Efficient IPv6 Neighbor Discovery for Wired and Wireless Networks

(WIND)

draft-chakrabarti-nordmark-6man-efficient-nd-04

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Background

- The Idea was first presented at IETF 82(6man, intarea):
  draft-chakrabarti-nordmark-energy-aware-nd-xx
- Next presentation in IETF 85 with focus on general efficiency in IPv6 networks in Wired and Wireless
  draft-chakrabarti-nordmark-efficient-nd-01
- Added optional TID bit for draft-pthubert-6lowpan-backbone-router to work with ND and to resolve movement of wireless nodes within the same subnet(IETF 87)
  draft-chakrabarti-nordmark-efficient-nd-02
- Latest version is updated with WG input

Motivation

- IPv6 ND (RFC 4861) was designed when wireless devices were not so popular [in the 1990s]
- IPv6 ND is in the heart of IPv6, But…
  - It depends on periodic multicasts, solicited node multicasts, DAD messages
  - Wifi switches/controllers don't work well with multicast messages and duplicates the multicasts into all ports introducing inefficiency in the link
  - Neighbor cache entry is created for an address resolution
  - SLAAC may not be reliable and the IP-address is not registered/owned by a subnet-router/domain
- Sleepy wireless, battery powered devices don't work well
  - with RFC4861 based DAD, address resolution and periodic multicast messages
- Many wireless/cellular links map multicast to broadcast in L2
  - Respective SDO or vendors come up with their own solutions to address these issues

Efficient-ND: Overview

- Reduce Multicast Messages
  - Leverages 6lowpan-nd [RFC 6775] concept for general IPv6 links
  - Saves unnecessary messages over Wifi/Wireless links
  - Provides efficiency in IPv6 deployment over Virtualized networks, Data Centers
- Introduces Registration method for hosts
  - Edge Router can keep track of hosts
  - Useful for deployments for subscriptions and charging
  - ND host scan/DOS attacks reduced
- Adds support for Wireless hosts and routers
  - ARO registration option
  - Age calculation and TID to choose the default router in multi-default router segment
  - Detection of host movement vs duplicate registration
- Supports IPv6 sleeping hosts
  - ARO is used to check for duplicates at the router
  - Reduced multicasts
- Adds support for legacy IPv6 nodes (mixed mode)
  - 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

Version updates since IETF87

Addressed WG comments

- Comments by Lorenzo Colitti and David Miles
  - Should clarify the problem statement and base solution
    - Done
  - Does registration work with multiple IP addresses?
    - Yes, as long as there is a unique 64bit ID supplied in the network
    - Multiple IPv6 addresses could be registered (ex: temporary IP-address)
  - Reviews required by host vendors
    - Review request sent to Dave Thaler and Stuart Cheshire

Version updates since IETF87(2)

- Comments by Andrew Yourtchenko and Suresh Krishnan
  - Clarification comments
    - Updated texts and email clarifications
  - Refer to draft-ietf-6man-resilient-rs?
    - Version 03 adds reference to resilient-rs draft
    - In LLN, we want to avoid repeated signalings- but this mechanism might be useful in certain scenarios(ex: line-powered high band width wireless networks, hosts that implement back-off algorithms)
    - Another possibility: Sleepy nodes try with default (3) RS request, if unsuccessful, try again when it wakes up [not updated yet in the draft]
    - Or MAX_RS_SOLICITATIONS could be configured to a slightly higher value (implementation dependent – though can be mentioned in the draft)

Version updates since IETF87(3)

- Comments by Andrew Yourtchenko
  - Can the Unicast RA be configurable to make it multicast RA?
    - In Mixed mode, both are possible. In NEAR mode it does not really make sense. But it can be configurable via implementation choice
  - What happens(recovery methods) if Neighbor Cache is full?
    - Document clarifies that the registration sends denial of new registrations
    - The NEAR can be configured to a value as to when it should consider the NC being full (I,e actual % full)
  - Unknown registrations can cause DOS attack?
    - NCE cannot be filled continuously with bogus entries
      - Temporary NCE have been introduced
      - Registration request fails if duplicate requests
      - Applying ceilings on registration requests by a node

Version updates since IETF87(4)

- Comments by Anders Brandt
  - Off-list editorial comments
    - Addressed most of them
  - Request for adding a ‘controller ‘ use-case
    - Done
  - Request to support infinite registration lifetime
    - Mutually agreed that infinite registration lifetime will not be supported for general applicability in efficient-nd

Version updates since IETF87(5)

- Comments by Jouni Korhonen
  - Relax MUST (section 7.1) for SLLA requirement with ARO for point-to-point links (ex: 3GPP links)
    - Clarified that SLLA not required for point-to-point links
  - Clarification requested on Appendix A.5 [3GPP IPv6 specifications]
    - Clarified text with TS29.061 reference [I,e longer default MAXRouterAdvInterval instead of RFC4861 default]

Version updates since IETF87(6)

- Comments by Mark ZZZ Smith
  - How does it handle router redundancy when VRRP protocols are used in NEAR?
    - Requires some text/specification on how to handle the registration with transparency in case one router fails [TBD]
    - Added a place-holder section on VRRP interaction

Open Issues

- Current ‘age’ information is only exchanged by NEAR but it uses the same ‘Registration lifetime field’ in NA with a status code =3 to indicate that the field contains age ownership response.

