

# Efficiency-aware IPv6 Neighbor Discovery Optimizations

**draft-chakrabarti-nordmark-6man-efficient-nd-00**  
**[Earlier draft-chakrabarti-nordmark-energy-aware-nd-02.txt]**

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# Summary

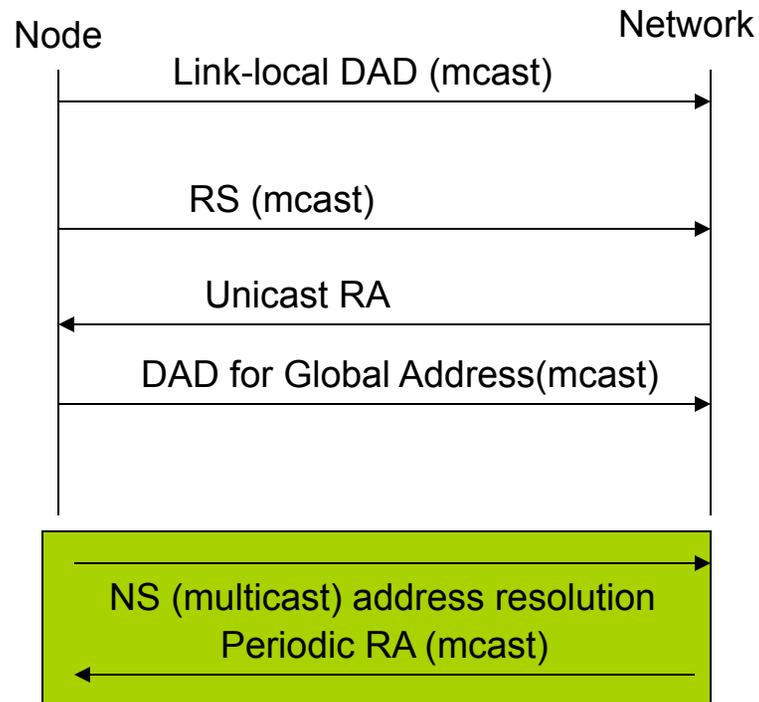
- Leverages 6lowpan-nd [RFC 6775] for general IPv6 links
  - No periodic multicast RA
  - Replaces DAD with Address Registration Option [ARO]
  - No multicast NS messages
  - Host-driven refresh of RA information – unicast RS to refresh
- Adds support for mixed-mode links
  - Combining RFC 4861 and efficiency-aware nodes on same link
  - Defines a new E-bit in the RA so hosts know the efficiency-aware routers
- Allows for sleeping hosts
  - ARO is used to check for duplicates at the router
- ND host scan attack removed/reduced
  - As more hosts use ARO the rate limit for sending multicast NS can be reduced reaching zero when all hosts on link use ARO

# Recent changes

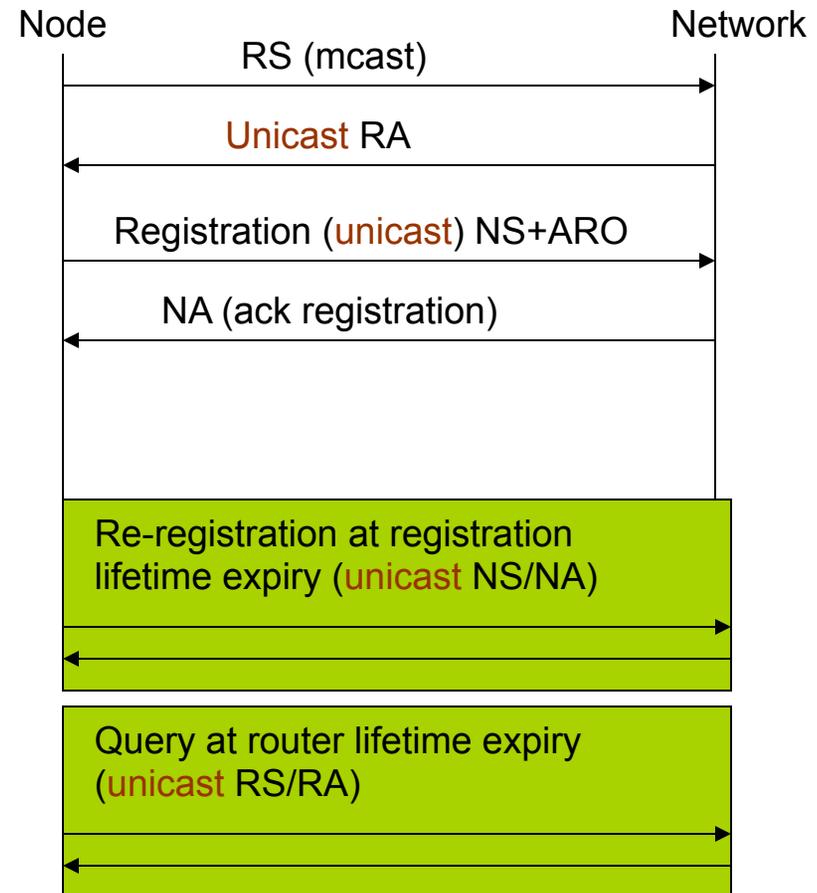
- Changes from draft-chakrabarti-nordmark-energy-aware-nd-02
  - Replaced “energy-aware” with “efficiency-aware” which covers both energy efficiency and other operational efficiency
  - Added consideration for DNA and clarified that this is useful for networks with MLD-snooping switches as well
  - Added use-cases, Support for Mixed-mode operations and a diagram for bootstrapping scenario.
  - Clarified its applicability when DHCP is used for address allocation.
- 6lowpan-nd approved as an RFC

