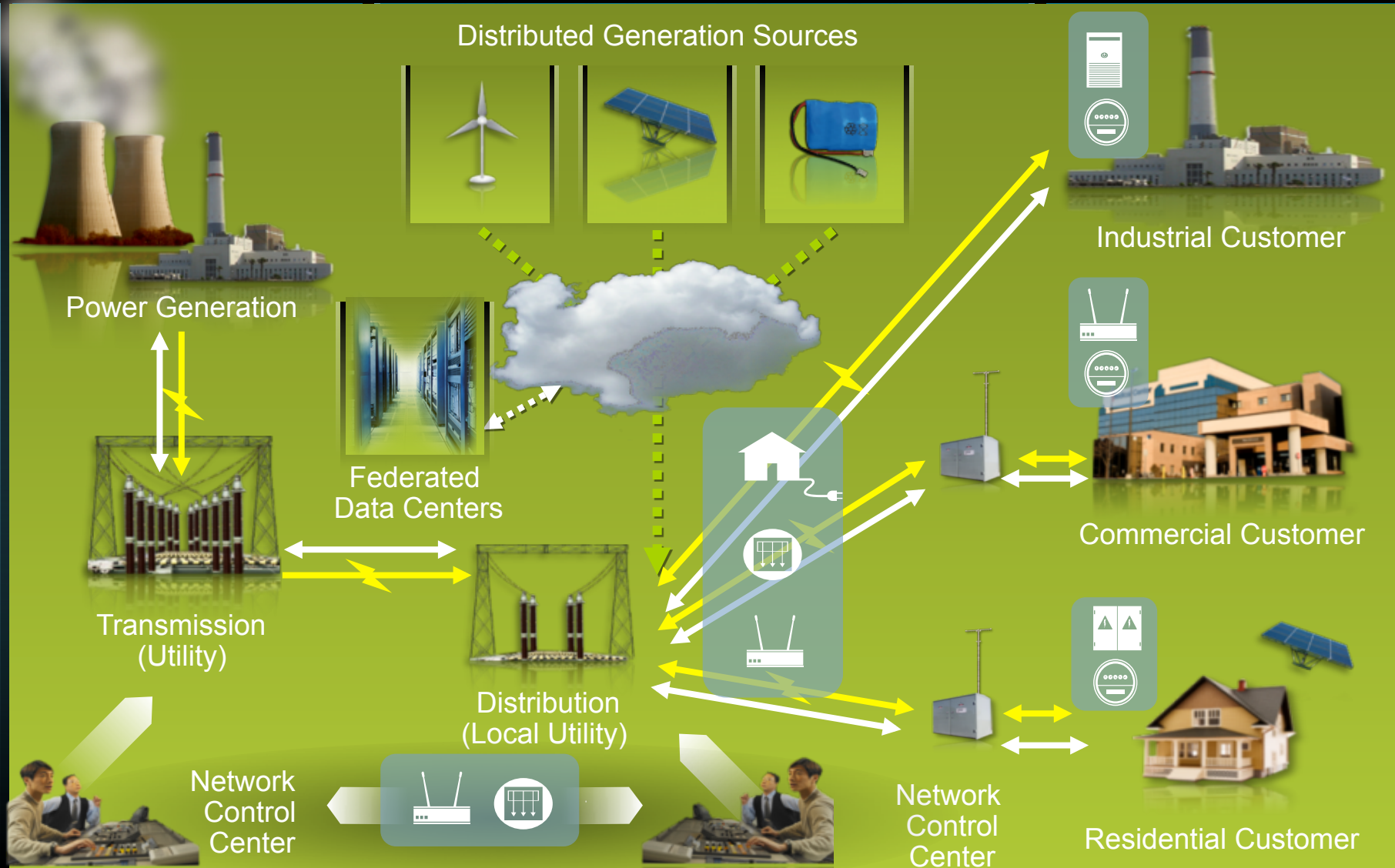
Learn from the Past

- Tunnelling and protocol gateways are not the answer
  - Easy way out for vendors to declare they are compliant
- **Protocol translation gateways is the wrong approach for the "Internet of Things":**

  Number of technical issues: lack of QoS end-2-end, fast convergence consistency

  Force down the path of the least common denominator

  Clearly not an enabler for innovation

  Different scale !

