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

74th IETF: 6lowpan WG Agenda

15:20	Introduction, Status	Chairs	(5)
15:25	2 – HC	JH	(30)
15:55	1 – Bootstrapping/ND optimization	ZS	(15)
16:10	5 – Use cases	EK	(00+x)
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00:00	6 – Security		(00)
16:40	0 – Fragment Recovery	PT	(40)
17:20	Cookies		

What is 6lowpan?

- **Interesting L2 network: IEEE 802.15.4**
  - **Low power, 20..250 kbit/s, 900 and 2400 MHz**
  - **Almost, but not entirely, unlike 802**
    - Small MTU, limited range

ALMOST

- **Job of 6lowpan: make this look like an IPv6 link**
  - **Classical encapsulation issues → format document**
  - **Reachability: mesh routing**
    - can do route-over, too
  - **No multicast: emulate, avoid (e.g., ND)**

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Compression Format for IPv6 Datagrams in 6LoWPAN Networks

(draft-ietf-6lowpan-hc-04.txt)

Jonathan Hui
Pascal Thubert

6LoWPAN WG Meeting
74th IETF Meeting
San Francisco, California

Background

- Improved header compression for:
  - Global Addresses
  - Multicast Addresses
  - Traffic Class and Flow Label
  - Hop Limit
  - UDP Header
  - Arbitrary Next Headers
- Maintain properties of RFC4944 compression
  - Stateless compression for link-local addresses
  - Context-based compression for global addresses

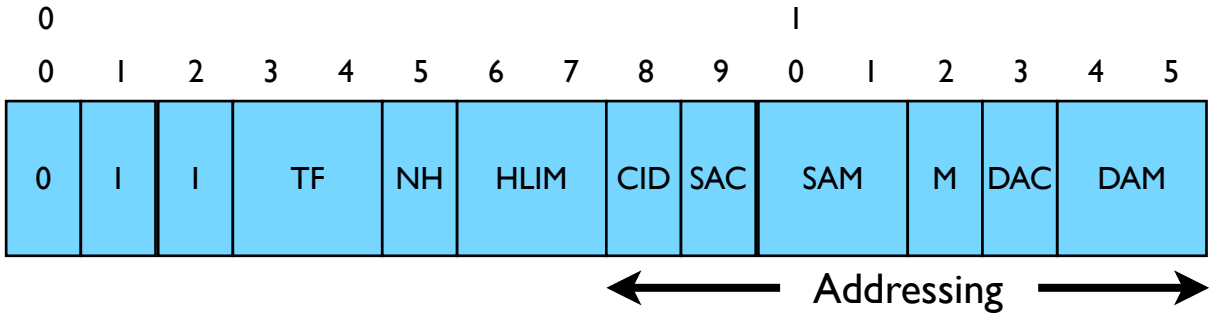
Changes from draft-03

- IP Header Compression
  - More discussion about contexts
  - Context database maps between (prefix, plen) and 4-bit context ID
  - How the context DB is maintained is out-of-scope

Changes from draft-03

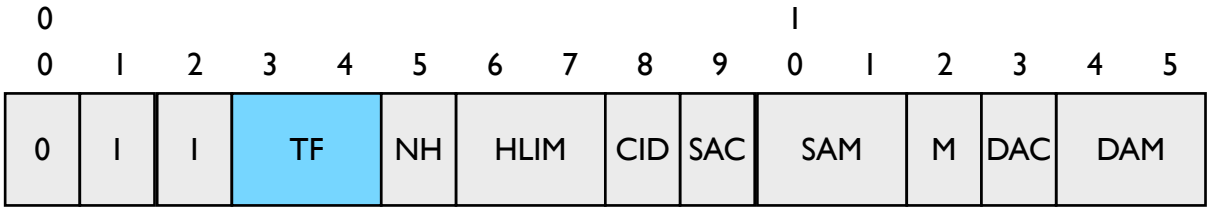
- UDP Header Compression
  - More discussion about port and checksum compression
  - 4-bit port range increases port collisions → upper layer integrity check
  - Checksum MAY be elided when:
    - Upper-layer message integrity check is in use
    - Tunneling
  - Endpoint MUST NOT elide Checksum unless authorized by source
  - Endpoint MUST reconstitute Checksum when expanding

