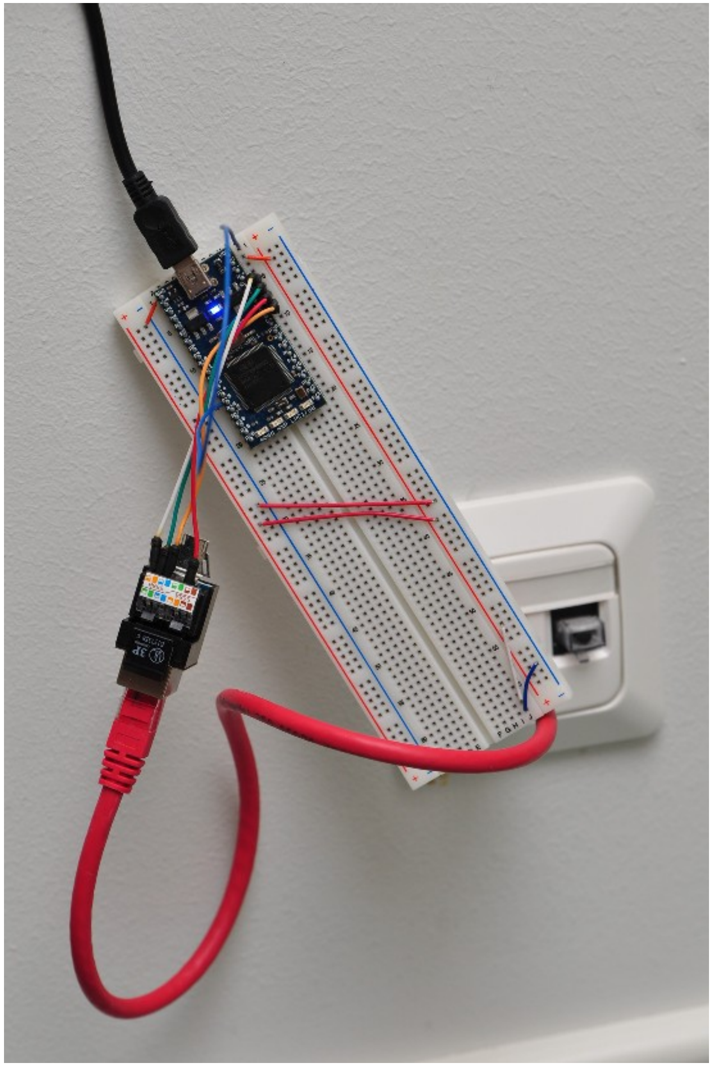
Tiny COAP Sensors



draft-arkko-core-sleepy-sensors

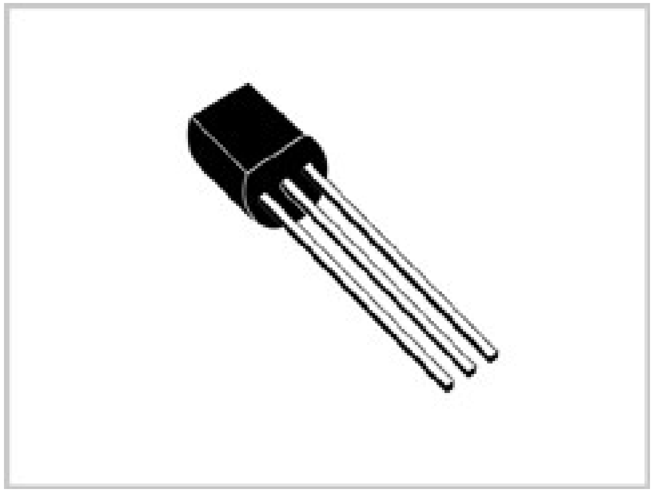
Jari Arkko, Heidi-Maria Rissanen, Salvatore Loreto, Zoltan Turanyi, and Oscar Novo