  Security holes …

- Use of IP allows access anywhere anytime anything
  - Allows consistent architecture and protocols
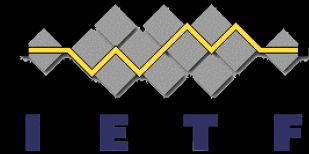
IP – an Open Layered Architecture

Applications (Telnet, SSH, SNMP,…)
Web Services (SOAP, XML, REST), CoAP

TCP

UDP

IP v6

over Foo adaptation layer (Ethernet, 6LoWPAN…

IEEE 802.15.4
868/915 MHz, 2.4Hz
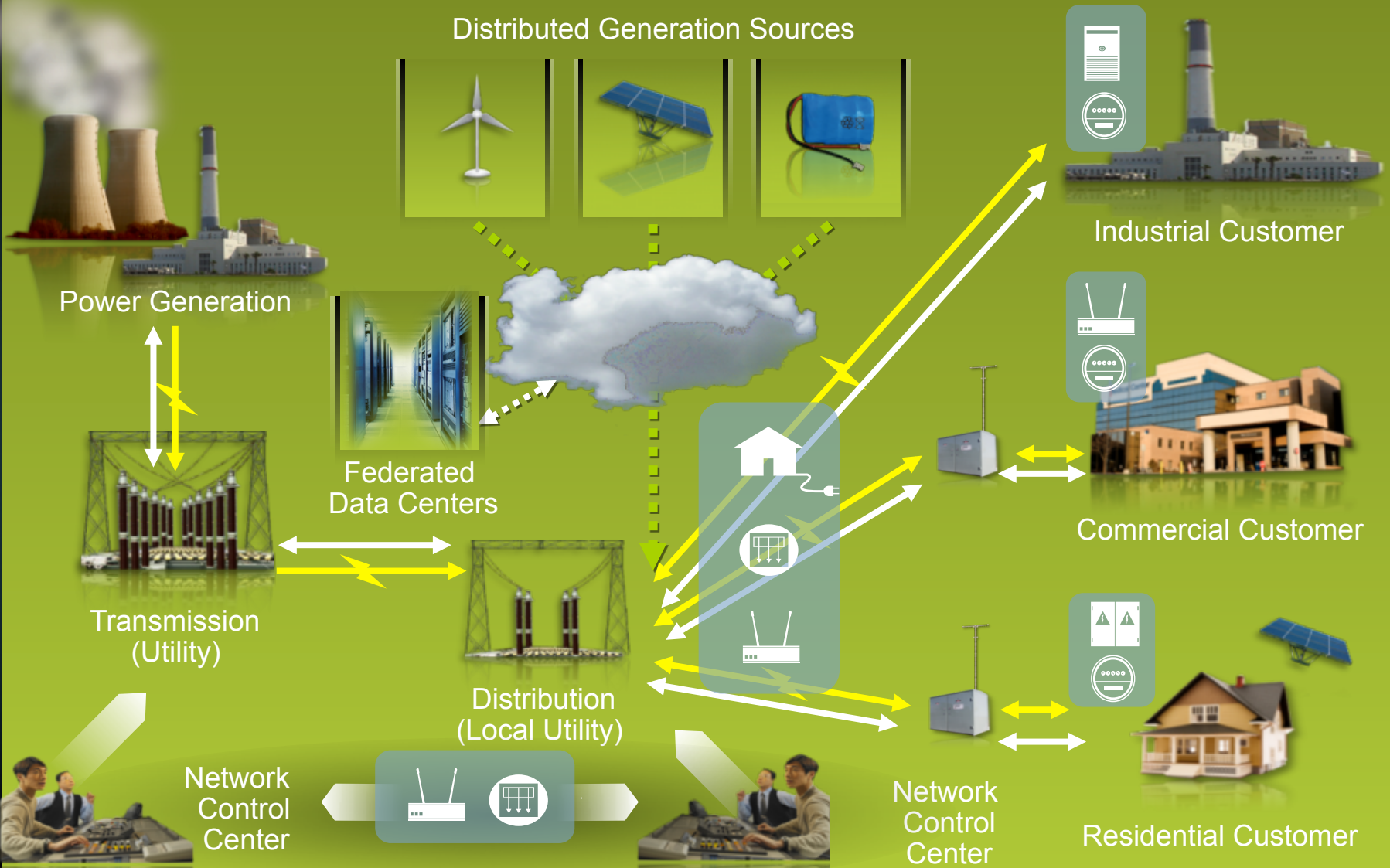
IEEE 802.11
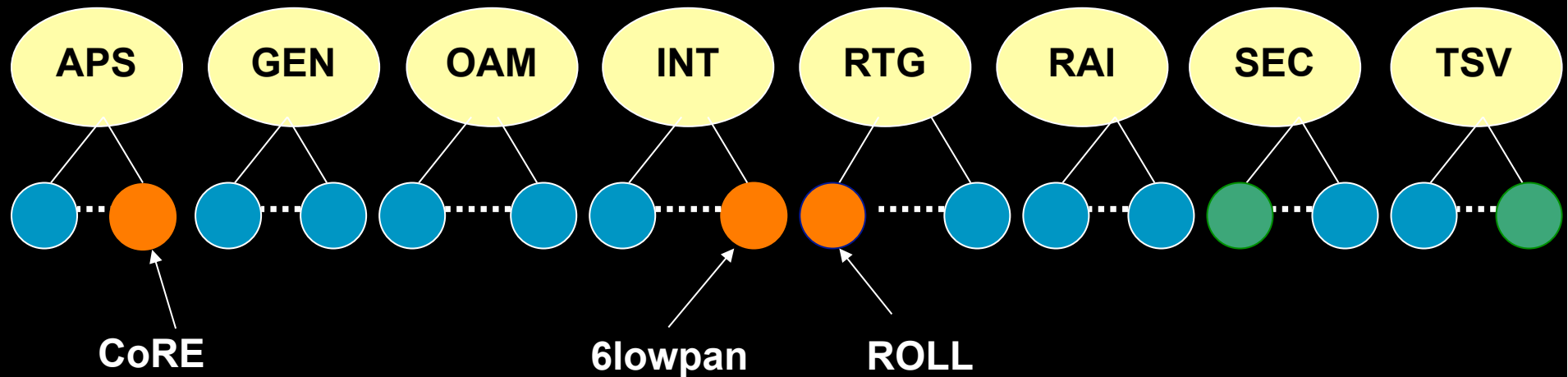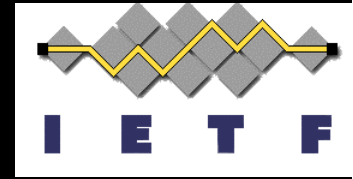a/b/g/n WiFi
Low power

