draft-ietf-6lowpan-nd-02

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Outline

- What is ND for 6LoWPAN (in 1 slide)
- Current status
- New features since Minneapolis
- Open issues on the table
- Next steps

Didn't read the draft yet?
See the end of this slide-set for a quick overview
ND for 6LoWPAN

- Simple bootstrapping on a LoWPAN
- Router and context information dissemination
- DAD and NS without multicast
- Enabling ND over entire LoWPANs
  - Wireless NBMA links, LoWPAN subnet model
- Unique short-address generation
- Compatible with link-layer mesh and IP routing
- Support for infrastructure and ad-hoc LoWPANs
- Fault tolerance and duplicate identifiers detection
Current status

- Draft was accepted as WG doc in Minneapolis
  - Lots of good and constructive feedback received
- -01 and -02 draft revisions since then
  - Closed 12 tickets so far plus lots of editing
- 3 technical issues + editorial issues on the table
- Draft is now stable and complete
- And we've seen good implementation activity
Changes from -00 to -01

- Wrote sections on fault tolerance (Sections 8.5-8.6)
- Wrote initial ad-hoc LoWPAN section (Section 9)
- Added message examples (Section 10)
- Removed ND Proxy [RFC4389] references
- Removed the E flag from Router Advertisements
- Removed the X flag from RR/RC
- Renamed Host II to Owner II
Changes from -01 to -02

• Fixed a bug in the lollypop text (16 = 0xf)
• Updated Ad-hoc LoWPAN operation (Section 9)
  • Use of ULAs [RFC4193], ER assignment
• Terminology and wording improvements
  • Addressed comments from Alex
Duplicate identifier detection

NS/NA

Backbone link

Edge router

Edge router

Edge router

A (2001:4DF1::310A, TID = 456)

B (2001:4DF1::310A, TID = 0)

TID Lollypop Mechanism

Reboot

Registered

0x0

0xf

wrap to 0xf

0xffff
Fault tolerance

- Use of secondary registrations for fault tolerance
  - Prepare network state for movement to new primary
  - Automatic primary->secondary backup operation
  - Bicasting possible
Ad-hoc LoWPANs

- Ad-hoc use of ND for 6lowpan defined
  - Election of simplified ER role for a router
  - Required: ER generates ULA [RFC4193] and disseminates it
  - Optional: ER supports basic whiteboard functionality
Open technical issues

- Checksum recalculation on RR/RC relay (Alex P.)
  - To be fixed in -03
- Trickle algorithm
  - Reference another document or write Tickle Appendix?
- Determining best router for registration (Peter S.)
  - Hosts and new routers have no way to choose a best on-link router to use for registration if multiple hops from ERs
  - Simple 8 bit “ER hop count” indicator would be sufficient
  - Such a field could easily be added to the Multihop Information Option
Open editorial issues

- Router Registration (RR) acronym change (Alex P.)
  - RR acronyms used in other RFCs
  - a) Is it really a problem? b) Alternative names?
- Document too long, hard to grasp (Alex P.)
  - Agreed, for 6lowpan newcomers and outsiders it should be easier to comprehend, ideas how?
  - The document is 47 pages... RFC4861 is 96 pages ;-) 
  - Intro is necessary – lack of architecture doc in 6lowpan
  - ER Operations could be compressed somewhat...
Next steps

- Solve current technical & editorial issues
- Release of -03 within 2-3 weeks
- Request comments from ADs and IAB people
- Move to last call well before Stockholm?
Reference Slides
Architecture - Route Over

LoWPAN Subnet

LoWPAN Link

h: Host
r: Router

LoWPAN Link
Architecture - Mesh-under

LoWPAN Subnet

LoWPAN Link

m: Mesh node
Architecture – Single LoWPAN

LoWPAN Subnet

Backhaul link

Edge router

o: Any node
Architecture – Extended LoWPAN

LoWPAN Subnet

LoWPAN Link

LoWPAN Link

Extended LoWPAN

0 Host

0 Host

Router

Router

Edge router

Edge router

Edge router

Gateway

Host

Internet

Backbone link

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Whiteboard model

- A whiteboard binding entry has the following fields:
  - Owner Interface Identifier
  - IPv6 Address
  - Lifetime

- Bindings are soft
  - Must be refreshed
  - Can be moved between ERs
Basic features

Whiteboard binding for all LoWPAN addresses

DAD and NS performed by the ER

Nodes register with an ER

RA Dissemination
Optional features

Subnet over the extended LoWPAN + backbone

Short-address generation

Extended LoWPAN

Subnet over the extended LoWPAN + backbone
Message exchanges

Node                                                  (Edge) Router

<-------- Router Advertisement --------

-------- Router Registration -------->

<-------- Router Confirmation --------

Node                    Router (relay)                 Edge Router

<---- RC ----           <---- RC ----

----- RR --->           ----- RR --->

----- RR --->

----- RC ----

----- RC ----
## RA message

```
+------------------+
|   Type    |   Code     |          Checksum             |
+------------------+
| Cur Hop Limit   | M | O | H | Prf | P | R | R |
| Router Lifetime |                |
+------------------+
| Reachable Time   |
+------------------+
| Retrans Timer    |
+------------------+
| Options ...      |
+------------------+
```

**M** - Used to indicate that address generation is supported.

**Prf** - Used to indicate if the sender is an Edge Router (Prf=01) or a Router (Prf=00).
RA options

6LoWPAN Prefix Information Option (A new option!)

CID – Context Identifier for use in 6LoWPAN HC compression.

Multihop Information Option
**RR/RC message**

```
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 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |     Code      |           Checksum            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Status    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Lifetime                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Binding option(s)...                                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

**TID** – Transaction ID for matching confirmations.

**P** – Primary flag for using an ER as primary. For use with secondary registrations.
RR/RC options

Address Option

```
+----------------+----------------+----------------+----------------+----------------+----------------+----------------+----------------+
|   Type   |    Length   |    Status   |     P      |     S      |
+----------------+----------------+----------------+----------------+----------------+----------------+----------------+
| D | A | R | Reserved | IPv6 Address |
+----------------+----------------+----------------+----------------+----------------+----------------+----------------+
```

P/S - Prefix and suffix compression fields.

D - Allow duplicates flag.

A - Address request flag.

R - Remove address flag.

Source link-layer address option [RFC4861, RFC4944]

Target link-layer address option [RFC4861, RFC4944]