Draft-chakrabarti-nordmark-energy-aware-nd-01.txt

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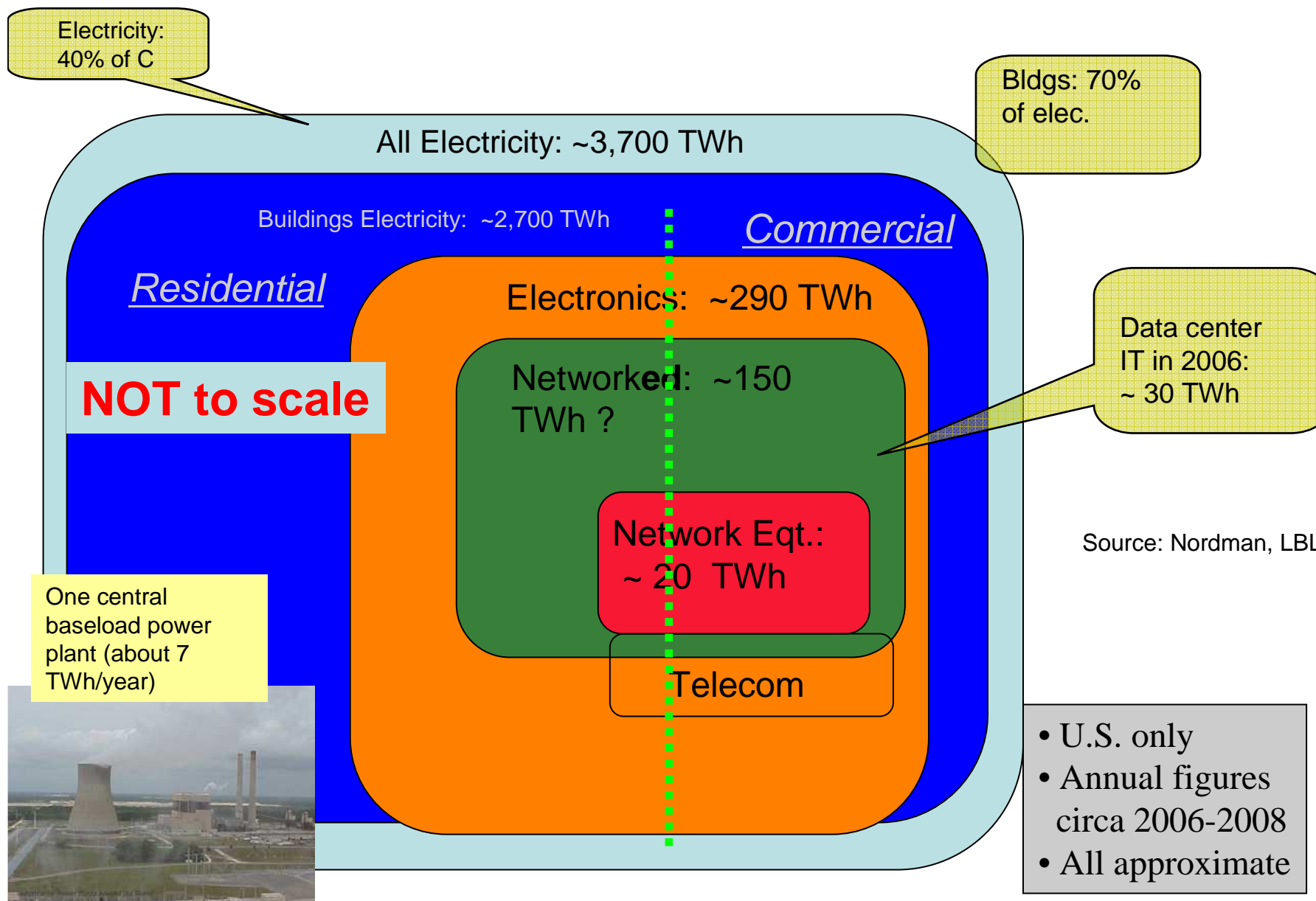
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Motivation

- Effort on Energy Efficiency throughout the Industry

- Reduce signaling messages in IPv6 Neighbor Discovery

- Promote IPv6 for Home Networking for Regular IPv6 Subnets

- Reduce traffic in Data Center VLANs due to ND

- Reduce IPv6 Signaling in Data Centers (Cost Savings)

- IoT IAB workshop in March, 2011

- Generalize 6lowpan ND ideas in Legacy IPv6 context

Electronics / Network electricity use

Electricity: 40% of C

All Electricity: ~3,700 TWh

Bldgs: 70% of elec.