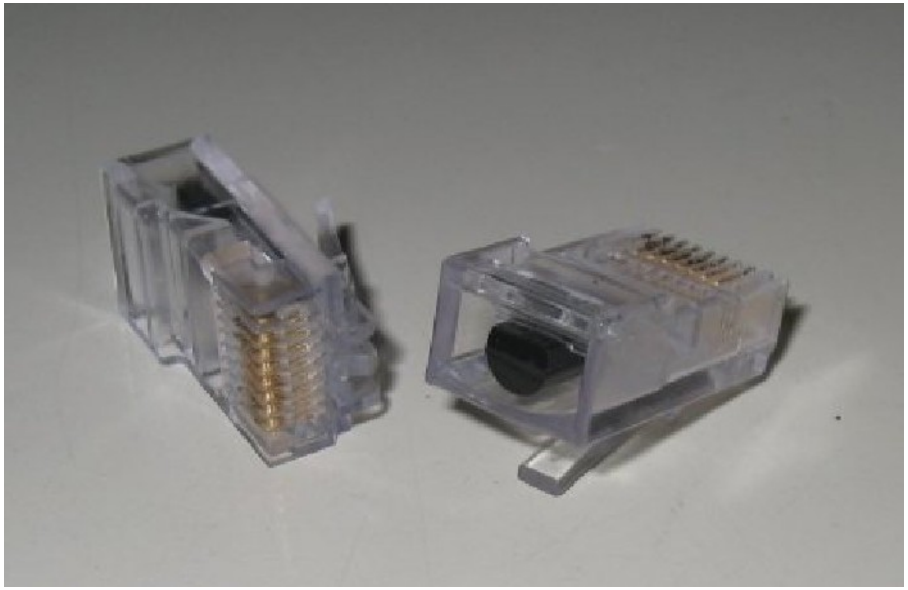
Ericsson Research

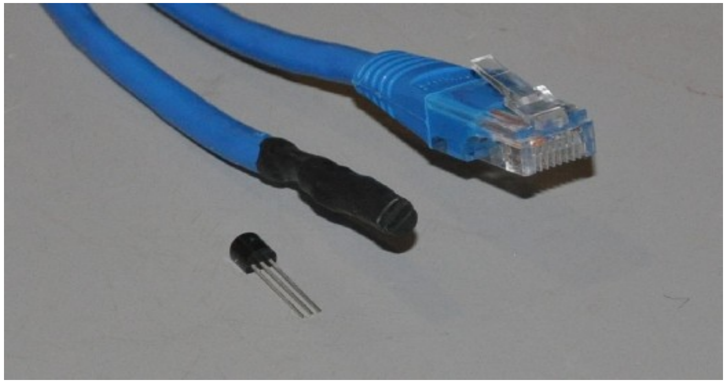
Legacy, Non-IP Technology

Can we do the same on IP?

YES we can!







Motivation

The goal was to create IP(v6) based sensors with

1. Natural support for *sleeping* nodes
2. Build something so simple that it could be re-implemented later with *gates* (not CPUs)
3. Communication models that fit the problem at hand
4. Good design from user perspective

Non-Goals

This is NOT

1. A general purpose implementation of COAP or any other protocol; we only implement what is actually needed in the application context
2. An implementation for general purpose computers
3. RFC compliance exercise. It works. 'nuff said.

Highlights from the Implementation

- Consists of 48 lines of assembler code
- Ethernet, IPv6, UDP, COAP, XML, and app
- Multicast, checksums, msg and device IDs
- Approaches theoretical minimum power usage
- No configuration needed

Look for packets to ff02::fe00:1 in the IETF wired network!

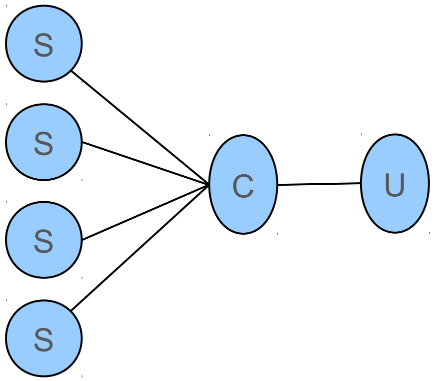
Making Small Implementions:
Problem 1 – Sleeping Nodes

The device should ideally sleep as much as possible

The fundamental issue is having to wait for responses

- Asking for an address from DHCP, waiting for a prefix from RA, waiting for DAD responses, waiting for COAP/HTTP requests, or waiting for COAP registrations

The communication model is wrong!



Do this instead:

1. Sensors multicast their readings
2. A cache node collects the messages
3. Other nodes access the cache at any time

Power Savings Comparison

Lets assume periodic messages once per minute. On a 10Mbit/s interface sending one message takes 100 us, i.e., ratio of sleep vs. awake is 600.000x

A node that wakes up for one second every minute to listen has a ratio of only 60x

10.000x difference!!!

Even if we assume that it takes ten times more to wake up and process the packet than the actual line speed is, we still get a 1.000x difference

Making Small Implementions: Problem 2 – Address Configuration

How do we get an address without having to stay awake?

The solution:

1. Use IPv6 link-local source addresses
   - No need to wait for RAs or remember prefixes
2. Use MAC-address -based generation of these addresses
3. Do not employ DAD
   - Not quite according to the RFC... but works better

