

# 6LowApp

Application Protocols for  
Constrained Node/Networks

Carsten Bormann, Cullen Jennings

# CoRE

Constrained RESTful Environments

Carsten Bormann, Cullen Jennings

- **Be aware of the IPR principles,  
according to RFC 3979 and its updates**

- ✓ Blue sheets
- ✓ Scribe(s)

# Agenda

13:00	Agenda bashing	Chairs
13:05	Goal and purpose of the BOF	Chairs
13:15	Description of the problem/problem space draft-bormann-6lowpan-6lowapp-problem-01	Carsten Bormann
13:30	Building Objectives draft-gold-6lowapp-sensei-00 draft-martocci-6lowapp-building-applications-00	Peter Van Der Stok
13:40	Smart Energy Objectives draft-sturek-6lowapp-smartenergy-00	Don Sturek
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14:45	Calling the questions	ADs

# Constrained Nodes

- 8 MHz CPU, 10K RAM, 48 K Flash
- Battery operated, 2 AA, 2 years = 200  $\mu$ W
- Sleepy nodes
  - like node-initiated communications

# Constrained Networks

- IEEE 802.15.4
- 20..250 kbit/s (0.9 or 2.4 GHz)
- Packet size < 128 Bytes
- Non-transitive link ( $A \rightarrow B \wedge B \rightarrow C \not\Rightarrow A \rightarrow C$ )
- No real IP multicast (just radio range)

# This is **not** research

- This stuff works in the field
- IETF Working Groups:
  - 6LoWPAN: INT
  - ROLL: RTG

# Areas of Application

## Focus:

- Smart Energy (Smart Grid)
- Home Automation / Building Automation

Smart Grid  
Industrial  
HAN  
Urban  
...embedded...