# Basic Ideas

## RFC 4861 ND



## Proposed Optimizations



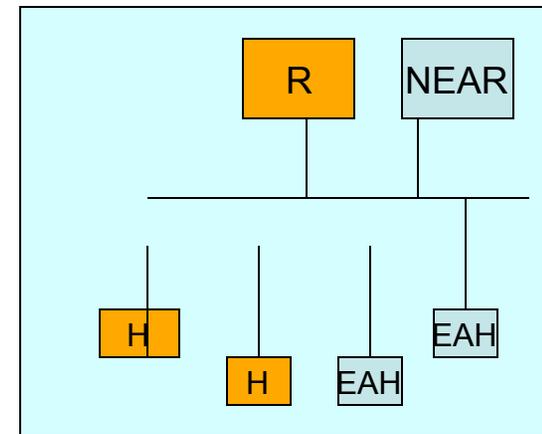
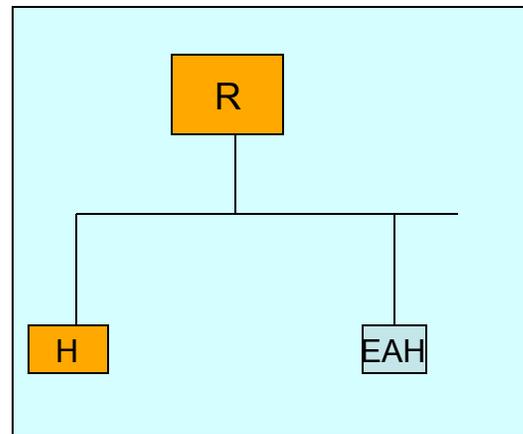
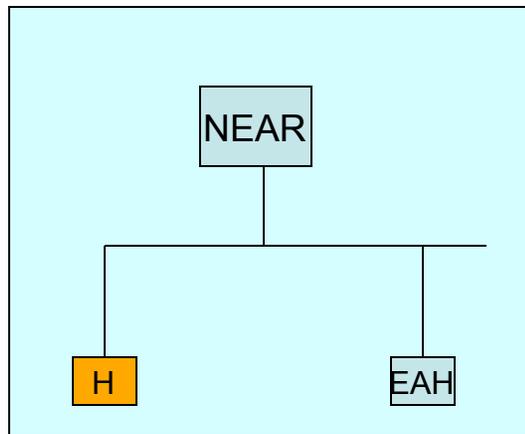


# Terminology

- ND efficiency-aware Router (NEAR)
  - Specified in this document
- Efficiency-Aware Host (EAH)
  - Ditto
- Legacy router
  - RFC 4861
- Legacy host
  - Ditto

# Mixed-Mode Operation

- efficiency-aware Router and legacy IPv6 hosts along with efficiency-aware IPv6 hosts
- Legacy Router and efficiency-aware hosts