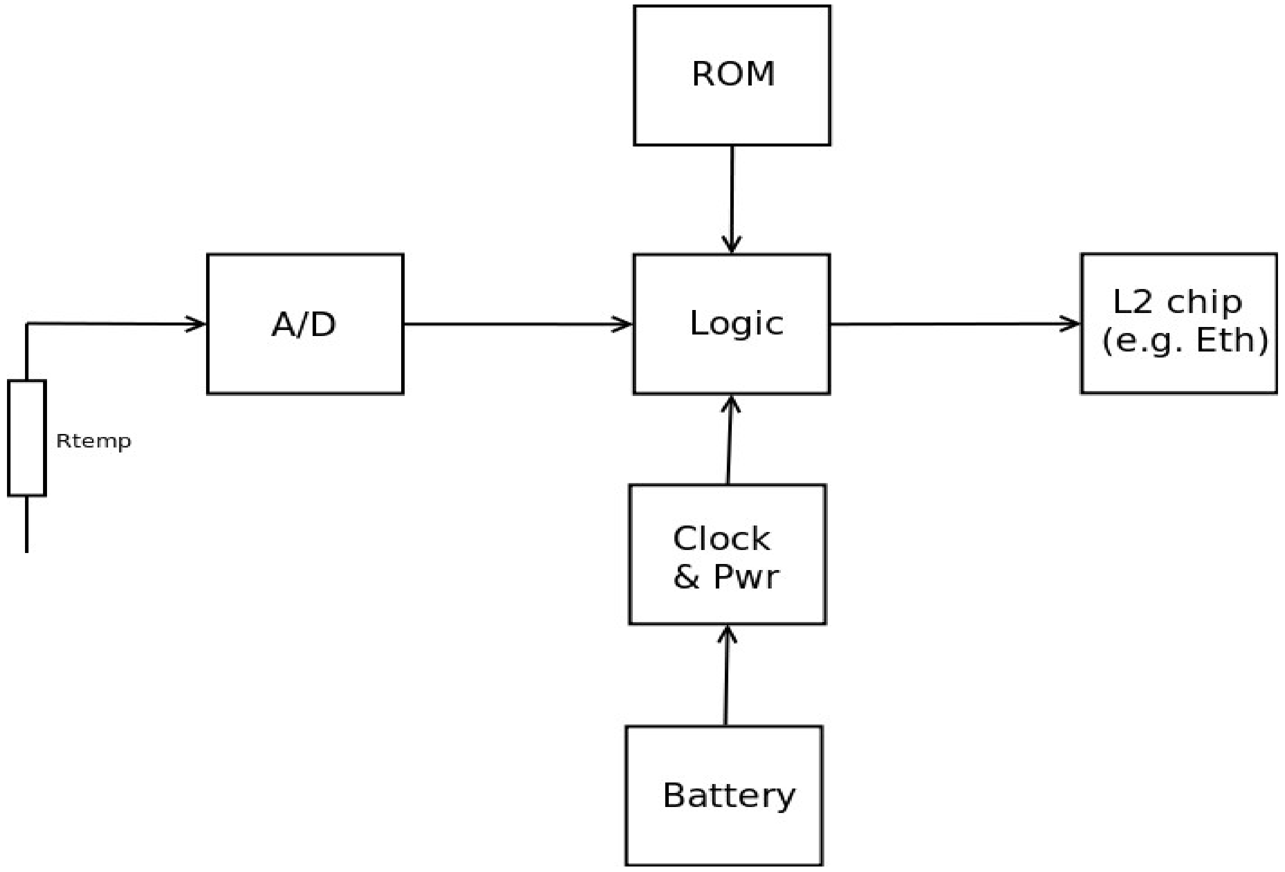
Making Small Implementions: Problem 3 – Zero Configuration

How do we avoid having to configure these tiny devices?

The solution:

1. Sensor IDs are burned into the hardware at factory
2. Sensors use multicast, no need to know any specific destination addresses
3. All configuration that might be needed (e.g., sensor X is at room Y) happens at the gateway/cache node

Draft Schema for HW Implementation



Reflections on COAP

There are areas where additional documention is needed

- How one should use multicast
- What data to include (URNs, payloads, options)
- How to configure COAP nodes in practical networks

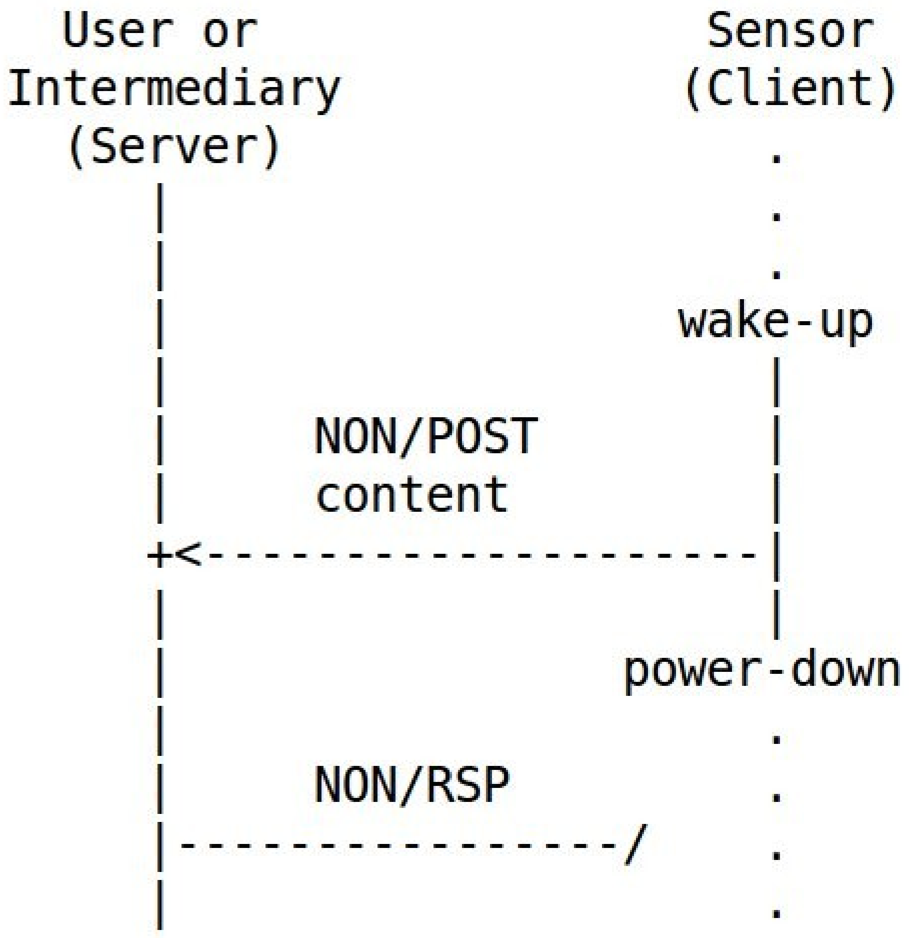
But there are also fundamental concerns

- The lightweight nature of COAP is more about small changes to syntax and behavior (TCP=>UDP) than about eliminating reasons behind complexity and power usage

Like re-arranging the deck chairs on Titanic!