# 6LowApp

## Problem Space

draft-bormann-6lowpan-6lowapp-problem-01.txt

# The 6LowApp areas

- Base application protocols

CoRE

- Service discovery

**Constrained  
RESTful  
Environments**

- Transport

- Security

- Data representation

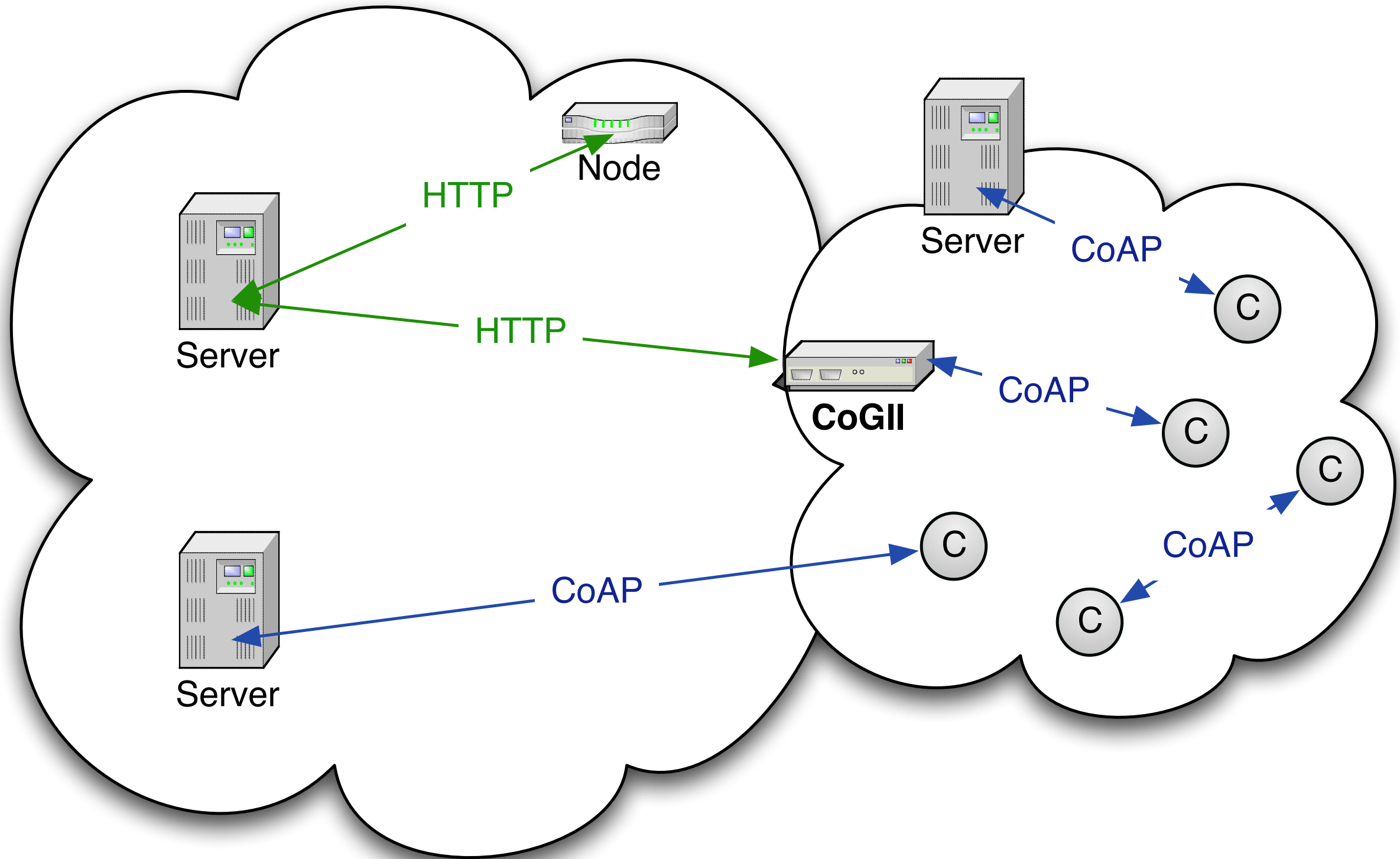
# Base Application Protocol

- CoAP: Constrained (network/node) application protocol (working title)
- Use REST as the model
  - GET/PUT/DELETE/POST
  - Use the same model for subscribe/eventing (still all about resources)

# CoGII

- CoAP works fine both intra-CNN or on the Internet
- CoAP speakers may need to talk to X speakers (X = HTTP, more?)
- **CoAP** to **General Internet Intermediary**
- **Not** dependent on application

REST



Server

Node

HTTP

HTTP

Server

CoAP

CoGII

Server

CoAP

C

CoAP

C

C

CoAP

C

The Internet

Constrained Environments

# CoAP vs. REST model

- Not just attribute getter/setter
  - Resources can be more complex than single values
- Build profile and discovery on top
- Multicast
  - Provide very basic form of aggregation

# Discovery

- What function do **you** have? → URI
- Who has function **x**? → URI...

# Transport Protocols

- Need transport
  - Today: TCP, UDP (go through firewalls)
  - “6LowTrans”? (2–7 years, or maybe pick)
- For now:
  - UDP as basic (intra-CNN)
  - TCP when you need it (more function)



# Security

- CoAP does not care
- Applications do care: Work with SEC area
- Session security: Well-understood
  - (D)TLS; maybe identify ciphersuites
- Object security
  - Hypothesis: Start with CMS

# Data Representation

- CoAP does not have to care (content-type)
- Support resources in many forms
  - (EXI appears to have interesting features)

# We do have HTTP?

- HTTP requires TCP
  - cannot do multicast
- HTTP is complex to parse, chatty
- HTTP has complex caching, 100-continue, conditionals, content negotiation...
- HTTP does not provide subscribe

# So what about \_\_\_\_\_P?

- SNMP:  
Likely candidate for some form of CoGII
- SIP: Definitely interesting
- XMPP: Also interesting
- SMTP: Come on...
- CoRE need not be the last group out of 6LowAPP!

# Focus

- We are doing this for constrained nodes/networks in:
  - HAN, Building Automation
  - Smart Energy V2
- Let's hear about their requirements