IPv6 Header Compression

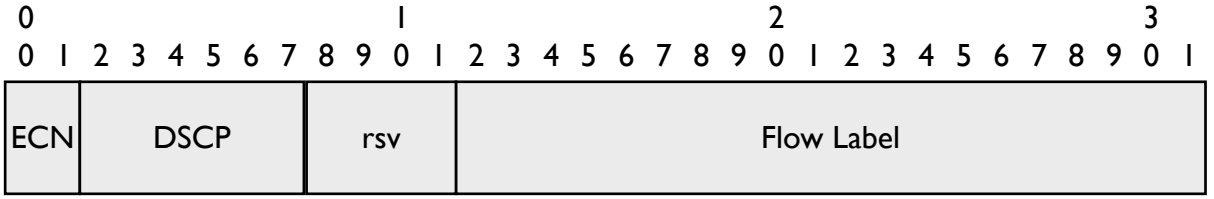


TF	2 bits	Traffic Class and Flow Label
NH	1 bit	Next Header
HLIM	2 bits	Hop Limit
CID	1 bit	Context Identifier Extension
SAC	1 bit	Source Address Context
SAM	2 bits	Source Address Mode
M	1 bit	Multicast Address Compression
DAC	1 bit	Destination Address Context
DAM	2 bits	Destination Address Mode

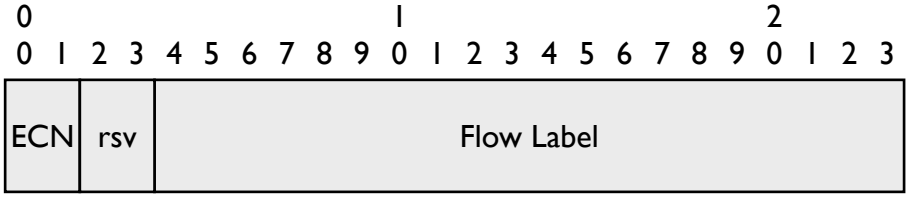
Traffic Class & Flow Label



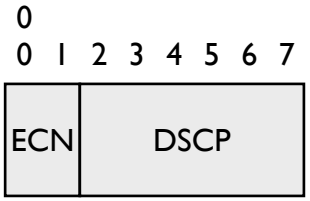
TF = 0



TF = 1

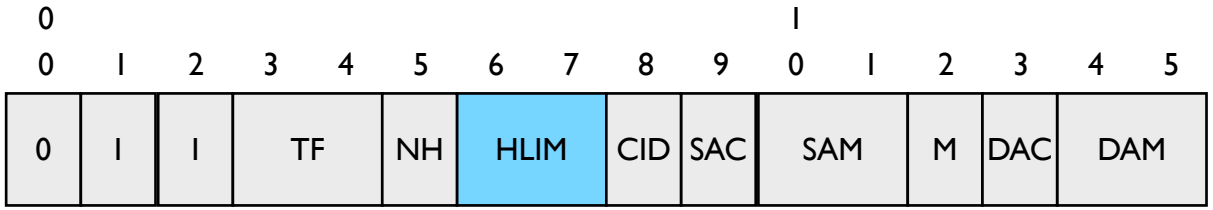


TF = 2



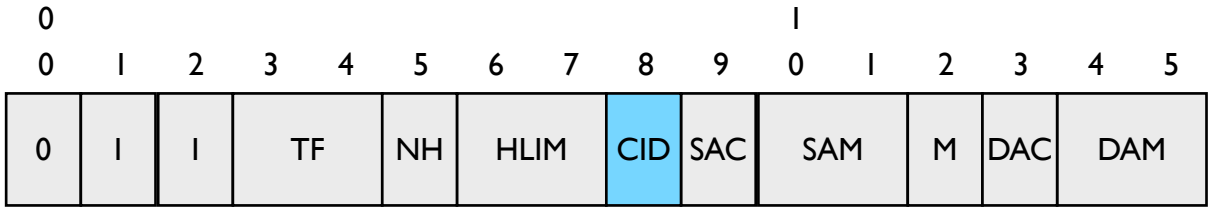
TF = 3 Traffic Class and Flow Label elided.