IEEE 802.3
Ethernet

HomePlug
PLC

W3C WORLD WIDE WEB consortium

I E T F

IEEE

IP end to end up to the device

Smart Grid: A network of Smart Objects

The Internet Engineering Task Force

APS   GEN   OAM   INT   RTG   RAI   SEC   TSV

CoRE   **6lowpan**   **ROLL**

Reuse whenever possible

So far … WAS (Wait And See) - *The current Trend* (IETF – 2007)
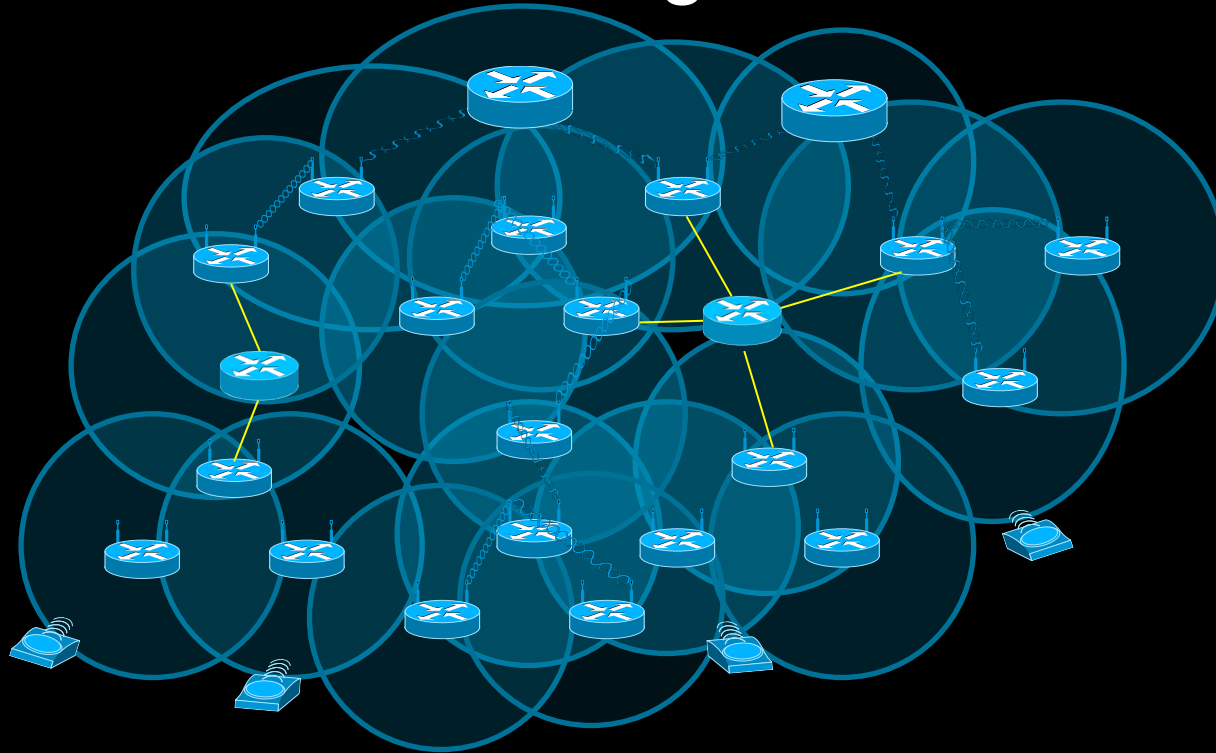
Most promoters of non-IP solutions have understood that IP was a MUST: they call this "IP convergence": **A protocol translation gateway ! Or Tunneling …**

