IPv6 over Low power WPAN WG (6lowpan)

Chairs:

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- **We assume people have read the drafts**
- **Meetings serve to advance difficult issues by making good use of face-to-face communications**
- **Be aware of the IPR principles, according to RFC 3979 and its updates**

✓Blue sheets
✓Scribe(s)

Milestones (from WG charter page)

Document submissions to IESG:

- **Aug 2008 x 2 Improved Header Compression (PS)**
- **Aug 2008 // 6 Security Analysis (Info)**
- **Sep 2008 // 3 Architecture (Info)**
- **Sep 2008 x 4 Routing Requirements (Info)**
- **Nov 2008 x 1 Bootstrapping and ND Optimizns (PS)**
- **Dec 2008 x 5 Use Cases (Info)**

Also: running documents for implementers, interop

77th IETF: 6lowpan WG Agenda

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13:05	2 – HC-06	JH (15)
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13:35	ipv6-nd-simple	EN/SC (15)
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Compression Format for IPv6 Datagrams in 6LoWPAN Networks

(draft-ietf-6lowpan-hc-06)

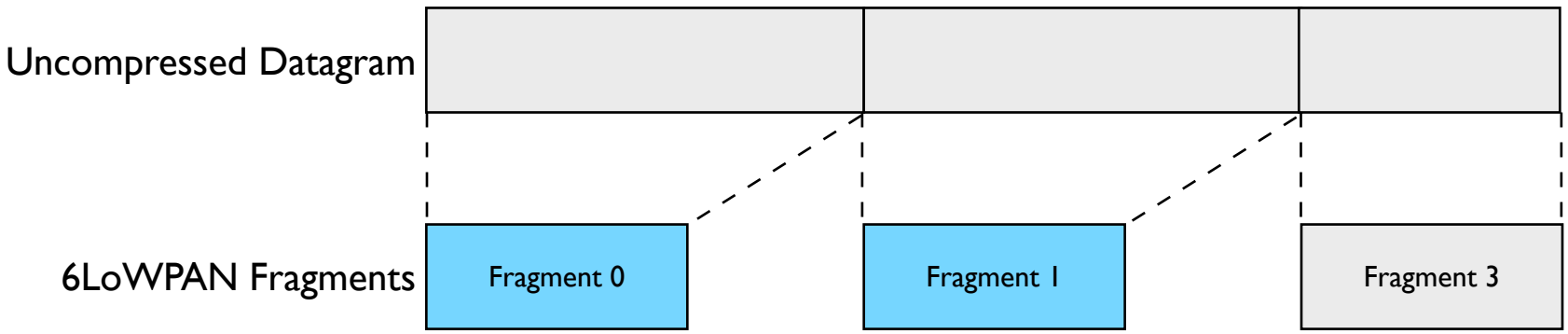
Jonathan Hui
Pascal Thubert

6LoWPAN WG Meeting
77th IETF Meeting
Anaheim, California

Outline

- No updates since Hiroshima
- WGLC comments
  - Lots of editorial feedback
  - Fragmentation
  - Deriving IIDs from IEEE 802.15.4 short addresses
- Next steps

RFC 4944 Fragmentation Problem



- Frag offset/length refer to uncompressed dgram
- When compressed info does not fit in first frag
  - What does dgram_offset mean?
  - Reassembly - how does a node know when it's done receiving?
  - Forward compatibility - what if a node does not know how to decompress a header?
- Routing headers to deliver datagrams

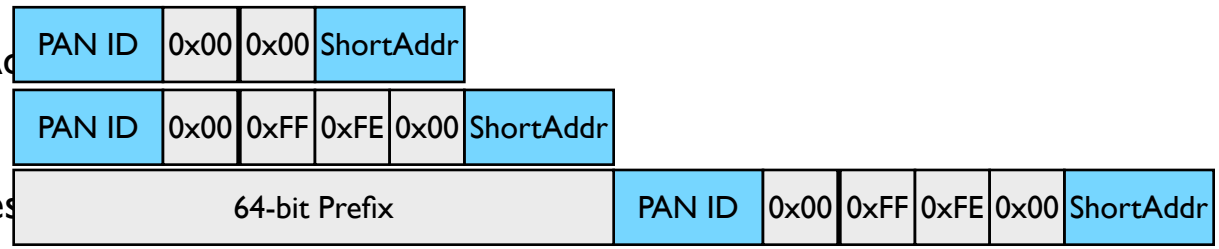
RFC 4944 Fragmentation Problem

- No changes to RFC 4944 fragment header
  - MUST NOT include compressed info in subsequent fragments
  - Drop datagram when need to expand a header that is not supported
  - Makes explicit what was implicit with RFC 4944
- Changes to RFC 4944
  - Change offset/length to compressed values
  - Create new fragment header