Hop Limit

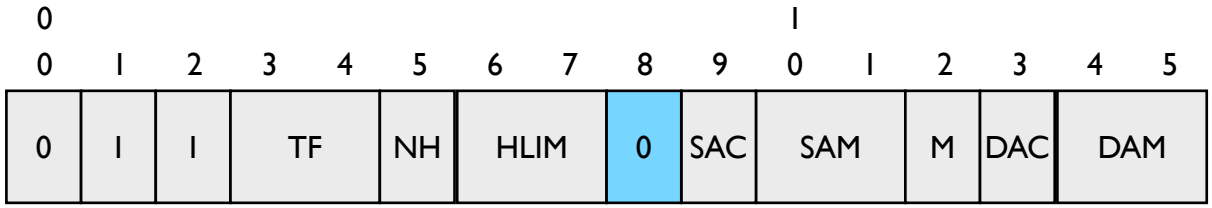


0	Hop Limit carried in-line.
1	Hop Limit = 1 and elided.
2	Hop Limit = 64 and elided.
3	Hop Limit = 255 and elided.

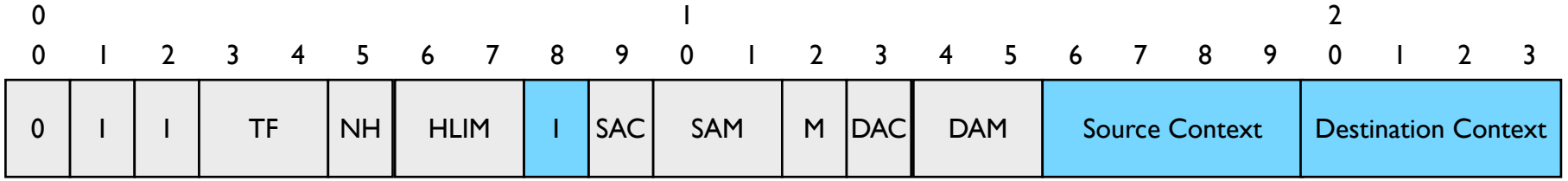
Context Identifier Extension



- CID = 0: Default context

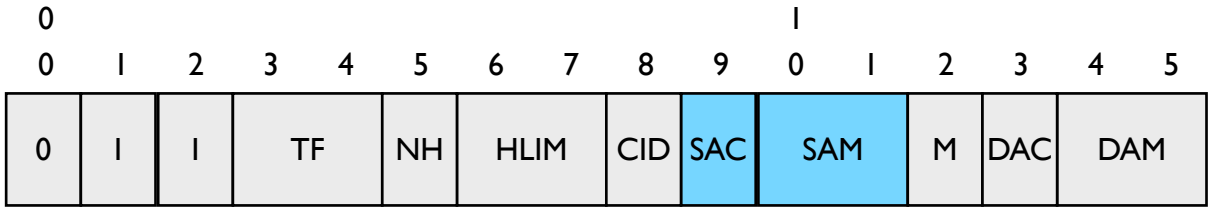


- CID = 1: Context identifier extension



- Number of contexts actually used is out of scope.

Source Address



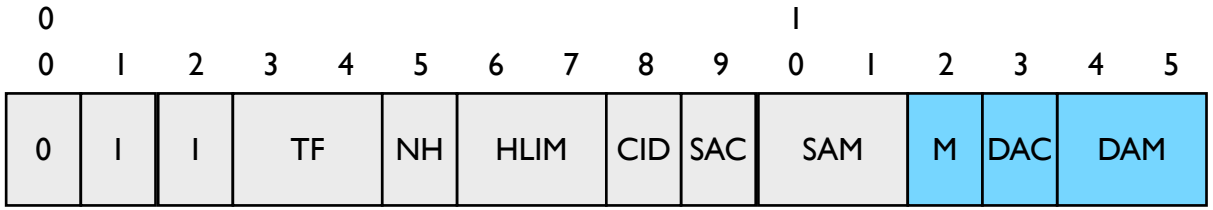
SAC = 0: Stateless compression for link-local communication

- SAM = 0 Completely elided (Unspecified Address)
- SAM = 1 64-bit IID
- SAM = 2 16-bit
- SAM = 3 Completely elided (IID from Lower Layers)

SAC = 1: Context-based compression

- SAM = 0 Full 128-bit Address
- SAM = 1 64-bit IID
- SAM = 2 16-bit
- SAM = 3 Completely elided (IID from Lower Layers)