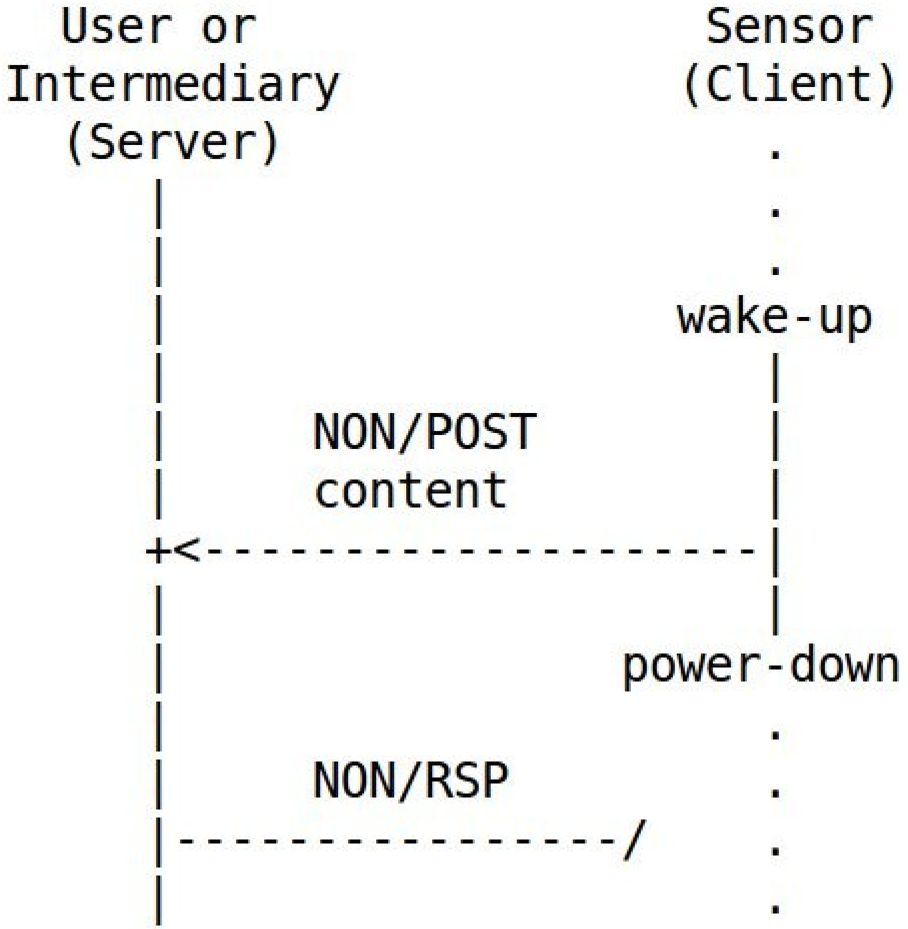
- COAP can (perhaps) be used in sleepy nodes, but it requires great care

Communication Models: 1. Send-Only

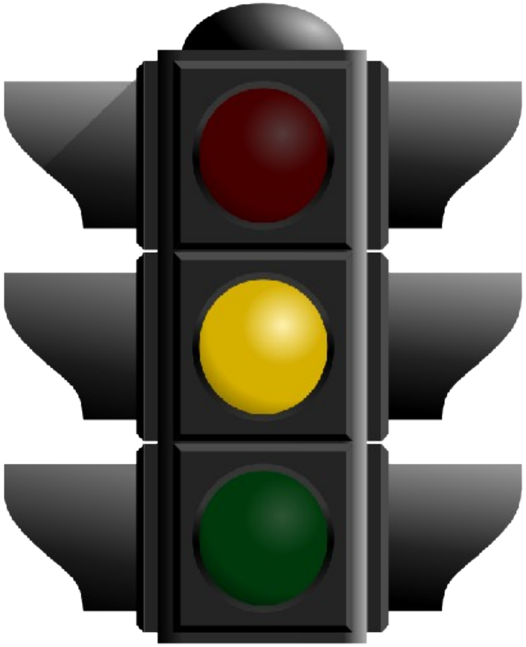


```
  User or                Sensor
Intermediary            (Client)
  (Server)                 .
     |                     .
     |                     .
     |                  wake-up
     |                     |
     |     NON/POST        |
     |     content         |
     +<--------------------|
     |                     |
     |                power-down
     |                     .
     |     NON/RSP         .
     |----------------/    .
     |                     .
```