- Consensus on list says "no changes to RFC 4944"

SLAAC with Short Addresses

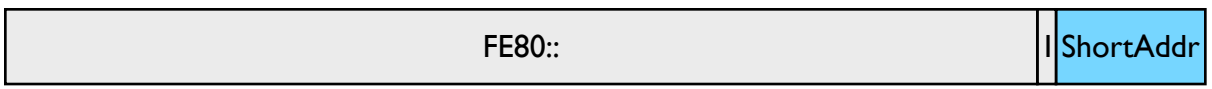
- 802.15.4 addr => Ethernet addr => 64-bit IID
  - Ethernet Ad
  - 64-bit IID:
  - IPv6 Addres



- Problems
  - 80-bit prefix uniqueness requires link-layer management
  - Collisions when PANIDs differ only in U/L bit
  - IPv6 address change when PAN ID changes

SLAAC with Short Addresses

- Define interface identifier to be 17 bits
  - ShortAddr scope is defined by PANID scope (a.k.a. subnet scope)
  - Add extra 1-bit to allow for ShortAddr = 0.
- For link-local addresses:



- For global addresses:

  - MUST utilize a 111-bit prefix
  - Utilize network-layer mechanisms to maintain uniqueness across subnets

Next Steps

- Reach consensus on
  - Fragmentation
  - SLAAC with IEEE 802.15.4 short addresses
- Post an update to hc-06
- WGLC

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draft-ietf-6lowpan-nd-08

Authors:
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Outline

- The IETF-76 Hiroshima consensus
- nd-08 = just the base mechanism
- Changes since IETF-76 (-07 to -08)
- Issues, ideas and next steps

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The Hiroshima consensus

- The consensus after IETF-76 Hiroshima:
- Separate the document
  - Base ND mechanism for the node-router interface
  - Optional backend solutions as separate drafts
- Make address detection optional
  - When address formed from an EUI-64
  - When address assigned using e.g. DHCPv6

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nd-08 = just the base mechanism

- Base ND optimization mechanism for LoWPANs
  - Optimizes the host-router interface
  - Node Registration mechanism with NR/NC
- Duplicate detection and address assignment performed when needed by the default router
- Multihop prefix and context information dissemination
- Compatible with link-layer mesh and IP routing
- Incorporates the new Autoconf addressing model

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Changes from -07 to -08

- First try at just the base mechanism
- Removed Extended LoWPAN and Whiteboard related sections
- Included reference to the autoconf addressing model (draft-ietf-autoconf-adhoc-addr-model)
- Added Optimistic Flag to 6AO
- Added guidelines on routers performing DAD
- Added text about DHCPv6
- Removed the NR/NC Advertising Interval
- Added assumption of uniform IID formation and DAD throughout a LoWPAN

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Current Issues

- Nits from Richard Kelsey and Robert Cragie
- Fix the integration of DHCPv6
  - Return lease info to the host somehow? Or have the host implement DHCP?
- Clarification on prefixes used for autoconfiguration and Context ID assignment
- Simplification and optimization still possible
- **How to support duplicate address detection?**
- **What kind of registration message do we need?**

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How to support duplicate detection?

- What kind of duplicate detection do we need?
  - And what it requires from registration messages

- Detecting duplicate short addresses (not assigned using DHCPv6)
  - Requires an EUI-64 in the registration
- Detecting duplicate EUI-64s (e.g. counterfeiting)
  - Requires an EUI-64, nonce and TID in the registration

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The Registration Message

- Registration between a node and its router(s)
- 6lowpan-nd uses an explicit NR/NC
  - Includes acknowledgement and error codes
  - Can be used for duplicate detection
  - Intuitive for use in registration
- nd-simple uses an overloaded NS/NA
  - Has no acknowledgement, can not be used for duplicate detection
  - Registration lifetime as an option
  - Re-uses RFC4861 specification text

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Next Steps

- WG to decide duplicate detection support level
- WG to decide registration message style
- Plans for nd-09
  - Integration of features/ideas from nd-simple
  - Fix for DHCPv6 integration
  - Better clarification of prefixes and context
  - Simplification and optimization
  - Editing to fix known nits

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Simple Neighbor Discovery

<draft-chakrabarti-6lowpan-nd-simple-00.txt>

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Relationship to 6lowpan-nd-08

- WG push back in Hiroshima on complexity
- Zach took the approach to shrink
- We took the approach to start from nothing and add minimal set
  - And we seemed to have missed very few things
- If we care about complexity
  - Find middle ground between the two drafts

What is missing in RFC 4861?