Destination Unicast Address



M = 0 (Unicast Address Compression)
DAC = 0: Stateless compression for link-local communication
DAC = 1: Context-based compression

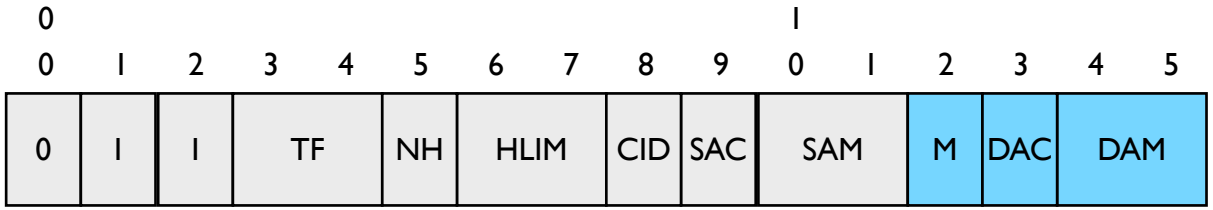
SAM = 0 Full 128-bit Address

SAM = 1 64-bit IID

SAM = 2 16-bit

SAM = 3 Completely elided (IID from Lower Layers)

Destination Multicast Address



M = 1 (Multicast Address Compression)
DAC = 0: Stateless compression

SAM = 0 | Flags | Scope | Right-Most 40 bits of Group Identifier | 6 bytes

FFXX::00XX:XXXX:XXXX

Solicited Node and Node Information Queries

SAM = 1 | Flags | Scope | Right-Most 24 bits of Group Identifier | 4 bytes

FFXX::XX:XXXX

Longer well-known addresses (all-dhcp-servers FF05::1:3)

SAM = 2 | Scope | Group ID (12 bits) | 2 bytes (Flags = 0)

FF0X::0XXX

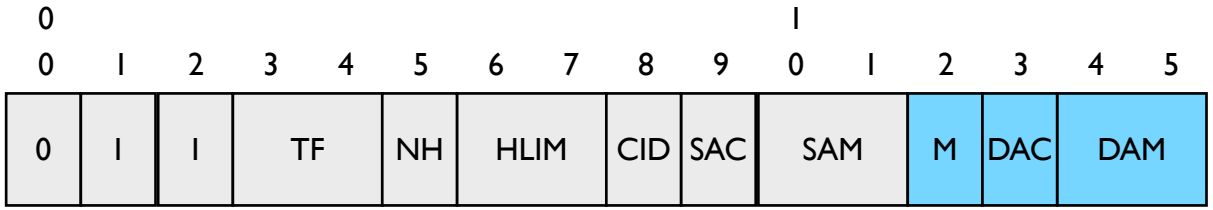
Variable scoped multicast addresses

SAM = 3 | GID (8 bits) | 1 byte (Flags = 0, Scope = 2)

FF02::00XX

Most common link-local cases (link-local all-nodes FF02::1)