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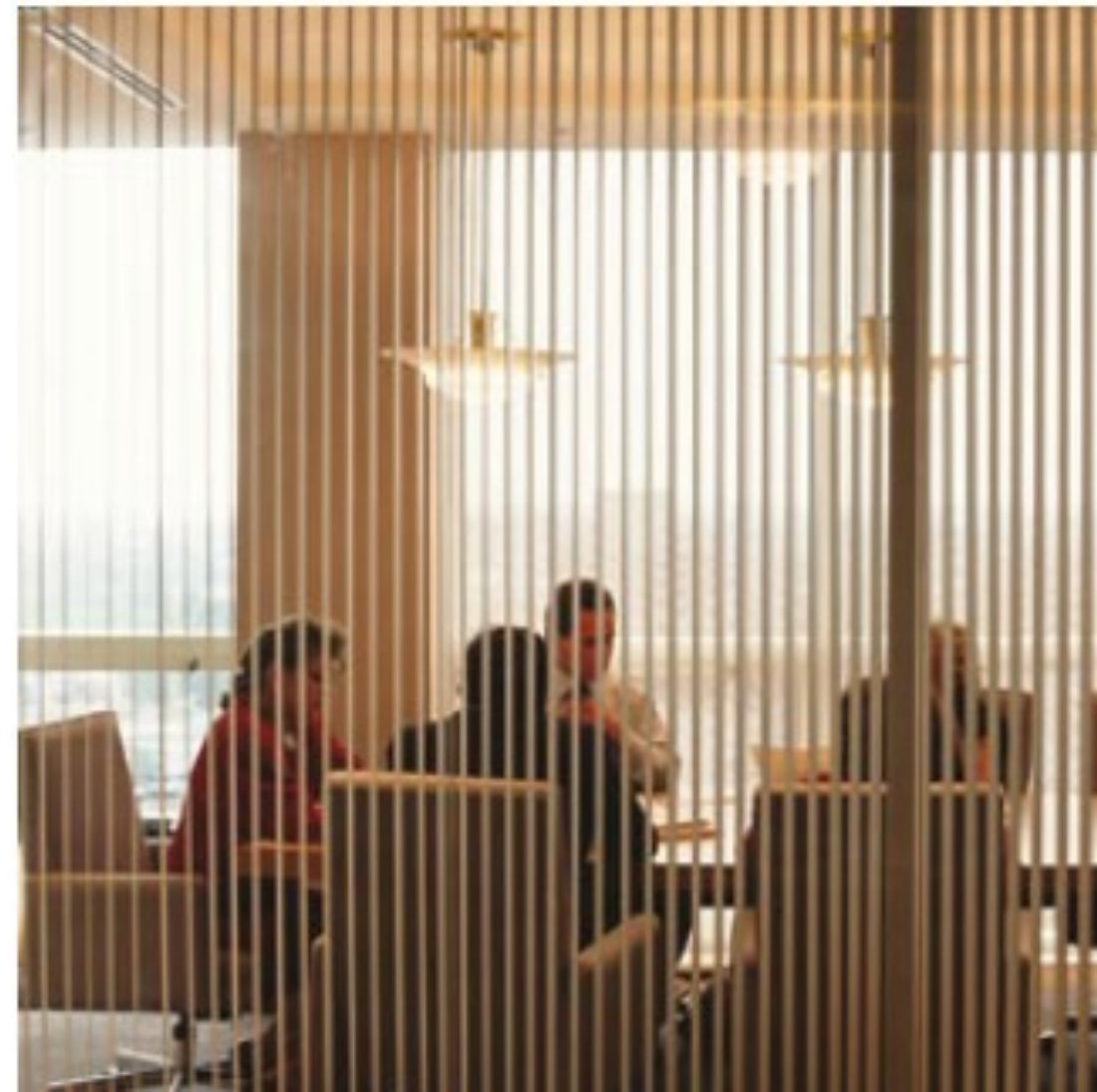
# Requirements on Internet for Buildings

draft-gold-6lowapp-sensei-00

draft-martocci-6lowapp-building-applications-00

Peter van der Stok  
Jerald Martocci  
Anthony Schoofs  
Richard Gold

November 9, 2009



# Contents:

1. Building control interest in 6LowApp
2. Requirements on building networks





# Three examples

Courtesy: Frost & Sullivan, CABA



*CityStars of Cairo*



King Abdul-Aziz Endowment Project.

