

6lowpan ND Update

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[draft-chakrabarti-6lowpan-ipv6-nd-01.txt](#)

Background

- Purpose is to reduce or remove
 - Neighbor discovery multicast packets
 - “Unneeded” unicast ND packets
- Version 00 had some initial ideas
- Discussion before and at Interim meeting lead to more possible optimizations
 - Captured in 01 draft
- Many optimizations are not 6lowpan specific
 - But we make some key assumptions to enable them

Goals

- Handle both simple star topology and mesh
- Avoid/reduce multicast Router Solicitations and Router Advertisements
- Reduce or avoid multicast for Duplicate Address Detection
- Avoid Multicast Neighbor Solicitations
- Do we need Neighbor Unreachability Detection?

Summary Of Changes from the last Rev

- A section on background of IPv6 Neighbor Discovery and identification of cases those need optimization
- A section on Assumptions on addressing mapping, topology of the network, L3/L2 layer routing between end-nodes and the IPv6-router
- Avoiding L2 broadcast for initial RS and RA
- Avoiding L2 broadcast for periodic RA
- Avoiding L2 broadcast (NS) for non-existing nodes
- Minimizing DAD multicast messages or avoiding DAD in case of EUI-64 L2 addresses
- Text on ways to avoid NUD (for hosts and routers)

Neighbor Discovery on 3 slides (1)

- Host boots
 - Performs DAD on link-local address
 - Sends MLD join for solicited-node MC address (for MLD snooping switches)
 - Sends NS to solicited-node MC address
 - No response in 1 second means there is no duplicate
 - Finds a router and prefixes
 - Sends RS message to all-routers MC address
 - Receives a RA; uses prefixes to form global addresses
 - Each formed address is checked with DAD

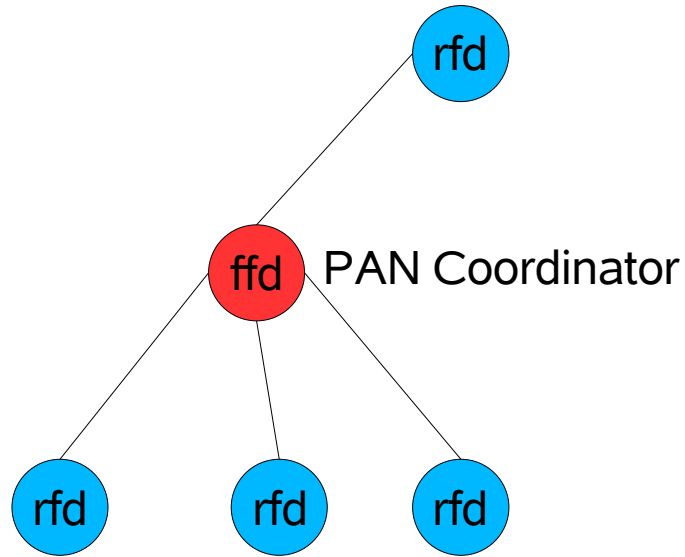
Neighbor Discovery on 3 slides (2)

- Host sends packet
 - If Neighbor Cache entry, send to that L2 address
 - If destination matches on-link prefix(es), multicast a NS
 - But there might not be any on-link prefixes advertised by the router
 - Otherwise, send to a default router
- Router can redirect for an on-link destination
 - Tell host the L2 address to use

Neighbor Discovery on 3 slides (3)

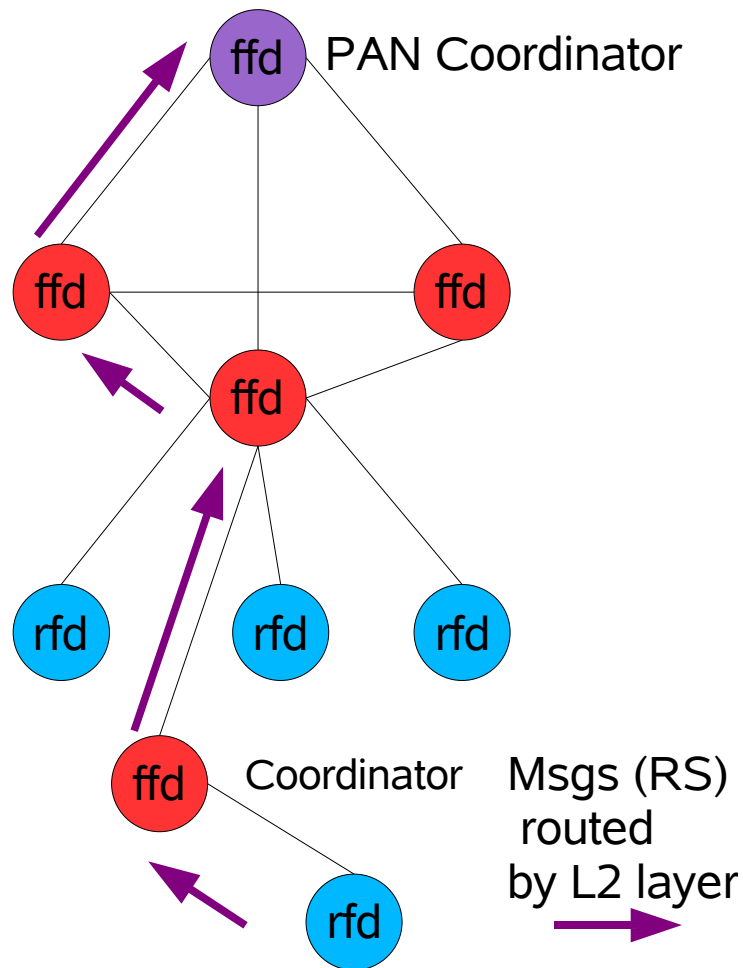
- Periodic Router Advertisements
 - Multicast to all-nodes MC address
 - Extend the expiry time for router and prefixes
 - Max router lifetime is 18 hours
 - Default values lead to one every ~6 minutes
 - Add or remove prefixes
- Detect dead routers and changing L2 addresses
 - Send unicast NS and get NA
 - Suppressed by upper-level advice that things are ok
 - If router is dead, use other router in list
 - If host is dead, drop packet