- Texts on VRRP Interaction

Next Revision

- Update the documents with comments
- Resolve the Open issue(s)

Next Step

- Requesting WG adoption

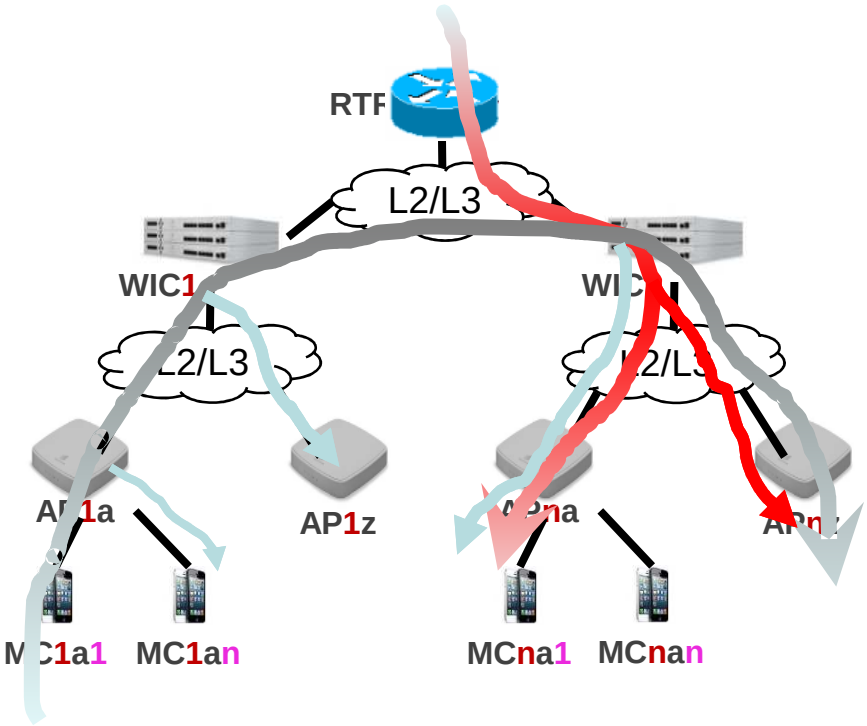
Backup Slides

AVOIDING MULTICAST/BROADCAST ISSUES IN WIFI NETWORKS

A motivation to solve the following problem

The WiFi bridge network amplifies the downstream broadcast and multicast traffic at both the AP and controller. There are two sources of downstream traffic.

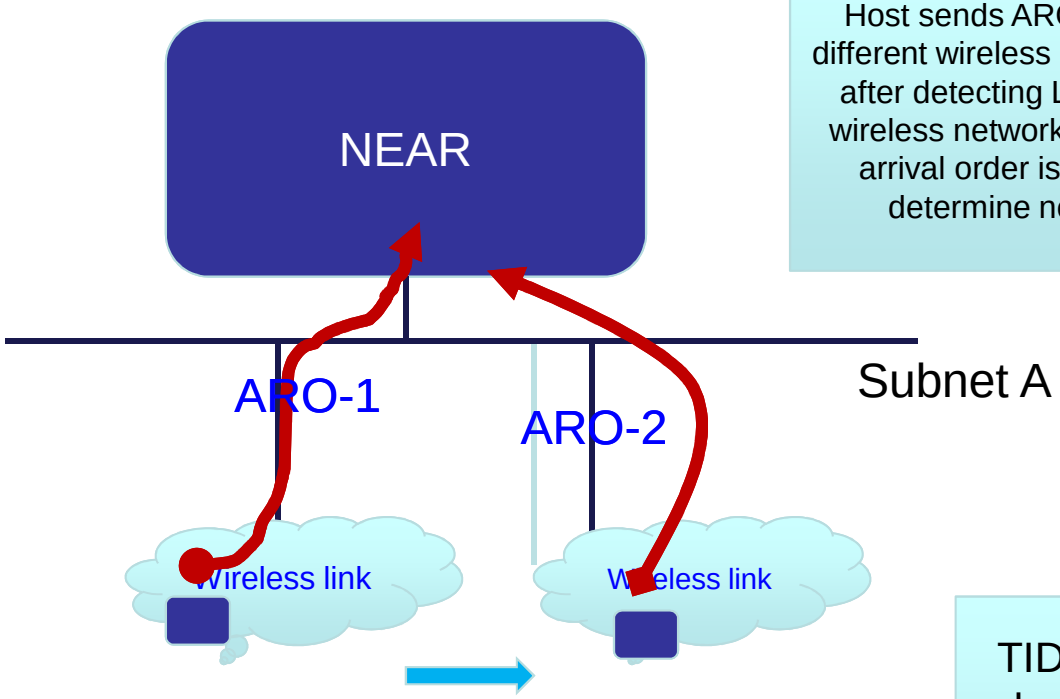
- Core network traffic going toward controllers, and controllers replicate this broadcast/multicast traffic to all of it physical (Eth: LAN & WAN) and virtual (CAPWAP) interfaces
- Mobile client traffic going to the Core network; and controllers replicate this (IPv4-ARP, IPv6-ND) traffic to all of it physical (Eth: LAN & WAN) and virtual (CAPWAP) interfaces