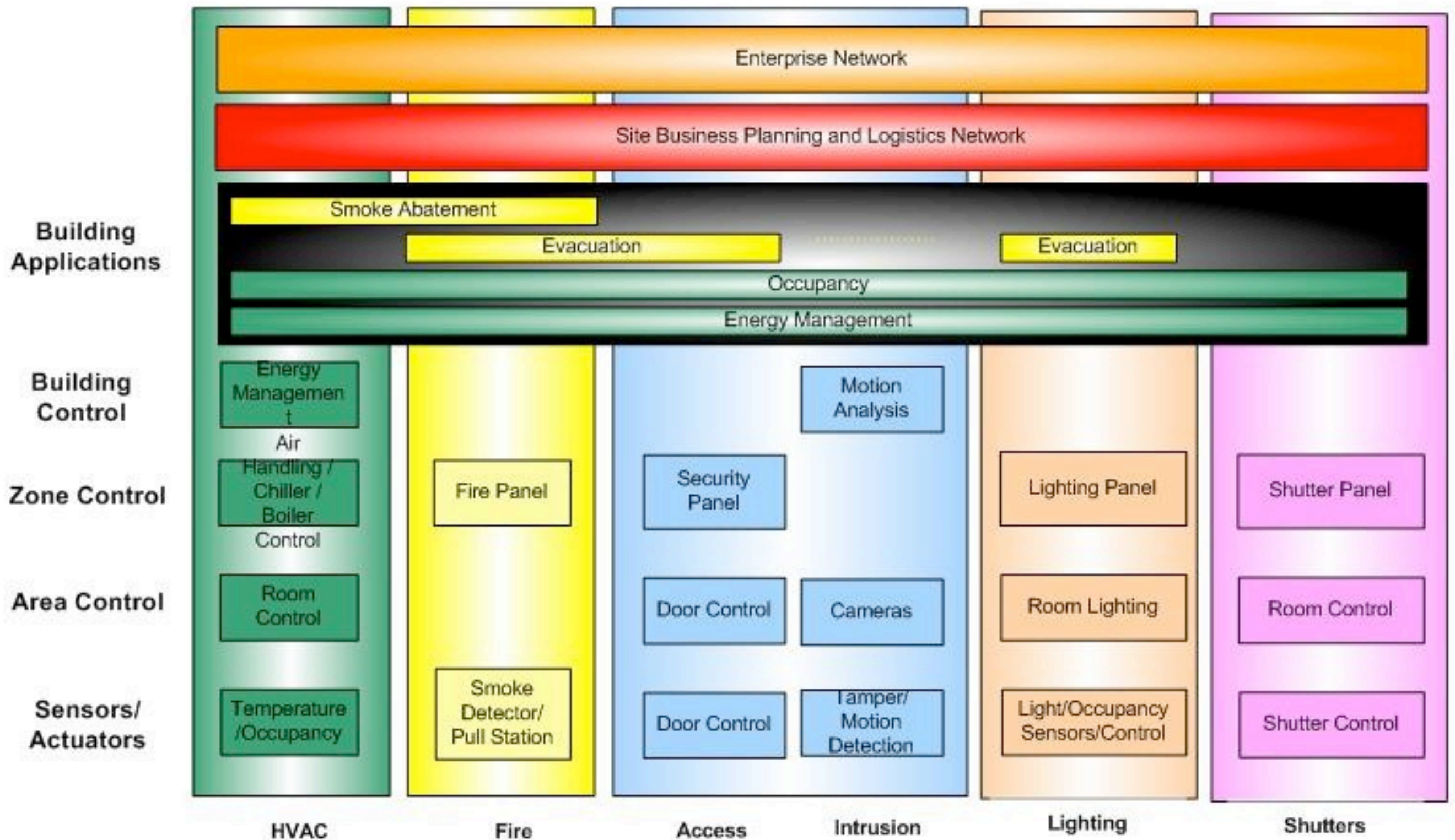


Retrofit in Breda, NL



# Silos

Many protocols with no generally accepted open standard



# Market conclusions

- BAS are mostly driven by energy saving.
- Wish for access to any service anywhere drives integration of networks.
- Internet Protocol (IP) is most likely network integrating standard.
- Integration leads to cost savings.



# Contents:

1. Building control interest in 6LowApp
- 2. Requirements on building networks**



# Building use cases

- Fire and smoke abatement
- Evacuation
- Occupancy/shutdown
- Energy management
- (Un)locking building
- Building energy conservation
- Occupant comfort and safety
- Pricing / billing
- Leakage detection

# Wireless technology

Wanted for:

- Retrofit
- More freedom in installation location
- Reduced installation costs

Changing batteries and wasting them is unwanted

Challenge:

Battery-less devices are off most of the time

# Network requirements

## Application support:

- Sending messages between nodes (obvious)
- Freedom of sensor/actuator placement
- Grouping of luminaries, sensors and switches
- Timeliness: actions within 200 ms or simultaneously
- Scalability: networks of tens to thousands of nodes
- (Re)configurability



Service and device discovery needed  
Service description syntax will be application dependent

**Backup slides**



# Backup slides

## 1. Integrated building control

*Frost & Sullivan: Bright Green Buildings, CABA, 2008.*

*<http://www.caba.org/brightgreen>*

## 2. Standards for building networks

## 3. Requirements on building networks

# Existing standards(1)



**DALI:** Lighting network. (IEC standard)

Covers whole stack from device description down to physical layer.

Multi-drop bus provides access to memory locations and transports DALI commands.

Memory locations have semantic meaning.

Supports grouping of devices in overlapping sets (scenes).



**BACnet:** Heating, Ventilation and Air Conditioning (HVAC) network.  
(ISO standard)

Covers whole stack from device description down to transport layer.

IP, RS232, LONTalk, EIA-485, ZigBee as underlying networking layers.

Object oriented information description and services to access objects over network.

# Existing standards(2)

**DMX512:** Lighting entertainment network (ESTA standard)

Covers whole stack from presentation layer down to link layer.

Based on EIA-485 standard, daisy-chained bus.

Values are sent to channels corresponding with device functions.

Architecture of Control networks (ACN) defines XML descriptions over IP.



**KNX:** Building Automation network

Covers whole stack from presentation down to physical layer.

Devices interconnected with multidrop bus (ABB i-bus EIB)

Datagrams contain typed data structures with standardized semantics



**LonWorks:** Building Automation Network (and more).

LONTalk covers stack from transport down to physical layer (message).

LONWorks covers stack from application down to session.

Defines syntax Standard Network Variable Types (SNVT), semantics depend on manufacturer



# Existing wireless standards(3)

**ZigBee:** Building network (and more).

Covers stack from device description down to network layer.

Defined on top of wireless standard IEEE 802.15.4.

Devices are described in tables.