Simple Star Topology



- Assume IP link (~subnet) has one PAN coordinator
- Assume one 6lowpan is one PAN ID
- Assume the coordinator's unicast address is known from joining the PAN

L2 Mesh Topology Support



- Assume one PAN coordinator per 6lowpan link
- Assume each coordinator has a parent coordinator
- Allows a unicast-only path to PAN coordinator
 - Can send packets to “all-routers” MC using this

Basic ideas

- Use unicast path to IPv6 router for RS
- Have the router track every IPv6->L2 address mapping for the PAN
 - Need to reliably learn this
- Using L=0 (no on-link prefixes) in RFC 2461 to avoid multicast NS
 - 1st packet sent to router, which forwards and redirects
- If hosts don't change L2 address, then much of NUD can be avoided
 - Is L2 EUI-64 or short addresses?

Avoid L2 broadcast for initial RS and RA

- End node sends RS to all-router multicast address
- Coordinators in the path relay the packet to the PAN-coordinator (IPv6 router) through L2 routing
- IPv6 router then responds with unicast RA
- IPv6 router records IPv6 and L2-address of the requestor
- End node forms IPv6 address upon receiving prefix info

Periodic RA

- Goal is to avoid lowpan-wide broadcast from IPv6 router
- IPv6 router keeps a table of IPv6->L2 of each node in the 6lowpan
- Three ideas:
 - Router uses serial unicast RA to each L2 address to send to each host
 - Increase default RA interval time significantly
 - Send unicast RA to each FFD's L2 address. FFDs cache RA info. FFDs use beacon time slot to broadcast RA in the neighborhood

Avoid multicast DAD

- Assume PAN coordinator (router) has complete list of IPv6 addresses used in PAN
- DAD message is unicast to PAN coordinator
- If there is no duplicate, drop DAD probe
- If there is a duplicate, relay (ttl unchanged) the DAD message to the host(s) that have a duplicate
 - The host will respond per RFC 2462
 - Do we need to optimize the multicast response? The probability of duplicates is very small

Avoid Multicast Neighbor Solicitations

- Routers advertise prefixes with no on-link prefix (L=0)
 - Can still do RFC 2462 stateless address autoconfig
 - Already part of RFC 2461 – no protocol changes
 - Avoids multicast NS from hosts
 - Hosts send first packet to the router
 - Router can send redirect with target's L2 address for an on-link target
 - Thus subsequent packets go directly between the L2 addresses of the hosts

Avoid L2 broadcast (NS) for non-existent nodes

- A packet can come from the PAN, or from the outside (the Internet) to the router, and the router doesn't have a Neighbor Cache entry for the destination
- RFC 2461 would have the router multicast a NS for the host
- We assume that the router has a complete list of all IPv6 addresses in the PAN
 - Hence it can drop such a packet (and send ICMP error)

Minimize unicast NUD?

- No host to router NUD is needed if IPv6 Router is stable and some L2 alert gets sent to the nodes if IPv6 Router goes down
 - Does this happen when the PAN coordinator dies?
- If IPv6 to L2 address mapping does not change, then periodic NUD from router to host can be avoided
 - But with 16 bit addresses the L2 addresses might change

How does router know all hosts?

- Each host will send a RS when it boots
 - Means that router will know the link-local address of each host
 - Should probably say that 6lowpan hosts not send the RS with the unspecified source address
- For EUI-64 based autoconf addresses, router can form them (prefix + EUI-64 from link-local)
- RFC 3041 temporary addresses are harder
 - Router would see the DAD message, but these are not reliable (sent once – could be dropped)
 - Do we need a reliable “address registration” message? At IP layer or at layer 2?

Short addresses

- Supporting short addresses?
 - How often might the short addresses change? More overhead to detect changes. (Need NUD?)
 - Or can we use some L2 mechanism to discover and update the mapping between EUI-64 and short addresses?

Avoiding Single Point of Failure?

- Does dual routers mean dual PAN coordinators?
- PAN coordinator failure
 - Today in 15.4 does this mean that everybody has to reconnect to the PAN?
 - Replicate the list of IPv6 ->L2 to a hot standby?
 - Replicate the EUI-64 ->16 address map likewise?
- Backup router even though single PAN coord?
 - Would it be useful?
 - Could invent way to replicate IPv6 -> L2 list to it

Other Open Issues

- Should the router that forwards packets back on the link (and sends redirect) decrement ttl?
 - In general case, this might be problematic for applications (e.g., apps sending MC with ttl=1 and assume they reach all hosts on link)
 - For 6lowpan this might not be a problem
- What's the default lifetimes and timers for routers and prefixes? Different than RFC 2461 defaults?

Comments/Questions?