Buildings Electricity: ~2,700 TWh

Commercial

Residential

Electronics: ~290 TWh

Data center IT in 2006: ~ 30 TWh

NOT to scale

Networked: ~150 TWh ?

Source: Nordman, LBL

One central baseload power plant (about 7 TWh/year)

Network Eqt.: ~ 20 TWh

Telecom

- U.S. only
- Annual figures circa 2006-2008
- All approximate

Background

- Draft-chakrabarti-nordmark-energy-aware-nd-00.txt

  – Presented at 6man @ IETF81 in Quebec City

  – Working group was interested in seeing updates on this work

  – Registration of nodes were seen to be a way to reduce ND flooding attacks

  – The main idea was inherited from the co-authors' work in http://tools.ietf.org/html/draft-ietf-6lowpan-nd-18
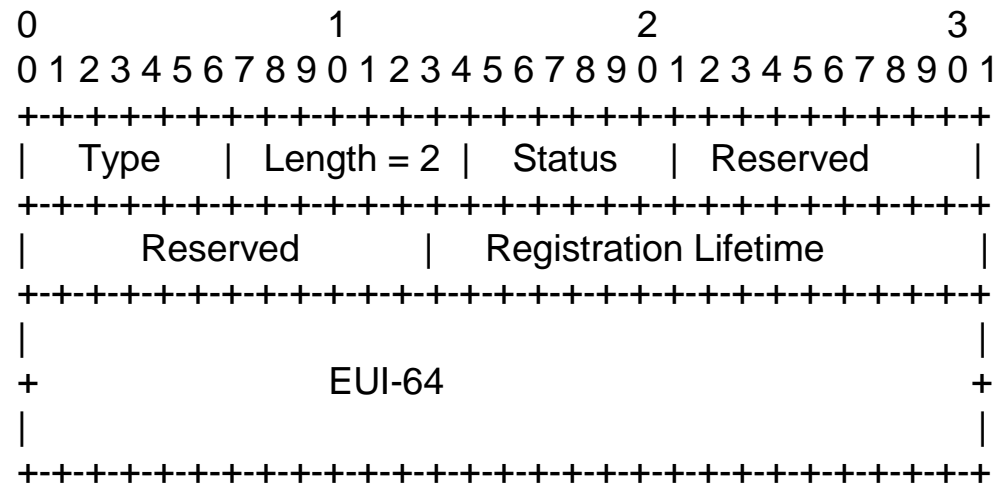
Basic Ideas Proposed at IETF81
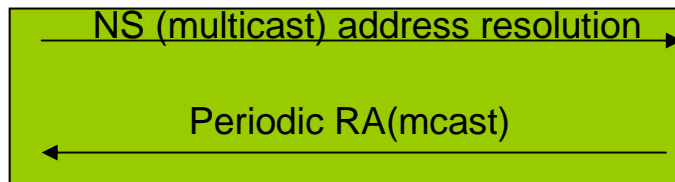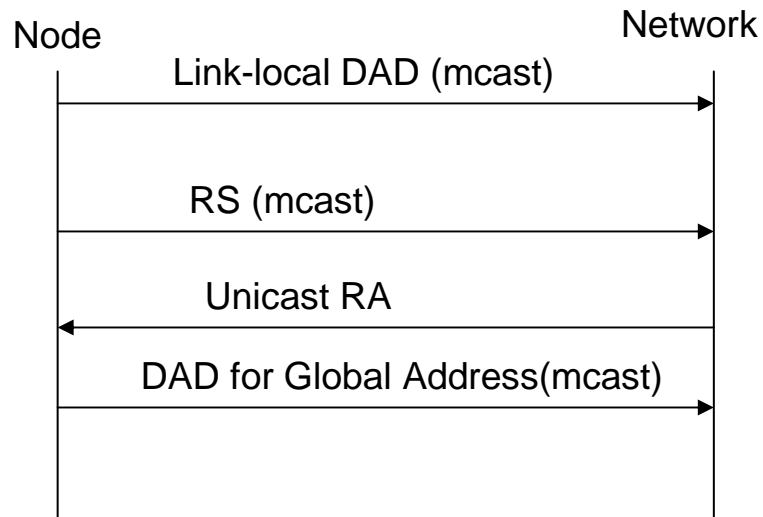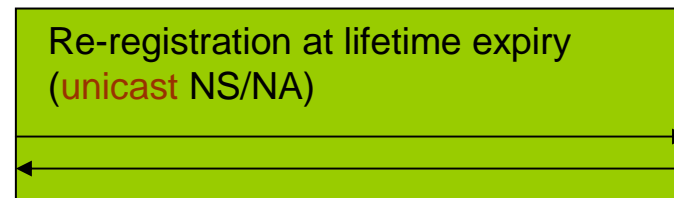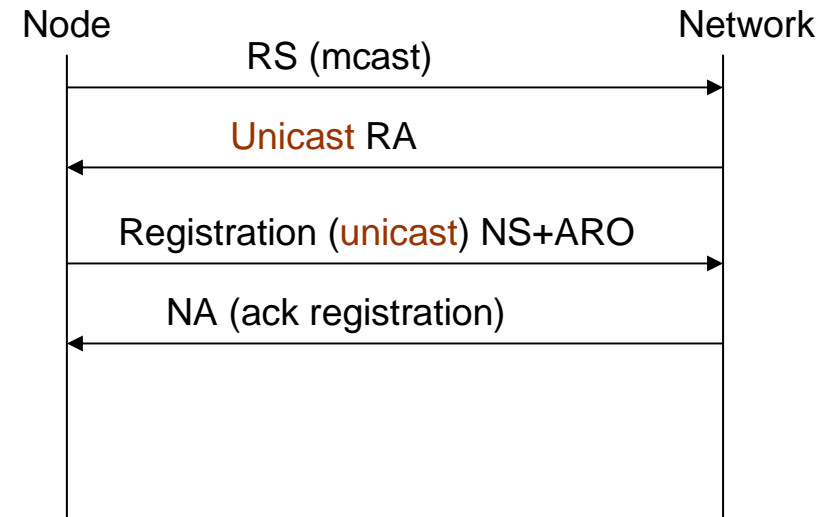
Address Registration