Supports grouping of devices in overlapping sets (scenes, groups).

Devices support clusters (standard messages with a function e.g. lighting).



**EnOcean** (batteryless),

Application to physical over low-power wireless channel



**Z-Wave**

Application to physical over low-power wireless channel



# Building Automation Systems

## Obstacles

- Many protocols with no generally accepted open standard.
- Inflexibility of control network configuration.
- Systems difficult to maintain and install.

## Drivers

- Energy saving.
- Access to any service from any location.
- Decoration and Atmosphere (Europe).
- Cheap and sharable sensors.
- Control domain integration.
- International regulation

## Market

- Building Automation Systems (BAS) growth of 6-8%.
- HVAC and Energy Efficient Lighting (EEL) most important markets.



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# 6LowAPP BOF

*ZigBee/HomePlug Smart Energy  
Application Support Needs*

Don Sturek  
e-mail: [d.sturek@att.net](mailto:d.sturek@att.net)  
November 9, 2009

On behalf of:  
Pacific Gas and Electric Company



# Organization for Smart Energy HAN Development

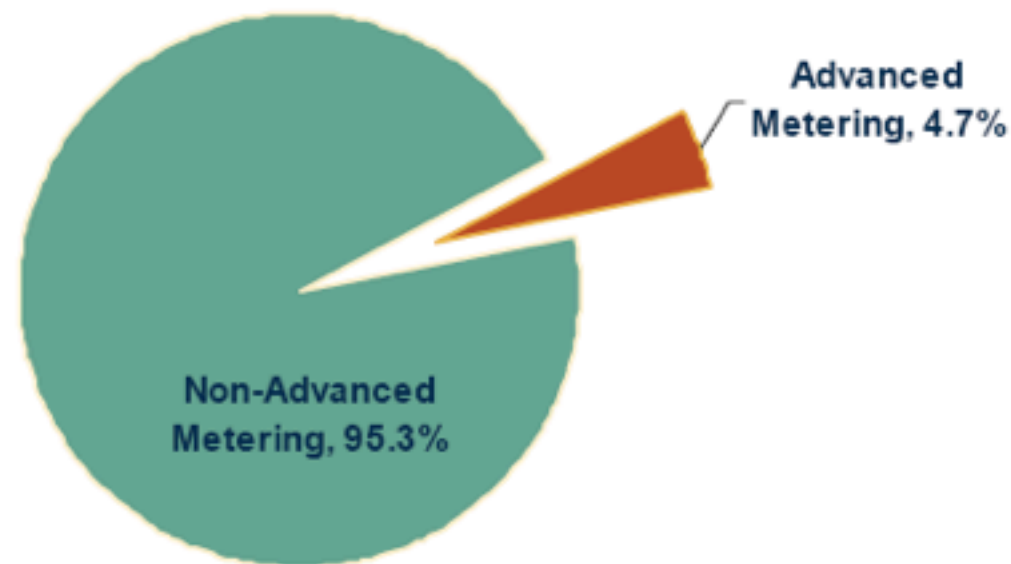
- ▶ US National Institute of Standards and Technology (NIST)
  - ▶ Smart Grid Roadmap and Priority Action Plans (PAPs 1 through 14)
- ▶ UCA International OpenSG
  - ▶ OpenHAN Requirements
  - ▶ Market Requirements Document (MRD) for Smart Energy V2
  - ▶ Platform Interoperability Requirements (initially for ZigBee IP and HomePlug AV/SE Network)
- ▶ ZigBee
  - ▶ Developing IP stack for IEEE 802.15.4 platforms based on OpenHAN and Smart Energy V2 MRD and Use Cases
- ▶ HomePlug
  - ▶ Development IEEE P1901 compliant powerline carrier solutions: HomePlug AV and HomePlug SE. Developing IP stack for HomePlug AV and SE platforms.
- ▶ Recognized Standards Development Organizations (SDOs)
  - ▶ IETF
  - ▶ IEC
  - ▶ IEEE
  - ▶ W3C



# Smart Metering Deployment Status

- ▶ Existing Smart Metering deployments address 5% of the US Smart Metering market through 2008 (see next slide)
- ▶ Though ZigBee/HomePlug will select technology for Smart Energy 2.0 by the end of 2009, need to have ongoing work in IETF to address deficiencies we may find in interoperability testing
- ▶ Need to create synergies between the Smart Metering application support and existing deployed internet systems (ie, web services, mature transports, existing security solutions, etc.)
- ▶ Need to support a mix of network topologies. Not all deployments will have predominantly constrained devices (but all deployments will contain constrained devices)

# Future Smart Meter Deployment in the US



Source: 2008 FERC Survey

**Table II-1. AMI meters: AMI-capable meters versus AMI in actual use**

	AMI-capable	Actually being used for AMI	Total customer meters (AMI-capable, actual AMI, and all other meters)
2006	8,398,455	947,224	141,994,039
2008	unavailable	6,733,151	144,385,392