Destination Multicast Address



M = 1 (Multicast Address Compression)
DAC = 1: Context-based compression

SAM = 0 Full 128-bit address in-line

SAM = 1

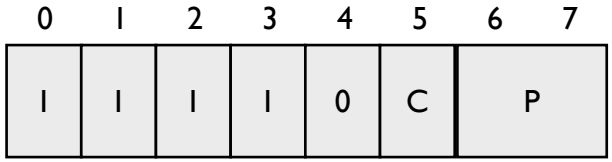
6 bytes

FFXX:RIID:[plen][prefix]:XXXX:XXXX
Unicast-Prefix-based Multicast Addresses

SAM = 2 Reserved

SAM = 3 Reserved

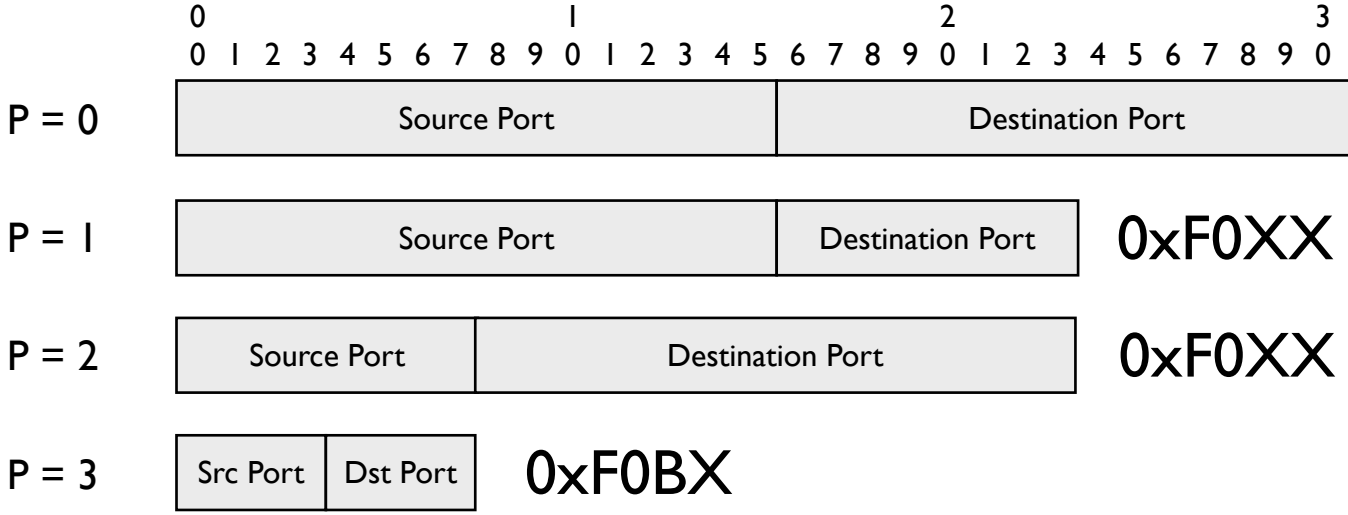
UDP



Checksum Compression

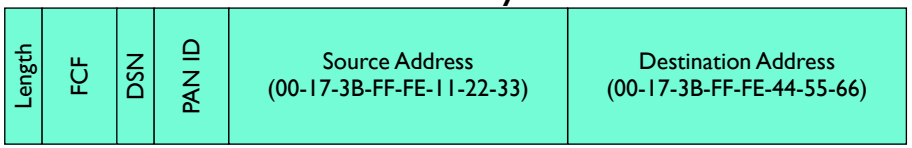
0	Checksum carried in-line.
1	Checksum elided with higher-layer end-to-end integrity checks.

Port Compression



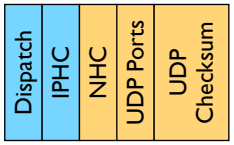
Some Examples

IEEE 802.15.4 Header - 22 bytes



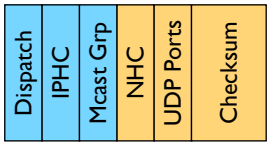
22 bytes

Link-Local Unicast (`fe80::0217:3bff:fe11:2233 → fe80::0217:3bff:fe33:4455`)



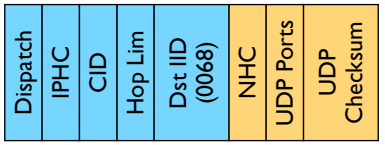
6 bytes

Link-Local Multicast (`fe80::0217:3bff:fe11:2233 → ff02::1`)



7 bytes

Global Unicast (`2001:5a8:4:3721:0217:3bff:fe11:2233 → 2001:4860:b002::68`)