6LoWPAN is an Adaptation Layer
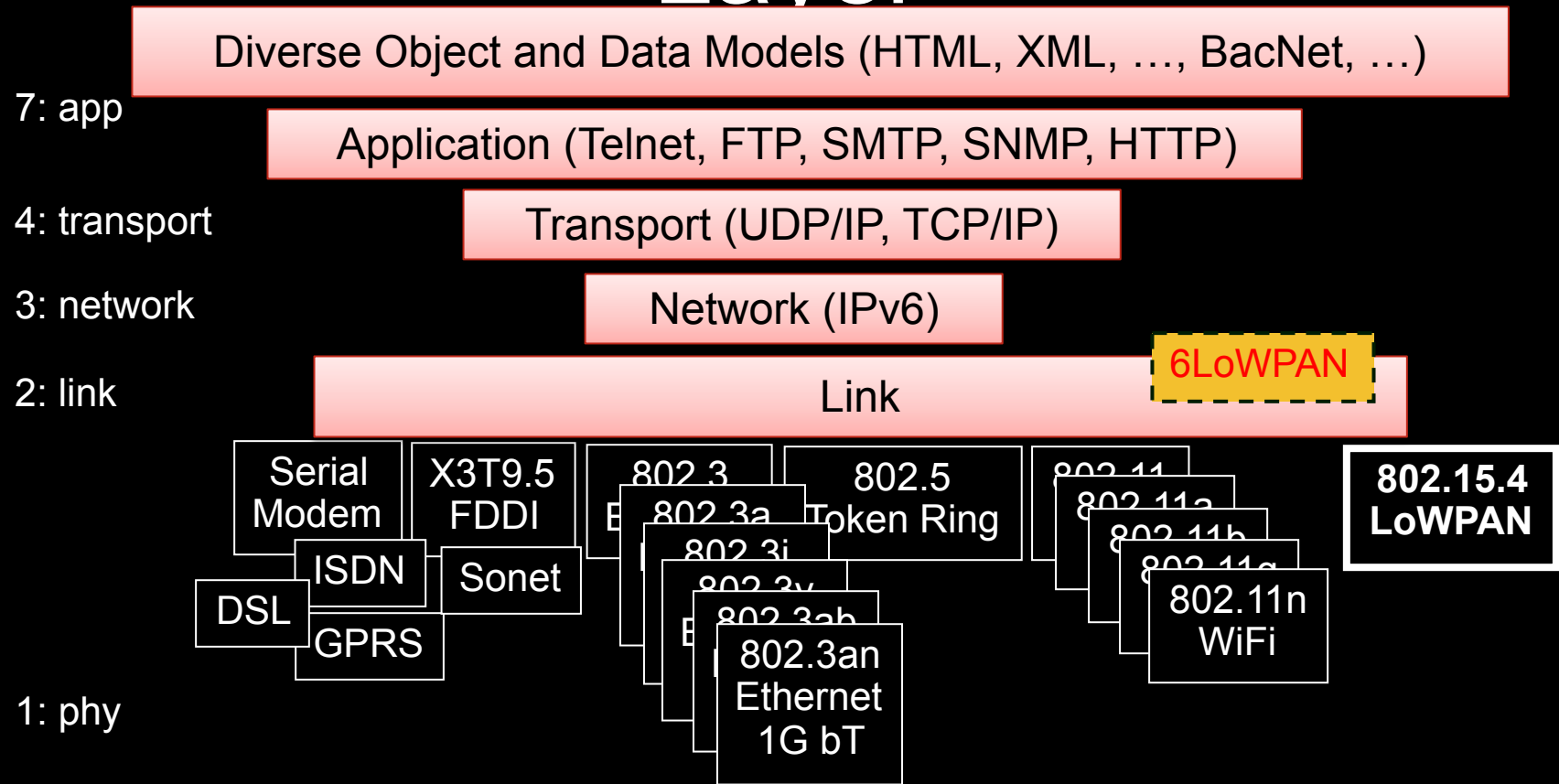
Diverse Object and Data Models (HTML, XML, …, BacNet, …)

7: app

Application (Telnet, FTP, SMTP, SNMP, HTTP)

4: transport

Transport (UDP/IP, TCP/IP)

3: network

Network (IPv6)

2: link

6LoWPAN

Link

Serial Modem

X3T9.5 FDDI

ISDN

DSL

GPRS

Sonet

802.3
802.3a
802.3i
802.3y
802.3ab
802.3an
Ethernet
1G bT

802.5 Token Ring

802.11
802.11a
802.11b
802.11g
802.11n WiFi

802.15.4 LoWPAN

1: phy

RPL (ROOT IETF WG) : a DV routing protocol building a colored DAG

RPL is specified in draft-ietf-roll-rpl

- RPL: DV Based Routing Protocol – DAG Formation
- The DAG is colored (Constrained Based Routing)
- Rules for parent selection based on metric, OF and loop avoidance
- Under-react is the rule !! (local versus global reroutes) to cope with transient failures
- Governed by Trickle Timers