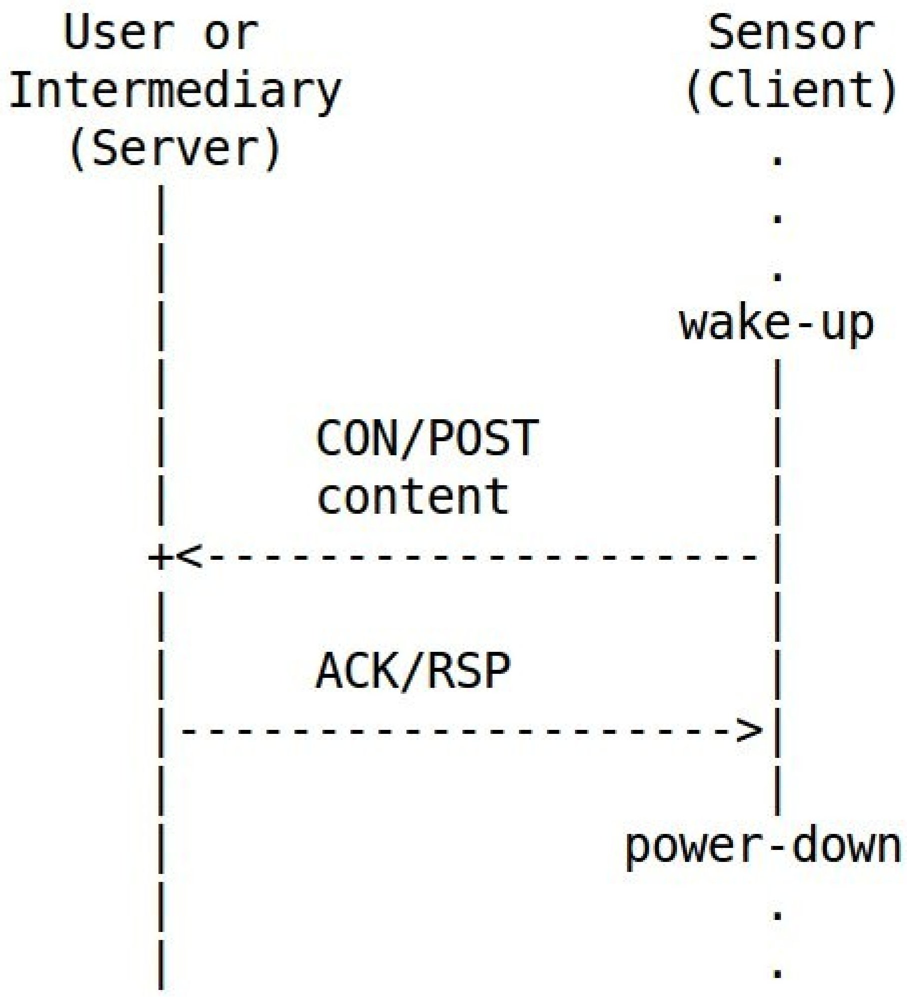
Communication Models: 1. Send-Only



```
  User or                Sensor
Intermediary            (Client)
  (Server)                 .
     |                     .
     |                     .
     |                  wake-up
     |                     |
     |     NON/POST        |
     |     content         |
     +<--------------------|
     |                     |
     |                power-down
     |                     .
     |     NON/RSP         .
     |----------------/    .
     |                     .
```