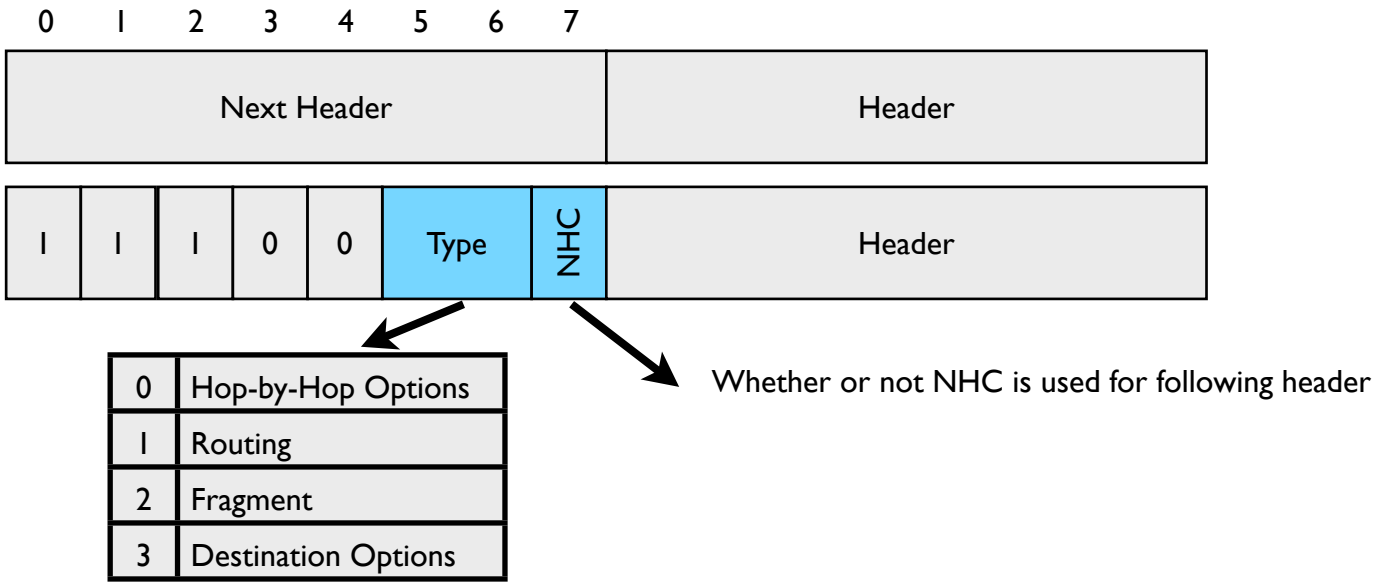
10 bytes

What is Compressible?

- Unicast
  - Link-local (including unspecified address)
  - Global (with prefix match in context db)
- Multicast
  - Most useful link-local addrs (all-nodes)
  - Other well-known addrs (all-dhcp-servers)
  - Solicited node addresses
  - Unicast-Prefix-Based addrs

Extension Headers?

- draft-04 can only apply NHC to a header directly following IPHC.
- Support compressed UDP header if IPv6 Extension Headers fall in between?
- One proposal:



Recap

- IP Header Compression
  - More discussion about contexts
  - Context database maps between (prefix, plen) and 4-bit context ID
  - How contexts are maintained are out-of-scope
- UDP Header Compression
  - More discussion about port and checksum compression
  - 4-bit port range increases port collisions → upper layer integrity check
  - Checksum MAY be elided when:
    - Upper-layer message integrity check is in use
    - Tunneling
  - Endpoint MUST NOT elide Checksum unless authorized by source
  - Endpoint MUST reconstitute Checksum when expanding

Other Notes

- ISA100 will use HC defined in draft-04
- Support for extension headers?
- Draft is stable → move to LC soon?

74th IETF: 6lowpan WG Agenda

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Design and Application Spaces for 6LoWPANs

(draft-ietf-6lowpan-usecases-02)

IETF-74 San Francisco

Monday, March 23, 2009

Eunsook Kim, Nicolas Chevrollier, Dominik Kaspar, JP Vasseur

Quick Summary

- Status:
  - WG draft since last October
- Recent updates (for version -02):
  - Clarification of terminology
  - Adapted all usecases to the same terminology aligned with 6LoWPAN ND, Routing Reqts drafts

To do and Future Plan

- To do:
  - 6LoWPAN applicability for Connected Home
  - Hope we finish this work right after this meeting
- Plan
  - To be LC-ready within a month

Problem Statement and Requirements for 6LoWPAN Mesh Routing

(draft-ietf-6lowpan-routing-requirements-01)

IETF-74 San Francisco

Monday, March 23, 2009

Eunsook Kim, Dominik Kaspar, Carles Gomez, Carsten Bormann

Status

- WG draft (-00 posted last November)
- Charter text: "6LoWPAN Routing Requirements" will describe 6LoWPAN-specific requirements on routing protocols used in 6LoWPANs, addressing both the "route-over" and "mesh-under" approach.