- Address Registration Option (ARO) is sent by the energy-aware hosts along with a unicast NS message
- Same as draft-ietf-6lowpan-nd definition
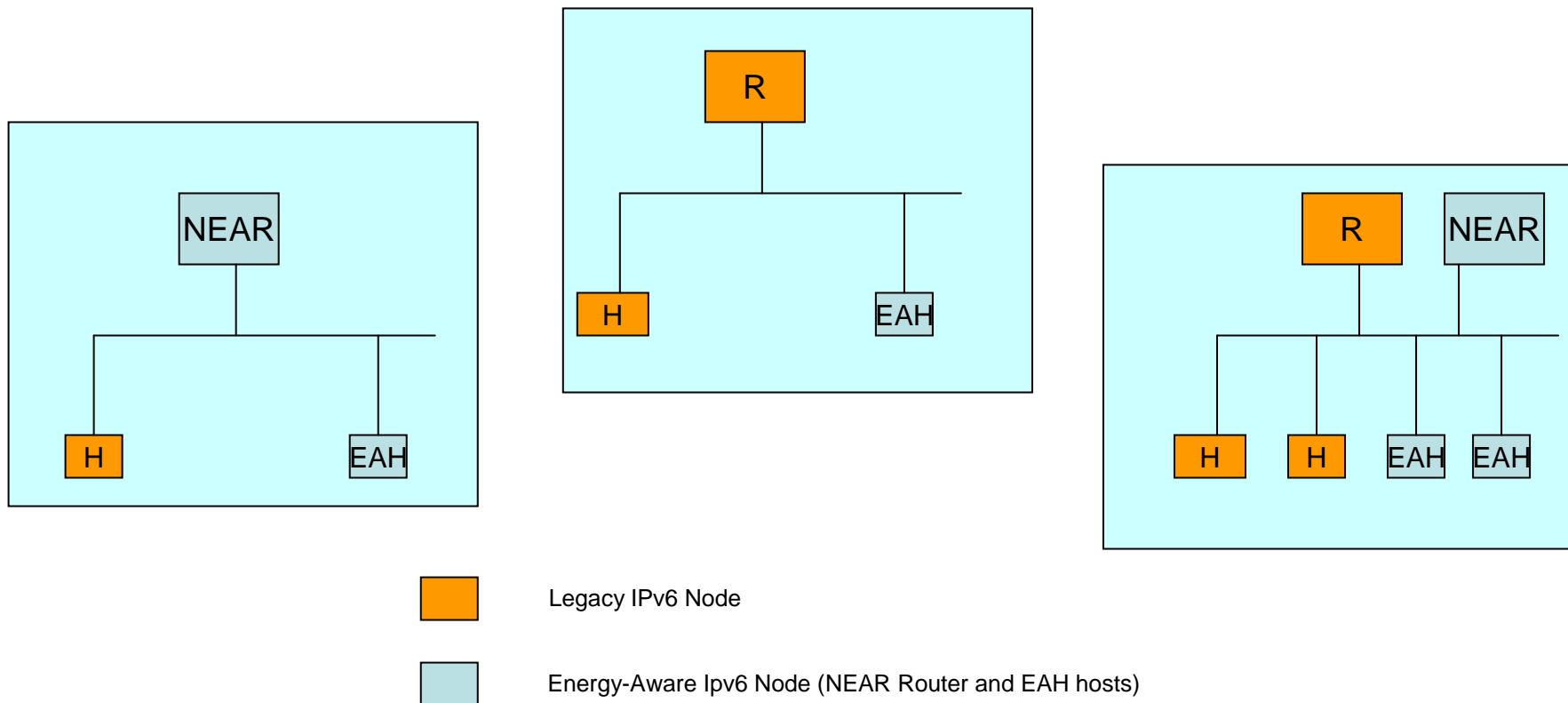- Used for both DAD and proactively installing Neighbor Cache Entries