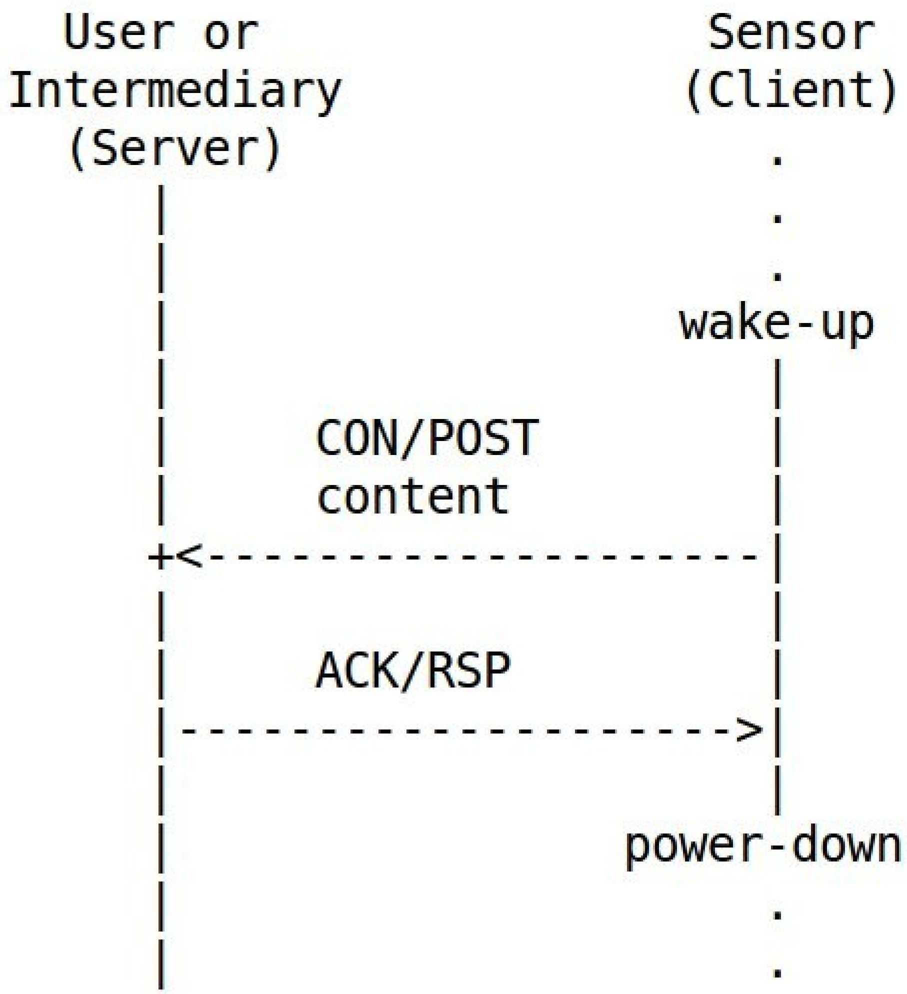


2. Send & Confirm

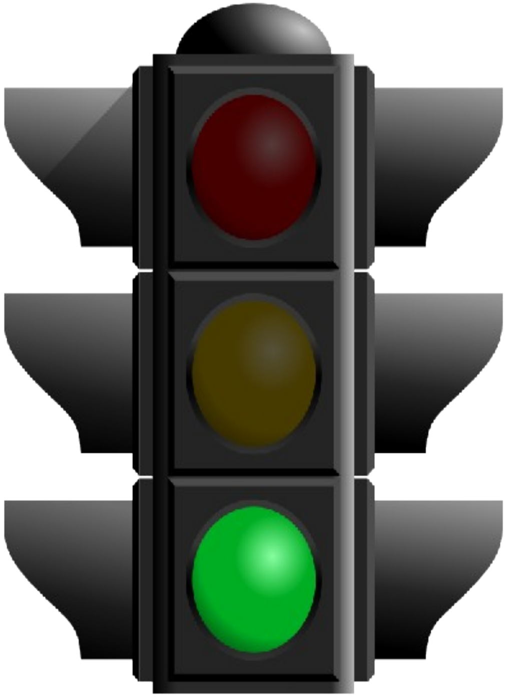


```
  User or                   Sensor
Intermediary               (Client)
  (Server)                    .
     |                        .
     |                        .
     |                     wake-up
     |                        |
     |      CON/POST          |
     |      content           |
     +<-----------------------|
     |                        |
     |      ACK/RSP           |
     |----------------------->|
     |                        |
     |                   power-down
     |                        .
     |                        .
```

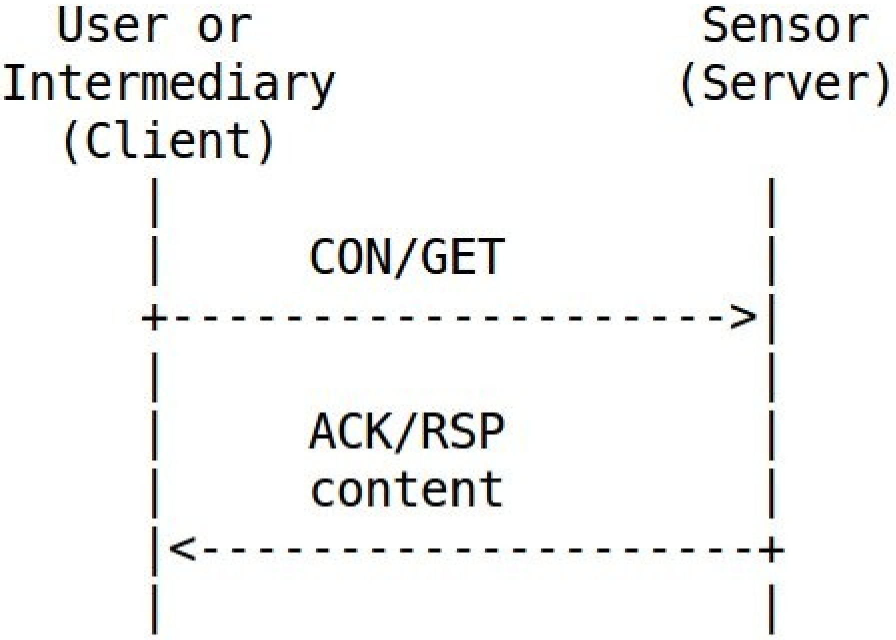
2. Send & Confirm



```
  User or                Sensor
Intermediary            (Client)
  (Server)                 .
     |                     .
     |                     .
     |                  wake-up
     |                     |
     |     CON/POST        |
     |     content         |
     +<--------------------|
     |                     |
     |     ACK/RSP         |
     |-------------------->|
     |                     |
     |                power-down
     |                     .
     |                     .
```