Source: 2006 FERC Survey and 2008 FERC Survey

# Some Assumptions

- ▶ HAN contains utility trusted and un-trusted devices. Both can co-exist and operate on the same HAN.
  - ▶ Trusted devices all have security certificates
  - ▶ Utility communicates price and message to all devices
  - ▶ Utility only communicates time of use, demand response and other sensitive information to trusted devices
- ▶ Differing topology assumptions by utilities:
  - ▶ Some are IEEE 802.15.4 based (hence ZigBee IP)
  - ▶ Some are PLC based (hence HomePlug AV/SE network)
  - ▶ PLC vendors would like to see full RESTfull HTTP and full XML
- ▶ NIST Priority Action Plan work has two assignees:
  - ▶ ZigBee for PAPs 3, 4, 9 and 10: Semantics for residence aligned with ISO/IEC TC 57 with syntax definition in Smart Energy V2
  - ▶ OASIS for PAPs 3, 4, 9 and 10: Semantics for commercial/industrial aligned with ISO/IEC TC 57 with syntax definition in OASIS EMIX
  - ▶ Would like to see alignment between these for light commercial and other “cross-over” solutions

# Technical Requirements for Smart Energy 2.0

- ▶ Clean layered architecture
- ▶ Source standards from approved SDOs (IEEE, IETF, IEC, W3C)
- ▶ Support multiple MAC/PHYs with preference for:
  - ▶ IEEE 802.15.4 and HomePlug AV/SE (IEEE P1901)
- ▶ Meet Market Requirements from ZigBee/HomePlug MRD and MRD Use Cases (now part of UCA International)
- ▶ Technology selection to date:
  - ▶ Platform:
    - ▶ REST architecture (GET/POST/PUT/DELETE) using HTTP wherever possible (as close to standard HTTP support as possible)
    - ▶ W3C EXI tokenized XML
    - ▶ Fixed/well known URI's. Attribute protocol using GET/SET/PUT/DELETE
    - ▶ The above technology selections leverages web services deployments and targets constrained devices using an attribute protocol
  - ▶ IEEE 802.15.4
    - ▶ 6LowPAN (route over), ROLL
    - ▶ IPv6 + UDP + (maybe) TCP
  - ▶ HomePlug AV/SE
    - ▶ IPv6 + UDP + TCP

# Timelines

- ▶ Completed now
  - ▶ ZigBee/HomePlug Market Requirements Document (MRD) and Use Cases
- ▶ Completed soon (December 2009)
  - ▶ ZigBee/HomePlug Technical Requirements Document (TRD)
  - ▶ ZigBee IP Specification
- ▶ January 2010
  - ▶ Start of interop on ZigBee IP
- ▶ August 2010
  - ▶ Start of certification on ZigBee IP
- ▶ More timeline data needed:
  - ▶ Start of interop on IPv6 over HomePlug AV/SE with Smart Energy V2 application
  - ▶ End product certification for devices using ZigBee IP and Smart Energy V2 over HomePlug AV/SE (Platform Interoperability Specification needed)

# Standards Selection needs for Smart Energy V2

## ► Where IETF can help

- Efficient REST support over 6LowPAN (“RESTfull HTTP like” using tokenized XML data)
  - We expect some challenges in ZigBee IP interoperability testing:
    - TCP on wireless mesh devices using small code footprint devices.
    - Full HTTP is probably too heavy a solution.
  - Need a plan to optimize our W3C EXI/RESTfull HTTP architecture to adapt to constrained devices
- Standardized Resource Discovery
  - Need to discover devices on the network providing specific resources without using text strings for command/response exchange
  - Want to avoid a complicated protocol that can locate anything using complicated parameter matching
- Guaranteed delivery and packet duplicate detection using UDP if TCP cannot be supported (using an existing transport protocol)
- Security using existing standards if possible (object based security)
  - Link Layer Symmetric Key Security. EAP and/or IEEE 802.1AR
  - EAP with security method support for ECC and/or RSA
  - Help with defining how to commission devices onto the network securely