- Functionality issues arise in route-over when a single subnet spans multiple links
- Performance issues due to ND multicasts for mesh-under
- Following slides detail the problems to consider

Functionality: Duplicate Address Detection

- DAD assumes link-local multicast packets can be used to find a potential duplicate
  - Doesn't work when a prefix spans multiple links
- For EUI-64 derived addresses we can skip DAD
  - Assumes vendors never allocate duplicate EUI-64
- But that doesn't handle short addresses, SeND etc
  - For short addresses, host can use regular DHCPv6

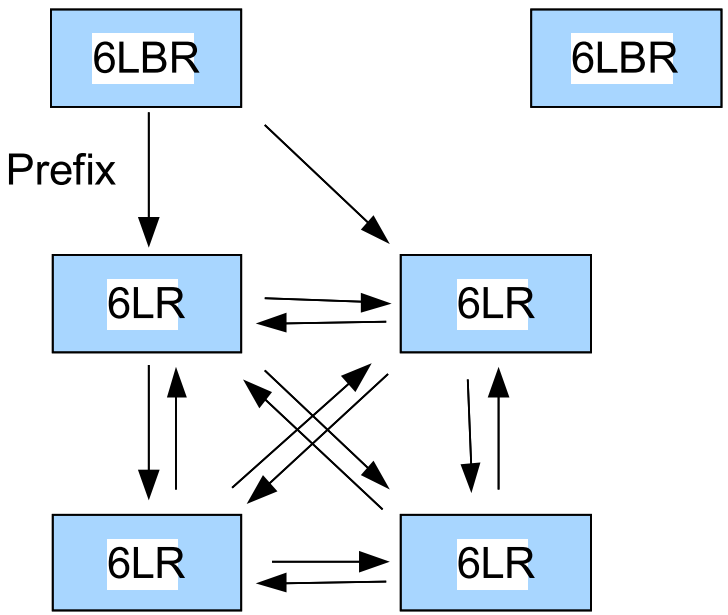
Functionality: Where is the host?

- The routers need to know where each host IP address is attached
  - Since the hosts do not run the routing protocol and prefix is spread across whole 6lowpan
- Implies a need for a registration mechanism
  - Note that DAD is separate, hence there is no need for a notion of the registration failing
  - Akin ES-Hello in the OSI protocol stack
- Host might switch to use a different router
  - Minimize the amount of effort to register with new router(s)

Functionality: Distribute prefixes from edge

- All the routers and hosts need to know the prefix (es)
- Assume the prefix(es) configured in 6LBRs (6lowpan border routers)
- Basic idea is for routers to listen to RA and use that in the RA they send
  - In nd-08 and this draft
- But this has a problem – prefixes might never go away

Prefix Distribution problem



Performance: Reduce multicast

- For 6lowpan there is a desire to avoid multicasts around
  - Duplicate address detection
  - Router needing to multicast NS for hosts
  - Router needing to multicast NS for non-existing hosts
  - Periodic unsolicited Router Advertisements
  - Router Soliciations