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |  Length = 2   |    Status     |   Reserved    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Reserved             |     Registration Lifetime     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                           EUI-64                              +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Draft version -01

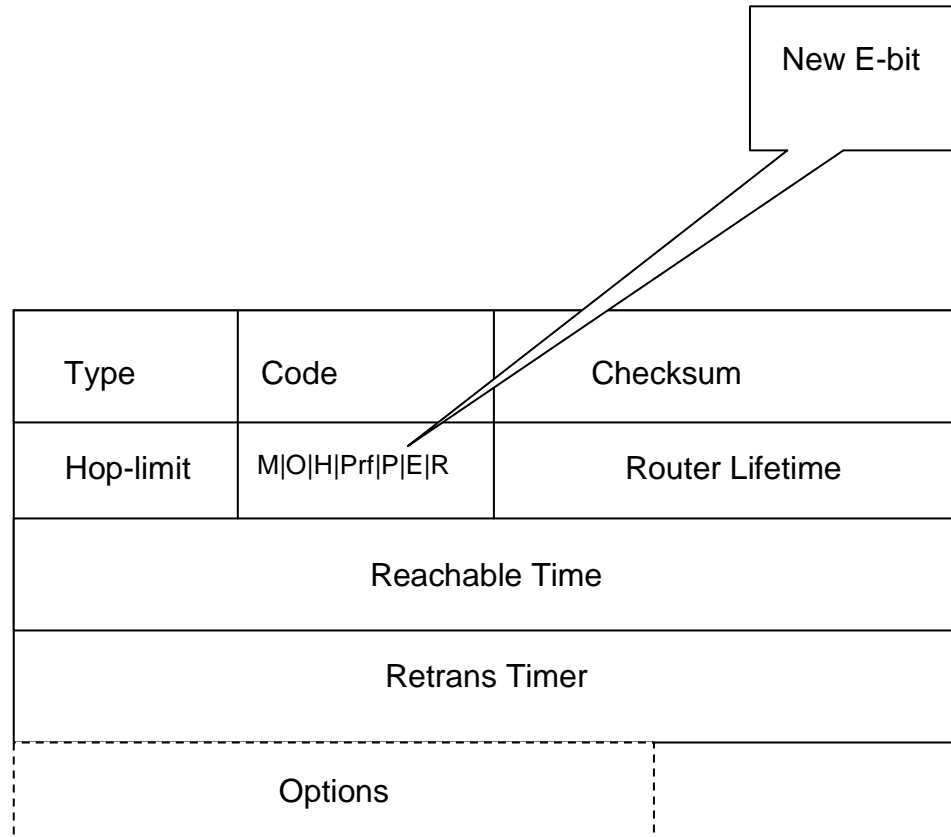- ## Major Changes
    - o Added support for legacy (RFC 4861) IPv6 nodes in the network (mixed-mode)
        - o Introduced a new flag-bit in ND RA to distinguish Optimized ND support from Legacy routers
    - o Clarified energy-aware Router and hosts behavior
    - o Clarified NCE management
        - o Introduced two types of NCE (Legacy and Registered)
    - o Added Use Cases