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# CoRE

Charter Presentation

<http://6lowapp.net>



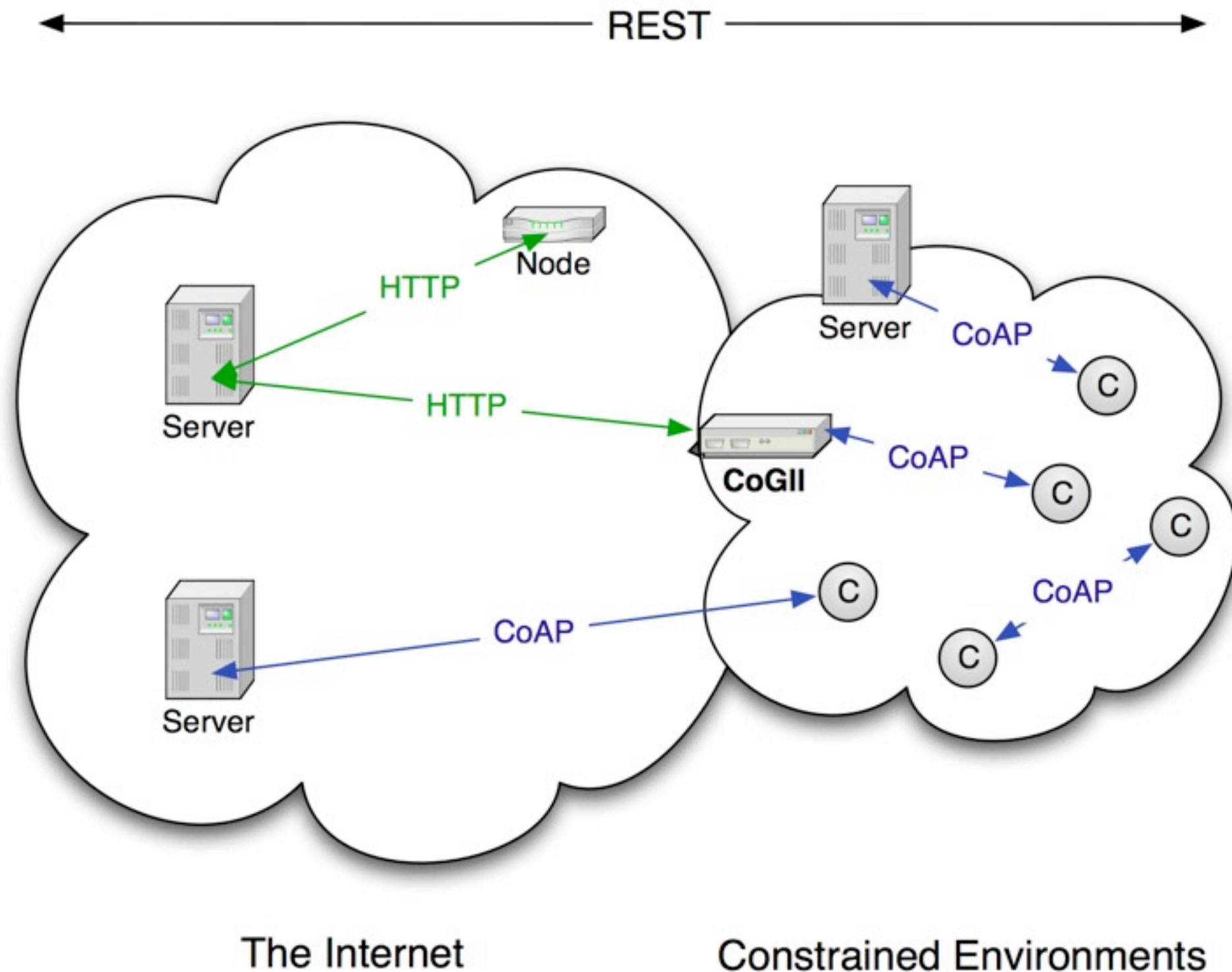
# Goal of a Charter

- Provide a quick public overview
- Set architectural approach
- Scope the work
  - Not to complete it!
- Set objectives and timelines
  - Specific work items and deliverables!
- Most importantly
  - Focus, focus, focus!

# Charter Summary

- Constrained nodes and networks
- RESTful architectural model
  - CoRE is a constrained extension of the web
- Close security area cooperation
- CoRE produces the work items:
  1. Objectives and architecture [Info]
  2. Constrained Application Protocol (CoAP) [PS]
  3. HTTP REST mapping [PS]
  4. Basic interface profile specification [PS]

# Architecture



# Architecture

"define a **framework** for a limited class of applications that deal with manipulation of simple **resources**"

"Resources that may represent sensors and actuators or other parameters"

"the architecture requires **push, pull** and a **notify** approach to manipulating resources"

"**may be** nodes called Constrained-to-General-Internet Intermediates (CoGII)"

"the CoGII does not have to be deployed at the boundary of the CNN and the more general network but can be deployed at various locations"

# Constrained Environments

"high degree of **packet loss**"

"severe limits on **throughput**, range, and available **power**"

"limited **code size** and limited **RAM** per node"

"periodically "wake up" for **brief periods**"

"Low-Power Wireless Personal Area Networks (LoWPANs) are an example"

# Requirements

"This WG is concentrating on requirements from energy (e.g. **Smart Energy 2.0**) and **building management** applications."

"The WG will coordinate on requirements from TBD (OpenSG/NIST, ZigBee/HomePlug, IPSO Alliance, OASIS, SENSEI; other SDOs and organizations)."