The CoRE Architecture
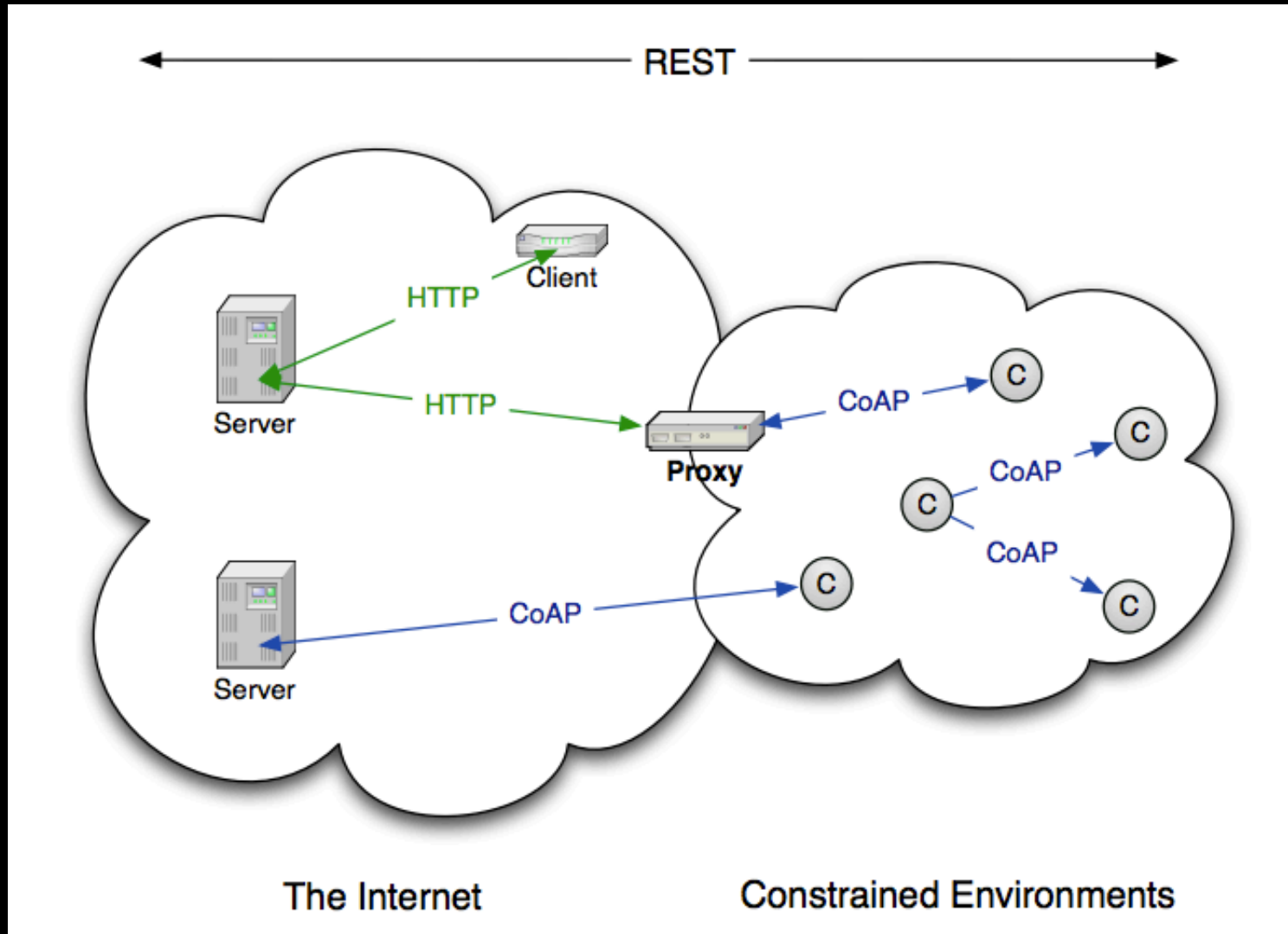
IoT and P2P ??

- Discussion during the last IoT IAB workshop – potential for new RG (see with Lars).
- Historically, ***centralized*** polling, with data storage in data centers,
- Need for a data management paradigm shift !
- Key issues …
  - Distributed actuation on local data (distributed intelligence)
  - Distributed Data storage => where is the data ?
- This is where P2P may play a role in the IoT !
- Thoughts ?