Mixed-Mode Operation

- Energy-aware Router and legacy IPv6 hosts along with energy-aware IPv6 hosts
- Legacy Router and energy-aware hosts

Legacy IPv6 Node

Energy-Aware Ipv6 Node (NEAR Router and EAH hosts)

The E-bit in RA

New E-bit

Type	Code	Checksum	
Hop-limit	M|O|H|Prf|P|E|R	Router Lifetime	
Reachable Time			
Retrans Timer			
Options			

NEAR and EAH in Mixed-Mode

NEAR

- Offers Periodic RA and provides Registration for energy-aware hosts(EAH)
- Advertises E-bit in RA flag when configured in energy-aware/mixed-mode
- Manages both Registered NCE entries and Legacy entries
- SHOULD have configuration knobs to turn on Energy-aware mode
- Recommended default mode for NEAR is Mixed-Mode
- NEAR MUST NOT set 'L' bit in RA

EAH

- First sends Multicast RS to the link to detect presence of NEAR if it did not hear a RA with E-bit upon joining the network already
- If it hears from both NEAR and legacy IPv6 Router, it always registers with the NEAR router
- Energy-aware hosts SHOULD de-register before moving away
- Mixed-mode SHOULD be the default mode for EAH

NCE Management

- Two Types of NCE
    - Legacy (RFC 4861 NCE)
    - Registered (in mixed-mode and energy-aware only mode)
    - Only **one** type of NCE can exist in Neighbor Cache at a time for any given IP-address
- Types are orthogonal to NCE states

- All NCE are started with Legacy NCE
    - Turns into 'Registered' NCE upon successful processing of ARO
- Registered NCE are NOT garbage-collectable
    - Registered NCE has its own life-time
    - Registered NCE are renewed by the EAH via Registration refresh before it expired

- Registration lifetime and EUI-64 are recorded for Registered NCE

Handling ND-DOS Attacks

The Issue: When an external attacker sends flood of packets to non-existing IPv6 addresses within /64 prefix, the NCE table of the router gets full with bogus entries while the router tries resolving those non-existent addresses and can not perform its normal function

Use Routers and nodes in Energy-aware mode

– All hosts register with the routers – packets to unknown addresses can be discarded by the router

– Tentative NCE entries are discarded if registration fails

– Duplicate entries must be checked before creating a valid NCE entry by checking EUI-64, MAC-address and IP-address

– All RS requests MUST contain SLLA option to avoid Neighbor Solicitation for the requestor's address resolution

Handling Sleepy Nodes

- Sleepy nodes must support Energy-aware mode only behavior

- No Multicast periodic RA

- No Address resolution Required

- Address Registration ensures DAD

- Uses Default-router for packet forwarding

- Sleep and Registration interval should be synchronized for maximum energy savings

Implementations

- The ARO concept/Registration is from 6lowpan-nd specification

- Several interoperable implementations of 6lowpan-nd exist today

- 6lowpan-nd is adopted in ZigBee and other SDOs

Use Case Scenarios

- Data Center Subnet Routers

- Home Routers and Residential Gateways

- M2M Networks

Next Step

- Working group document ?

- Comments are welcome

Thanks!