"The WG will closely coordinate with other IETF WGs including ROLL, 6LoWPAN, and appropriate groups in the IETF OPS and Security areas."

# Application Protocol

"will define a Constrained Application Protocol (CoAP) for the manipulation of Resources on Devices"

"CoGIIIs can provide various forms of **caching**"

"will define a mapping on the CoGII from CoAP to a HTTP REST API"

"will support a **non-reliable multicast** message to be sent to a group of Devices"

"header size on the order of **10 bytes**"

"The protocol will operate by default over **UDP**... may optionally be bound to **TCP** or other reliable transports"

# Discovery

- "specify a way to support **interface profiles, extensible** by vendors and other standards bodies, which define the particular **Resources** on a Device and what manipulations are possible"
- "how to use CoAP to **discover** Devices on the CNN and to interrogate them to find out which interface profiles they support"
- "CoGIIIs may also provide support for discovering Devices that may not be currently responding"
- "specify a small set of basic interface profiles to illustrate how this is done"

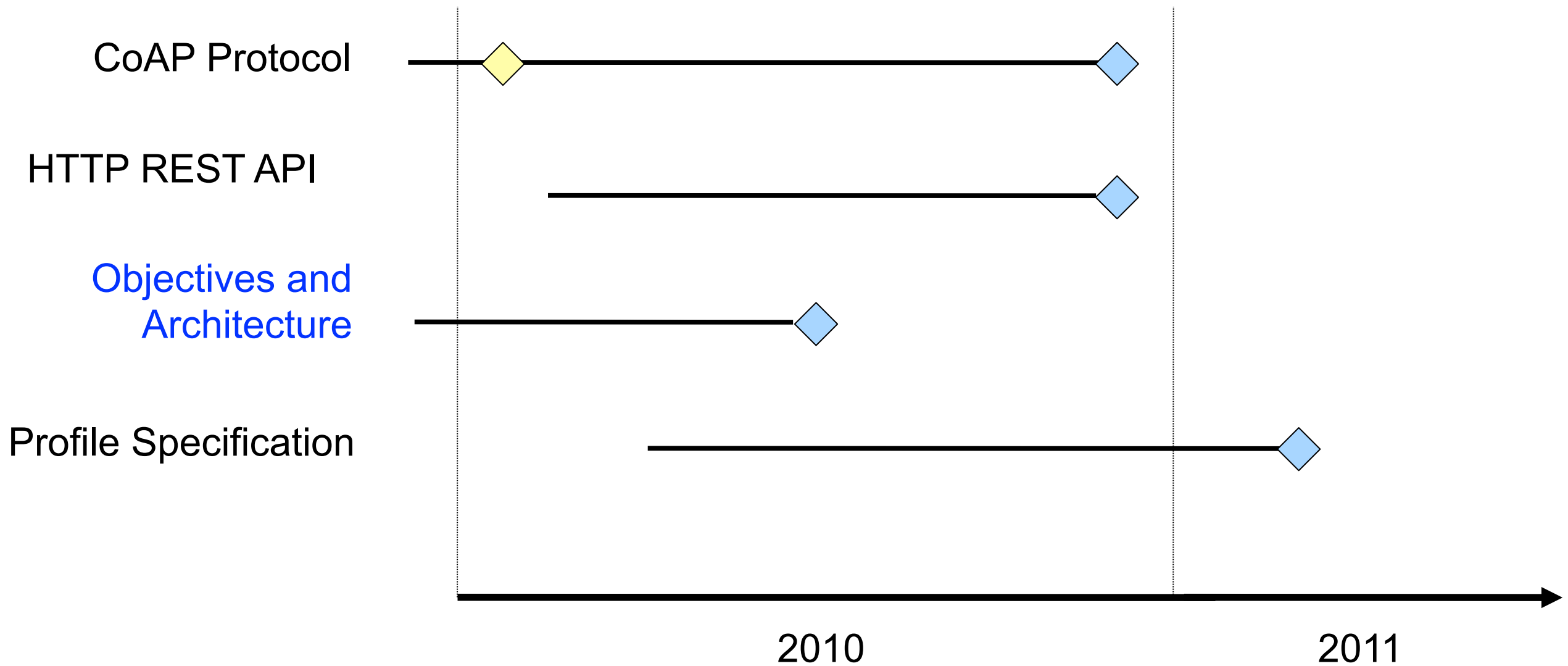


# Security

“Security, particularly keying of new Devices, is very challenging for these applications.”

- The WG looks at three commissioning types:
  - Duckling mode
  - Out of band key mode
  - Certificate mode (optional)
- CoAP can be used with session (e.g. (D)TLS) or object security
- CoAP will work with the security area to optimize object security, e.g. starting with CMS

# Milestones



Standards-Track

Informational

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