Collected Comments

Major comments at IETF-73:

1. Make sure interface to 15.4 is clearly defined (IEEE 802.15.4 dependent terminology)
2. Discuss hibernation-induced latency with the latency requirements.
3. Improve discussion of mutual requirements of routing and header compression.
4. Refine discussion of how MAC-layer ACKs can go into routing

We asked for feedback from:

- Active 6lowpanner (One)
- roll draft authors (One)
- Experts from outside 6lowpan and roll (One)

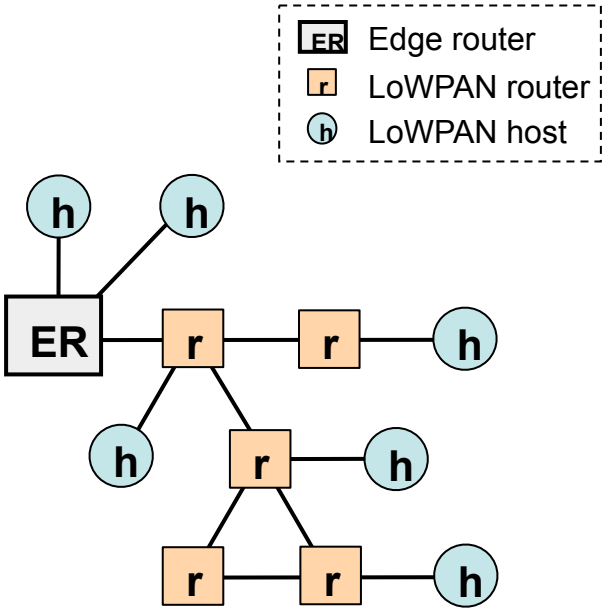
We got very positive comments! Thanks for all who gave good feedback.

Major comments from emails for -00 (covered in -01)

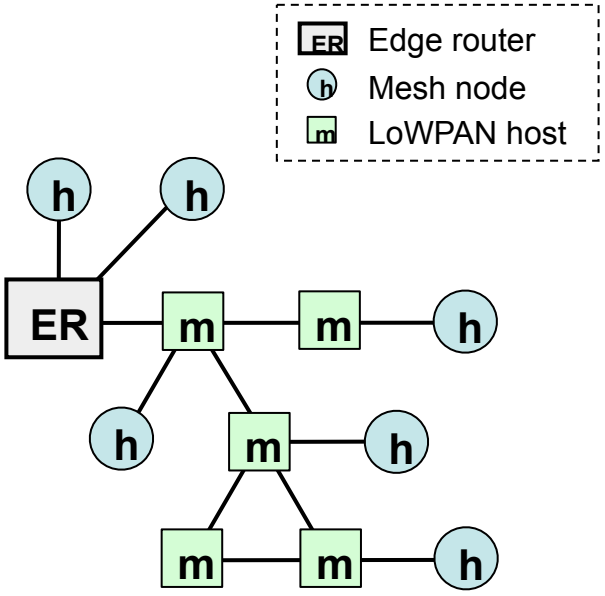
1. Make the document more useful for people not familiar with 6lowpan
2. Clarification for terminology (IEEE 802.15.4 dependent terminology)
3. Terminology for mesh-under routing (routing / switching / forwarding?)
4. Routing categories
5. Multicast issues

Major Changes (-00 → -01)

- Terminology
  - New terminology section (aligned with ND)
  - Corrected terminology throughout document
- 6LoWPAN Headers for Routing
  - New subsection added
- Reference Network Model
  - New subsection added
  - Explains Mesh Under and Route over



A Route Over LoWPAN



A Mesh Under LoWPAN

Major Changes (-00 → -01) (cont'd)

- Routing Requirements
  - [R03] fragmentation
    - Clarification of wording
  - [R05] Latency
    - Addition of impact of duty cycling
    - Consideration of non-legacy 802.15.4 link
  - [R09] Metrics
    - Clarification of wording
  - [R14] Security consideration
    - Update on utilization of MAC-layer ACK → MAC-layer ACK cannot be relied upon.
  - [R16] discovery and maintenance of mesh under neighbors
    - Clarification of wording

To do and Plan

- One quick re-spin for -02
- WG LC with -02

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6LoWPAN Fragment recovery

(draft-thubert-6lowpan-simple-fragment-recovery-03)

Pascal Thubert

6LoWPAN WG Meeting
74th IETF Meeting
Minneapolis, Minnesota

Need for fragment recovery

- Considering
  - that 6LoWPAN packets can be as large as 2K bytes
  - that a 802.15.4 frame with security will carry in the order of 80 bytes of effective payload,

=> An IPv6 packet might be fragmented into ~ 25 fragments at the 6LoWPAN shim layer

- This level of fragmentation is much higher than that traditionally experienced over the Internet with IPv4 fragments.
- At the same time, the use of radios increases the probability of transmission loss and Mesh-Under techniques compound that risk over multiple hops.