Solution:
Optimization on mcast, DAD, periodic RA + Introducing ARO

Implementations are coming up with vendor specific solutions to avoid the amplification

Out-of-Order Registration Handling

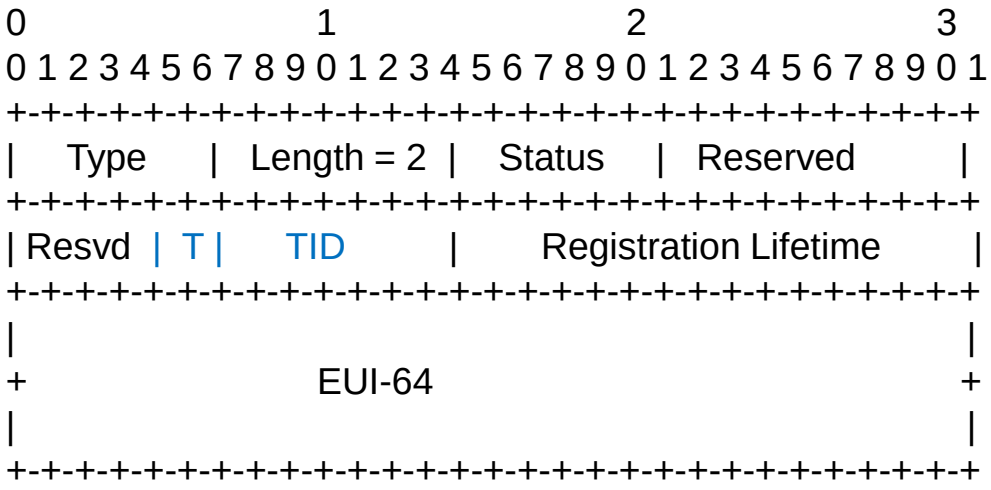


Host sends ARO-1 and then moves to a different wireless link and then sends ARO-2 after detecting L2 –link move. But due to wireless network delay ARO-2 and ARO-1 arrival order is revered. TID is used to determine newest registration link

TID comparison also helps movement in Backbone routers, RPL (Pascal)

Address Registration Option (updated)