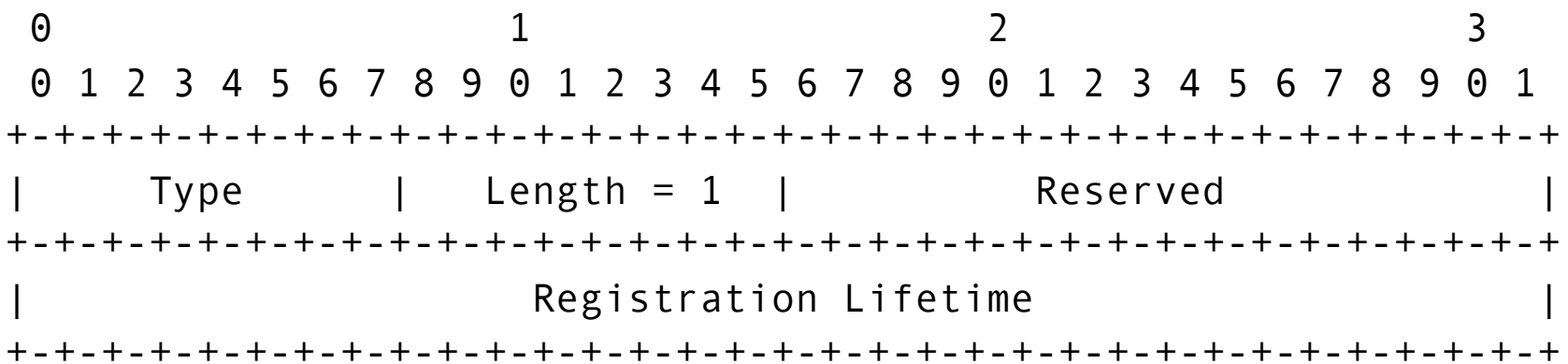
Highlight of draft

- Concepts of 6LBR, 6LR and host
- 6lowpan ND options
- Clarifies prefix assignment, bootstrapping, ND for Mesh-under and Route-over topologies
- Requires a 6LBR in the solution for reliable communication – source of prefix for 6lowpan
- Independent of underlying mesh routing protocols