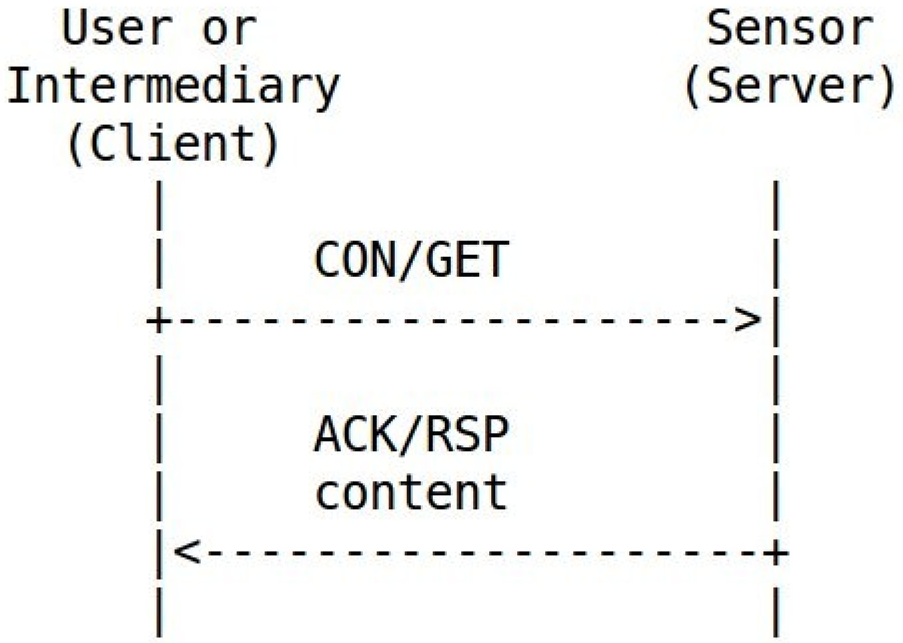


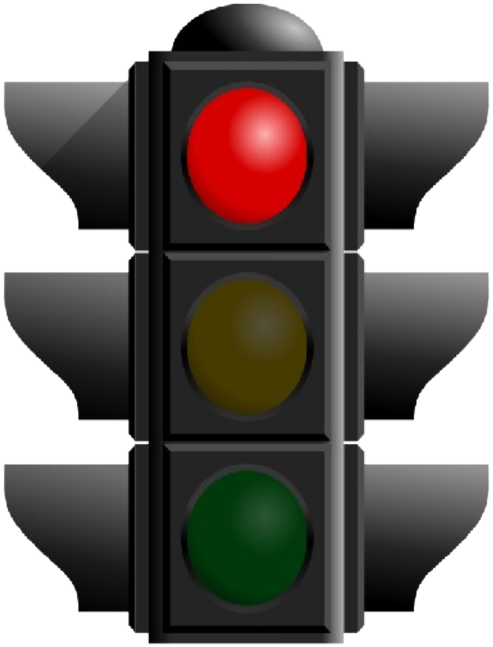
3. Server



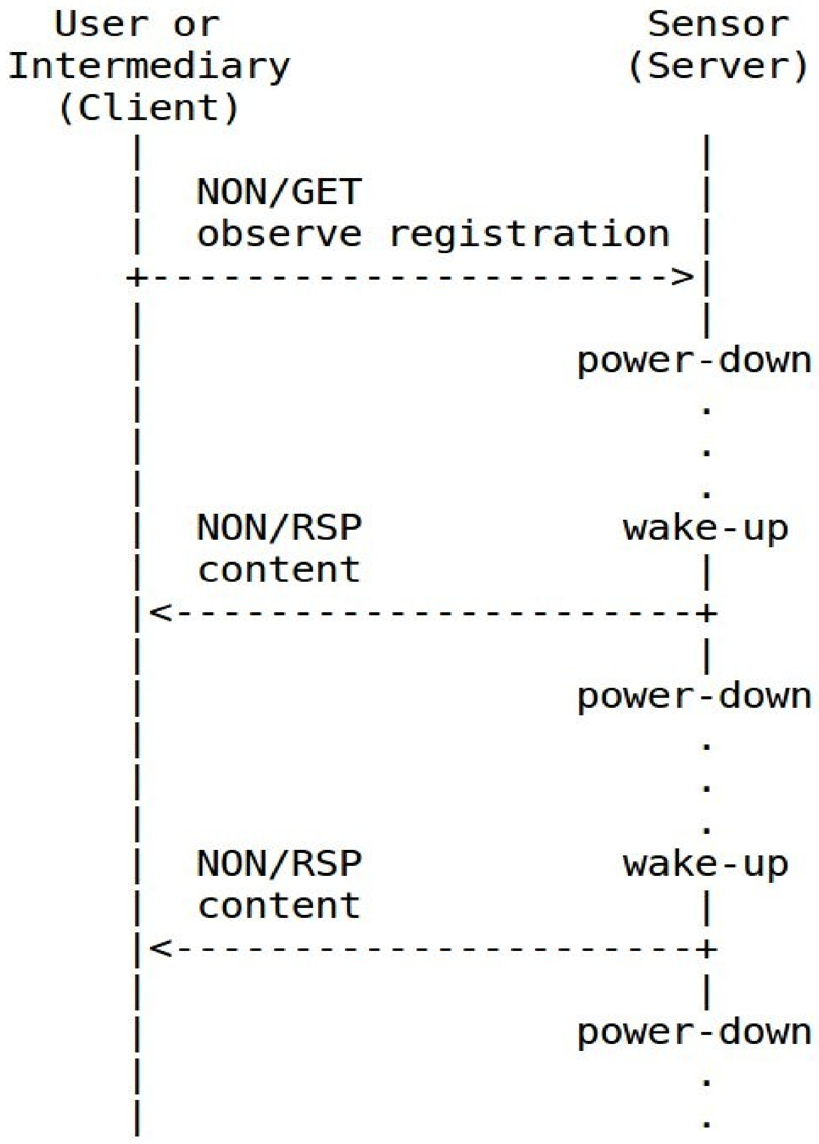
```
  User or                    Sensor
Intermediary                (Server)
  (Client)
     |                         |
     |     CON/GET             |
     +------------------------>|
     |                         |
     |     ACK/RSP             |
     |     content             |
     |<------------------------+
     |                         |
```