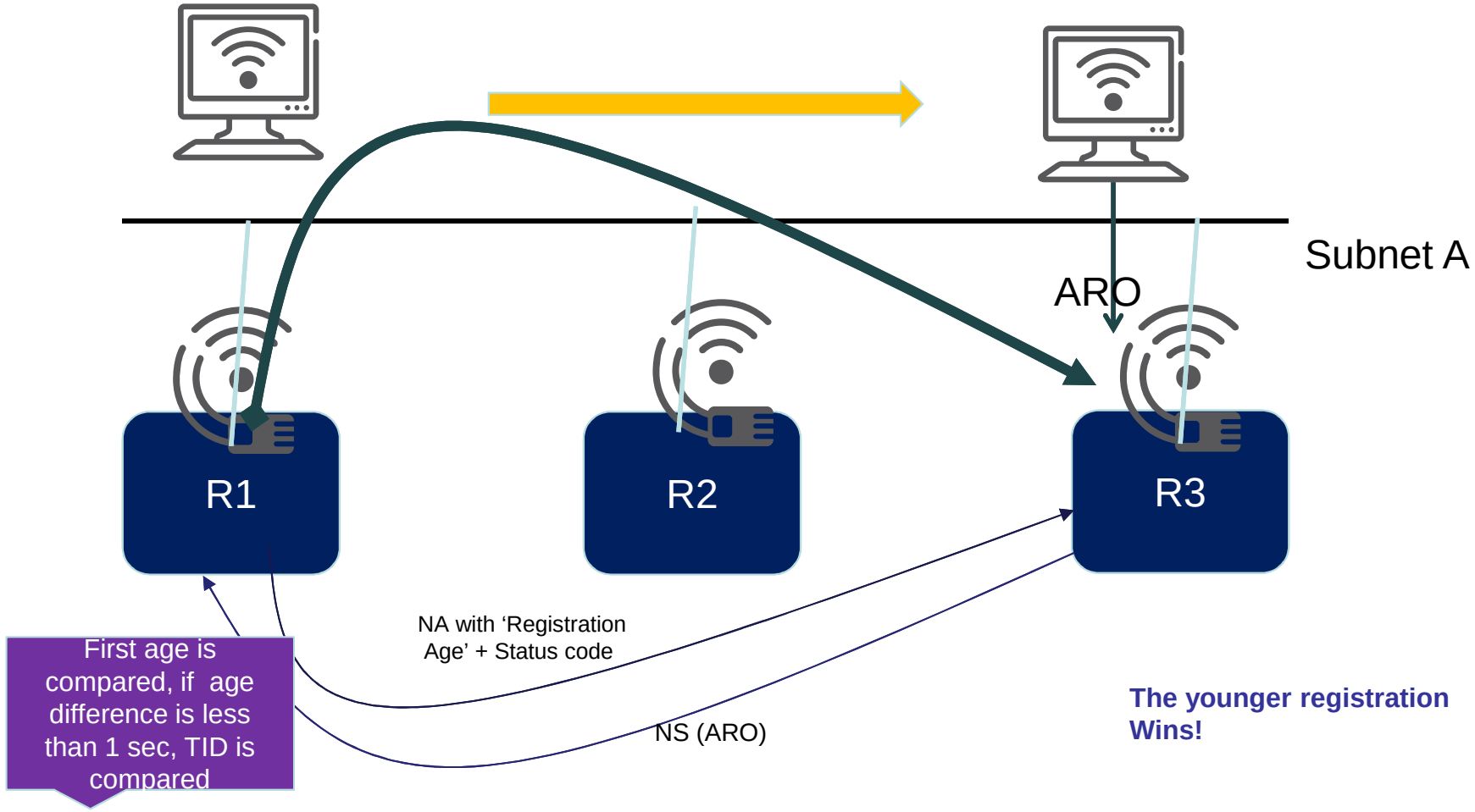
- Address Registration Option (ARO) is sent by the efficiency-aware hosts in a unicast NS message
- Optionally ARO may be sent by the NEAR to another NEAR in order to resolve ownership of registration
- TID field may be used by the NEAR routers to detect duplicate registration and as well as local mobility



ARO with NS from Node.

Partial registration and Local Mobility Solution

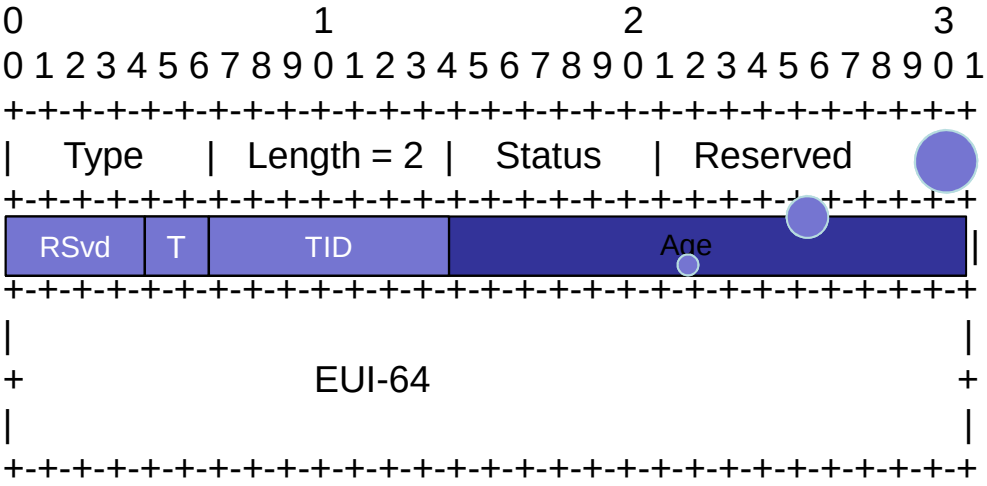
- The Wireless node moves and registers with the closest router for efficiency ; The routers negotiates among themselves who should win the registration and then inject /delete routes to the network accordingly
- The ‘Partial registration solution’ is not mandatory but recommended



Address Registration Option with NA

(when used between NEAR routers)

- Address Registration Option (ARO) is included by the efficiency-aware routers in a unicast NA message
- The ‘Registration Lifetime’ field is used by the NEAR routers (optionally) to resolve the conflict resolution in order to update the ownership of the registration of the node



Alternative Idea: use an option to ARO for ‘age’

ARO with NS from Node.

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 respose
- MLD snooping
  - No use of solicited-node multicasts means less MLD snooping state

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