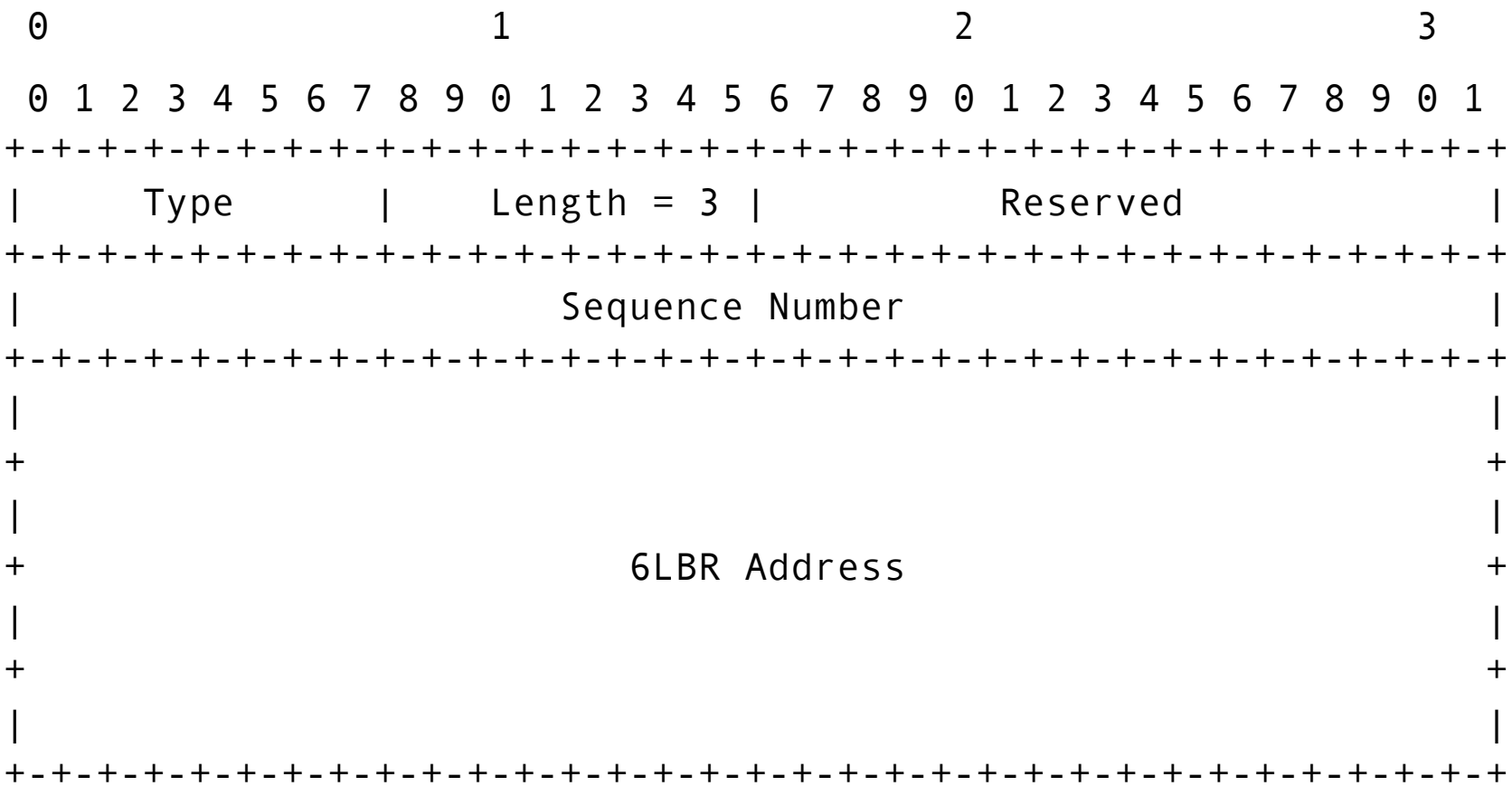
Approach

- Configuration the same as in nd-08
  - Prefix(es) assigned to 6lowpan
  - Advertised in RA with 'A' bit set; not 'L' set
- Registration uses new Node Lifetime option in Neighbor Solicitation
  - Host specifies how long to store based on its sleep schedule
  - One NS for each global address of host
- A new Authoritative Router option in RA
  - Used to purge old information from RAs
  - Allows for multiple 6LBRs

Node Lifetime option



Authoritative Router option



[Note that draft has a typo with an additional field.]

Loosing the default router

- Neighbor Unreachability Detection can be used
  - Uses unicast NS/NA
- RFC 4861 assumes that if router lost then a multicast RA will be received from other routers
  - But we don't want periodic multicast RA
- Instead, when NUD fails for router, handle as if the interface had failed and been restored
  - Send up to three multicast RS to find router(s)
- Combine this with re-registration

Example: Sequence of NUD and registrations

- Assume a host that sleeps for 10 minutes
- On wakeup sends a UDP packet; waits for an application ACK (retransmits if needed)
- Initially needs to find at least one router
- When it wakes up, the router might be unreachable
- How do the pieces fit together?

Initial boot sequence

- Send RS per RFC 4861
- Once RA received send NS with registration
  - Lifetime set to more than 10 minutes
- Can choose to register with multiple routers
  - But host needs to refresh all its registrations

Sequence at host wakeup

- Send UDP packet to default router
  - NUD state was STALE (older than 30 seconds)
  - Transitions NUD state machine to DELAY
- If application ACK in less than 5 seconds
  - Application can suppress NUD (reachability confirmation in RFC 4861)
- Otherwise unicast NS to default router (NUD)
- After 3 tries (3 seconds), state = UNREACH
- New in draft: trigger sending multicast RS here

Bits missing from current draft

- Need to be able to carry the compression contexts with the prefixes
  - Hence we need the CID part of the RA prefixes from nd-08
- Desire to select router closer to the edge
  - Using the two-bit default router preferences as in nd-08 seems useful

Security

- Can Secure Neighbor Discovery optionally be used in the future?
- I think this is easy as long as each registration message is only for one IP address
  - That is what is in the draft
  - Otherwise we could make things more efficient when a host has multiple IP addresses
- But the SeND addresses are not EUI-64 derived
  - Need for DAD across the 6lowpan

Open Issues

- Short address support: is DHCPv6 on host what we want?
- NUD vs. L2 acknowledgements?
  - If the MAC layer provides an ACK/NACK should we exploit that?
- Avoid multicast RS?
  - Problem is that host doesn't know the routers' L2 addresses
  - If L2 “anycast” address this multicast can be avoided

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Discussion topics 6lowpan

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IETF 6lowpan and 802.15.4 standard(s)

6lowpan references to 802.15.4:

Reference to 802.15.4-2006 draft-ietf-6lowpan-hc-06.txt

Reference to 802.15.4-2003 RFC 4944 - Transmission of IPv6 Packets over 802.15.4 Networks (September 2007)

Evolution of 802.15.4:

802.15.4-2003: now deprecated

802.15.4-2006: main formatting-related differences:

– more generous payload size (actual vs. worst-case header-size calculations)

– security (complete overhaul)

802.15.4 TG4e: main formatting-related differences:

– significant overhead reduction (exploits shared state between communicating parties)

Suggestion: consider moving towards newer versions of 802.15.4

IETF 6lowpan, overhead reduction, and security

6lowpan efforts on "compressed" IPv6:

– draft-ietf-6lowpan-hc-06.txt

– RFC 4944 - Transmission of IPv6 Packets over 802.15.4 Networks (September 2007)

Notes:

– Other IETF groups (e.g., 6lowapp, RoLL) use IPv6 as well and would benefit from overhead reduction.