3. Server


User or Intermediary (Client)
Sensor (Server)
CON/GET
ACK/RSP content

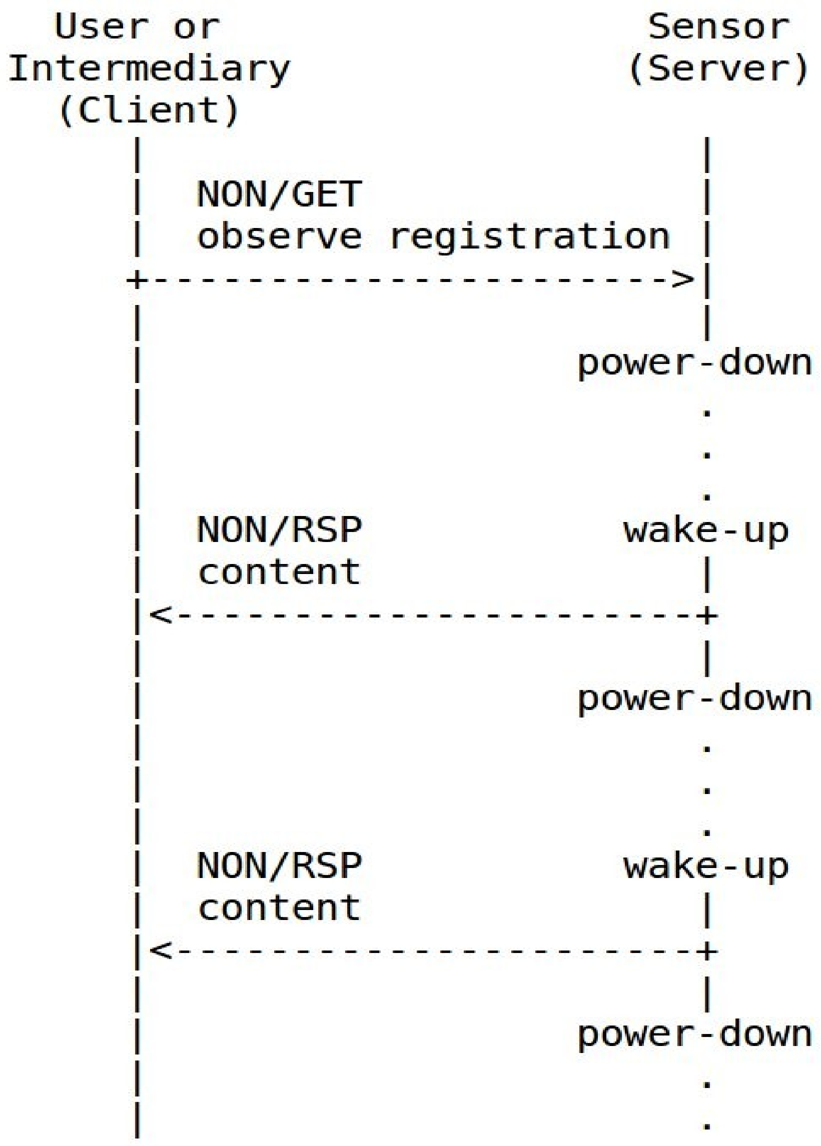


4. Observer

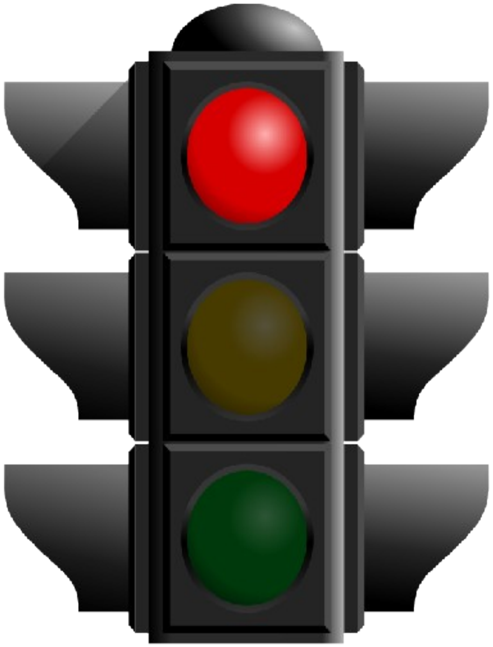


```
  User or                      Sensor
Intermediary                  (Server)
  (Client)
     |                           |
     |  NON/GET                  |
     |  observe registration     |
     +-------------------------->|
     |                           |
     |                      power-down
     |                           .
     |                           .
     |                           .
     |  NON/RSP                wake-up
     |  content                  |
     |<--------------------------+
     |                           |
     |                      power-down
     |                           .
     |                           .
     |                           .
     |  NON/RSP                wake-up
     |  content                  |
     |<--------------------------+
     |                           |
     |                      power-down
     |                           .
     |                           .
```

4. Observer



```
   User or                          Sensor
 Intermediary                      (Server)
  (Client)
      |                               |
      |   NON/GET                     |
      |   observe registration        |
      +------------------------------>|
      |                               |
      |                          power-down
      |                               .
      |                               .
      |                               .
      |   NON/RSP                  wake-up
      |   content                     |
      |<------------------------------+
      |                               |
      |                          power-down
      |                               .
      |                               .
      |                               .
      |   NON/RSP                  wake-up
      |   content                     |
      |<------------------------------+
      |                               |
      |                          power-down
      |                               .
      |                               .
```



Suggested Changes to COAP Specs

Multicast and Non-Confirmable requests:

- Specify better what the re-transmission rules should be for non-confirmable requests
- Specify what the multicast transmission rules are with respect to congestion (random delays etc)
- Consider standardizing what destination addresses and target URIs to use

Communication models

- Explain the implication of different models
- Change the observer model so that it becomes compatible with sleeping nodes

ERICSSON