

# Energy Aware IPv6 Neighbor Discovery Optimizations

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

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# Background

- RFC4861/62 is based on periodic multicast for information updates
  - Router Advertisements
- Host-to-host multicast
  - Address resolution using multicast NS
  - Duplicate address detection using multicast NS
- DAD assumes hosts are always awake/present to defend their addresses

# 6lowpan-nd

- Specific to IPv6 over IEEE 802.15.4 (RFC 4944)
- Intentionally doesn't interoperate with RFC 4861/62 on the same link
- Includes address registration and multicast avoidance
- Also includes
  - 6lowpan compression context option
  - Optional multi-hop prefix and context distribution
  - Those are not the subject of this draft

# Address registration and multicast avoidance

- Explicit, host-driven registration to routers
- Host-driven refresh – send RS to get RA
  - No periodic multicast
- Hosts multicast RS if they don't know any routers
- RA prefixes options have on-link=0
  - All packets sent to routers
  - Option to use Redirect to get direct path [Not in 6lowpan-nd]

# Utility

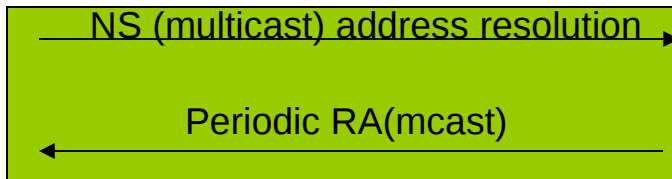
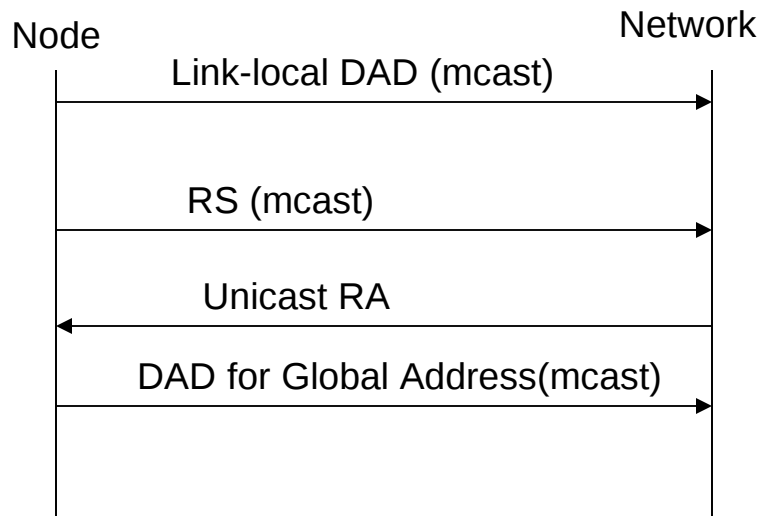
- Reduce host processing
  - Hosts don't need to process unrelated multicasts
- More robust on radio links
  - Where multicast is less reliable than unicast
- Allows for sleepy nodes
  - DAD handled by routers neighbor cache
- Removes some ND DoS issues
  - All IPv6 addresses known by routers

# Background

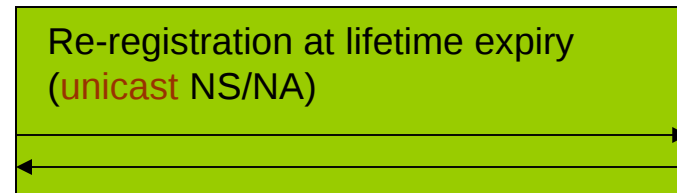
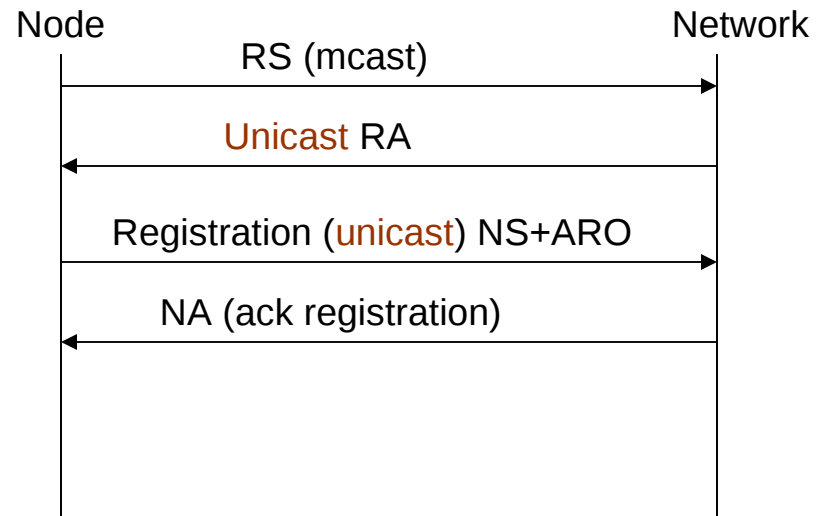
- Draft-chakrabarti-nordmark-energy-aware-nd-00.txt
  - Presented at 6man @ IETF81 in Quebec City
  - Working group was interested in seeing updates on this work
  - Registration of nodes were seen to be a way to reduce ND flooding attacks
  - The main idea was inherited from the co-authors' work in <http://tools.ietf.org/html/draft-ietf-6lowpan-nd-18>