Note: with RFC 4944, not always possible, e.g., if (traffic class, flow label) ≠ (0,0)

– Overhead reduction may become robust if security enabled

Security for constrained IPv6 applications:

Current work seems to "borrow" general IPv6 security constructs, which may not be suitable for resource-constrained environments (energy, communication and computational overhead, latency, storage cost, implementation cost).

Suggestion: consider overhead reduction and security for resource-constrained networks

Future Work

Suggestions:
– Investigate moving towards newer versions of 802.15.4;
– Consider further overhead reduction techniques, in coordination with other IETF groups interested in resource-constrained networks (e.g., 6lowapp, roll, smartgrid);
– Fully consider security for resource-constrained networks with IPv6.

Discussion:
– Interest in these efforts?
– How to realize (re-charter, coordinate with others, etc.)?

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Simple DHCPv6 for 6LoWPANs
(draft-hui-6lowpan-dhcp-00)

Jonathan Hui

6LoWPAN WG Meeting
77th IETF Meeting
Anaheim, California

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Outline

- Background
- Why DHCPv6
- Simple DHCP for 6LoWPAN networks
- Next steps

Background

- 6LoWPAN networks need configuration
  - Usual application, network, vendor-specific parameters
  - 6LoWPAN parameters (e.g. HC contexts)
  - Link parameters (e.g. IEEE 802.15.4 short address)

Why DHCPv6?

- Most widely used mechanism for managing configuration information across a network
  - Stateless and stateful operation
  - Relay Agents allow DHCP server to be off-link (great for route-over)
  - Very general and extensible (potential downside)

- Goal: simple and compact DHCP for 6LoWPANs
  - ***Focus on utilizing as little as necessary***
  - Strict subset of DHCPv6
  - Define options for 6LoWPAN-specific parameters
  - Allow stateless translation between 6LoWPAN-DHCP and DHCPv6

Overview

- 6LoWPAN Edge Routers
  - MUST implement DHCP server or relay agent
  - MUST subscribe to ANY_6LOWPAN_DHCP_ROUTER_AND_AGENT
- 6LoWPAN Routers
  - MUST implement relay agent (simple and stateless)
- Overall effect
  - Nodes can obtain configuration if network is connected by routers
  - Selection of a specific DHCP server at the edge routers
  - No need to use multicast to discover DHCP server/relay agent

DHCPv6 Simplification

- Eliminate binding to a specific DHCP server
  - No server discovery mechanism
  - Do not maintain state about servers
  - Rely on 6LoWPAN edge router configuration to point to server
- Reduce DHCP messages to:
  - Solicit with Rapid Commit (initial request)
  - Rebind (refresh information)
  - Information-request (stateless DHCP request)
  - Reply (server response to messages above)

DHCPv6 Compaction

- Assume EUI-64 for client identifier
  - Save 8 bytes in header (for all messages)
- Assume a single relay hop within 6LoWPAN
  - Utilize client-identifier as peer address
  - Relay header reduced to a single byte
- Reduce granularity of time fields to 10 sec units
  - Reduce time fields to 2 bytes each
- Maintain 2-byte type/length fields
  - Can carry existing DHCPv6 options unmodified if needed

Example Messages

- Solicit/Rebind Message (58 octets)
  - DHCP Header, Elapsed Time Opt, IA_NA Opt, IA Addr Opt, 6LoWPAN Short Addr Opt
- Reply Message (52 octets)
  - DHCP Header, IA_NA Opt, IA Addr Opt, 6LoWPAN Short Addr Opt
- Relay Solicit/Rebind Message (59 octets)
  - Relay Header, DHCP Header, Elapsed Time Opt, IA_NA Opt, IA Addr Opt, 6LoWPAN Short Addr Opt
- Relay Reply Message (53 octets)
  - Relay Header, DHCP Header, IA_NA Opt, IA Addr Opt, 6LoWPAN Short Addr Opt

Next Steps

- Does this make sense?
- Is there interest in this kind of work?

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