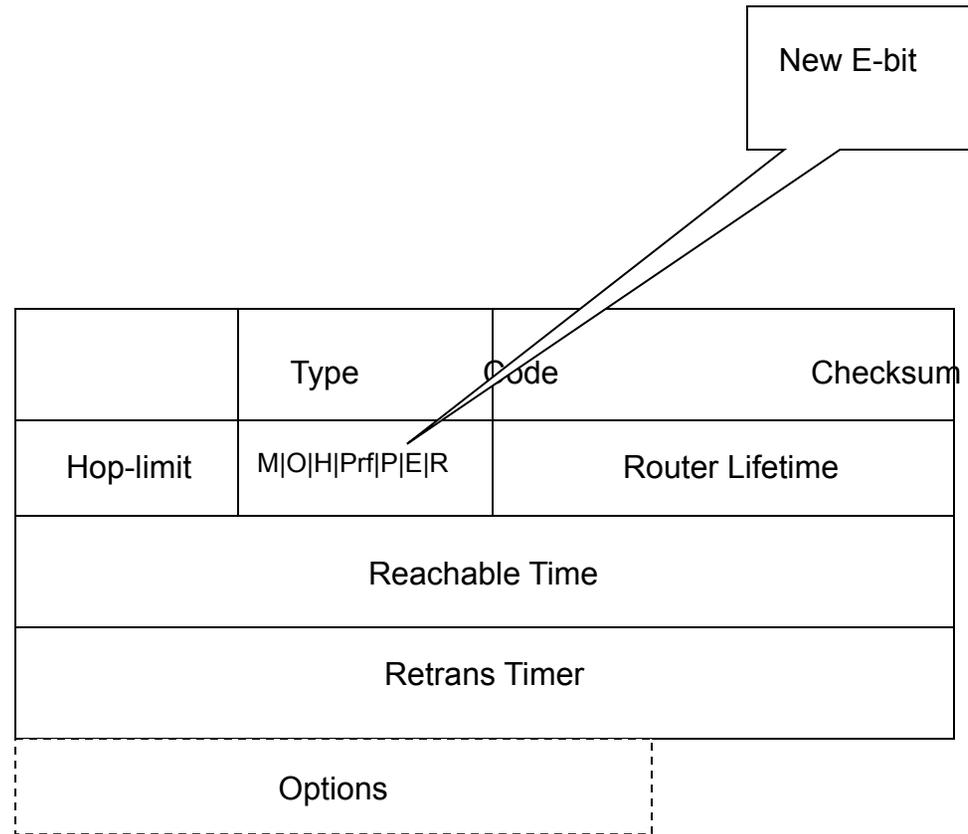


Legacy IPv6 Node



Efficiency-Aware IPv6 Node

# The E-bit in RA



# NEAR and EAH in Mixed-Mode

## NEAR

- Sends periodic RAs for legacy hosts
- Supports ARO for EAH
- Advertises E-bit in RA
- Manages both Registered NCE entries and Legacy entries
- SHOULD have configuration knobs for Mixed vs. Efficiency-aware-only 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, the NEAR(s) gets preference as a default router(s)
- Registers with more than one NEAR (if multiple are available)
- Efficiency-aware hosts SHOULD de-register before it moves away or switches to legacy mode

# Mixed-mode

- Legacy host multicasts DAD probe
  - In mixed mode, NEAR proxies based on registered NCEs
- Legacy host sends data packet to any router since  $L=0$ 
  - Legacy router would multicast NS
  - NEAR would proxy with an NA based on registered NCEs
  - [Alternative is to require that a mixed link has only NEAR routers]
- EAH uses ARO for DAD
  - In mixed mode, NEAR should multicast DAD probe before ack'ing ARO

# Interaction

- Detecting Network Attachment (DNA)
  - Orthogonal
  - DNA sends a unicast NS to previously know router(s)
  - That can now include an ARO
  - DNA also sends a multicast RS (in case moved to new link)
  - Same as a regular RS/RA on power-on
- DHCPv6
  - ARO is used for link-local address
  - DHCPv6 client SHOULD check DAD for assigned address. If ARO is available use that instead of multicast DAD probe
- Secure ND
  - RFC 37971 recommends allowing un-secured DAD on first try
  - Allows for NEAR to proxy DAD response
- MLD snooping
  - No use of solicited-node multicasts means less MLD snooping state

# Open Issues

- 6lowpan-nd has a “SHOULD NOT” for sending redirects
  - To avoid hidden terminal issues in radio networks
- On general IPv6 links redirects are useful
  - Avoids sending all packets via routers
  - NUD will detect and remove stale redirects
- Should we allow redirects in this specification?

# Next Step

- Accept as 6man working group document ?
- Comments are welcome

*Thanks!*

Backup slides

# NCE Management

- Two Types of NCE
  - Legacy (RFC 4861 NCE)
  - Registered (in mixed-mode and efficiency-aware only mode)
- NCE 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
- In efficiency-aware only mode a TENTATIVE legacy NCE is created for a short time and deleted if the entry does not get registered
- Registration lifetime and EUI-64 are recorded for Registered NCE
- Only **one** type of NCE can exist in Neighbor Cache at a time

# Handling ND-DOS Attacks

- Only in efficiency-Aware mode
- 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 and avoids Neighbor Solicitation for the requestor's address resolution

# Handling Sleepy Nodes

- Sleepy nodes must support efficiency-aware mode only behavior
- No Multicast periodic RA
- No Address resolution Required
- Address Registration ensures duplicate checks
- Uses Default-router for packet forwarding
- Sleep and Registration interval should be synchronized for maximum energy savings