# Basic Ideas Proposed at IETF81

## RFC 4861 ND



## Proposed Optimizations







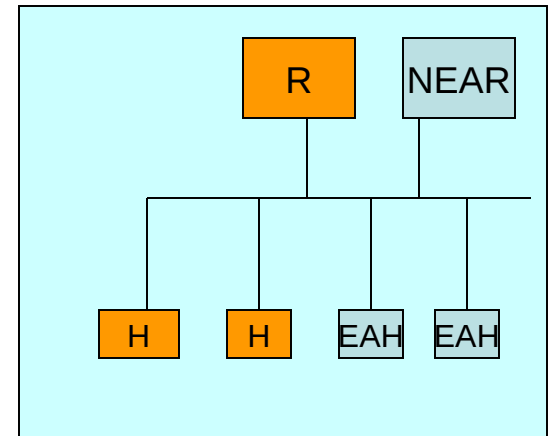
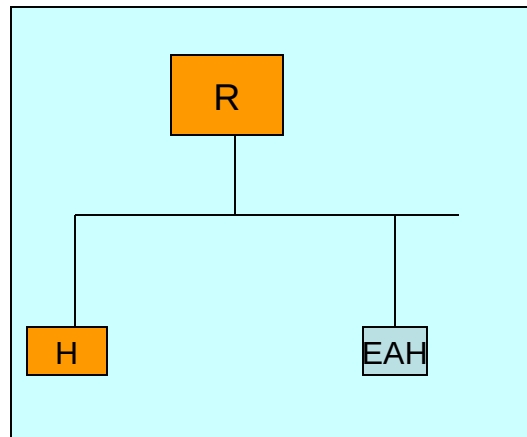
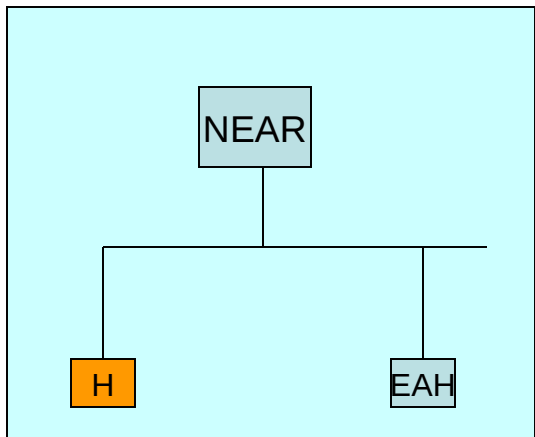
# Draft version -01

- 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

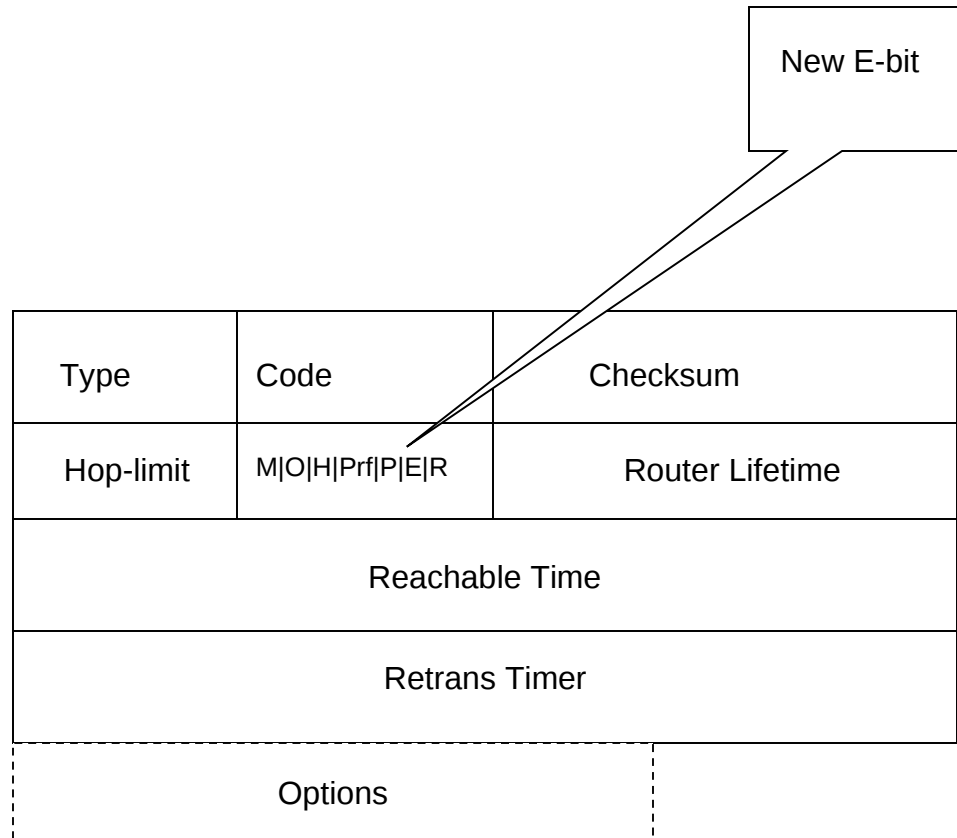


Legacy IPv6 Node



Energy-Aware IPv6 Node (NEAR Router and EAH hosts)

# The E-bit in RA



# 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

# Next Steps

- Need to clarify multiple areas of utility
  - Perhaps separate energy-aware document and protocol document
- Comments are welcome

*Thanks!*

# 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

# 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