Other problems related to frags

- Hop by Hop recomposition
  - Should be avoided: latency and memory hit
- Multipath
  - Forwarding fragments over multipath multiplies the impact of an anomaly
- Recovery buffers Lifetime
  - Terminating device with limited capacity may have trouble maintaining buffers. How long?

Explicit Congestion Notification

- ECN in IPv6: Traffic Class bits 6-7

Binary	Keyword	References
00	Not-ECT (Not ECN-Capable Transport)	[RFC 3168]
01	ECT(1) (ECN-Capable Transport(1))	[RFC 3168]
10	ECT(0) (ECN-Capable Transport(0))	[RFC 3168]
11	CE (Congestion Experienced)	[RFC 3168]

  - Not compressed separately by 4944
  - Added to draft-ieft-6lowpan-hc

- ECN Echo
  - Not an IP function (usually transport)
  - Thus provided by this draft between fragmentation endpoints

ECN use

- Indicate Congestion in the LoWPAN
  - End to End effect on Transport
  - Required by ISA100.11a
  - Local Effect on Fragment flow control

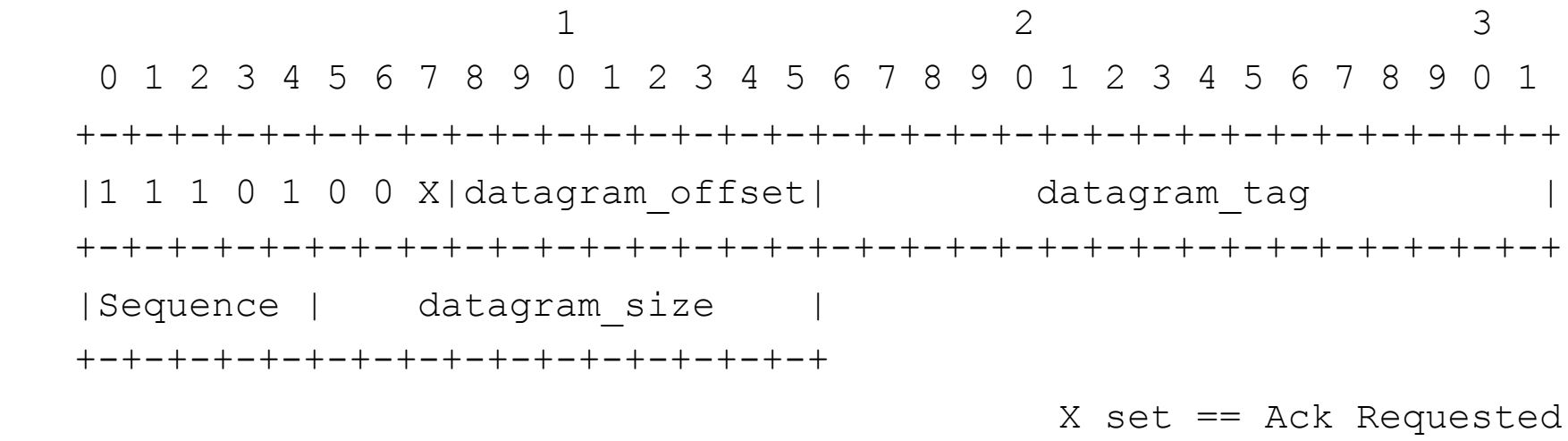
- Early detection
  - Avoid Wasteful discard of packets
  - Conditions equivalent to RED

Fragment Recovery proposal

- 32 bits SAck Bitmap
- Variable window size for congestion control
- Round Robin for multipath
- 4 new dispatch types

Pattern	Header Type	
11 101000	RFRAG	- Recoverable Fragment
11 101001	RFRAG-AR	- RFRAG with Ack Request
11 101010	RFRAG-ACK	- RFRAG Acknowledgement
11 101011	RFRAG-AEC	- RFRAG Ack with ECN echo

Recoverable Fragment Dispatch type and Header



X (check) bit

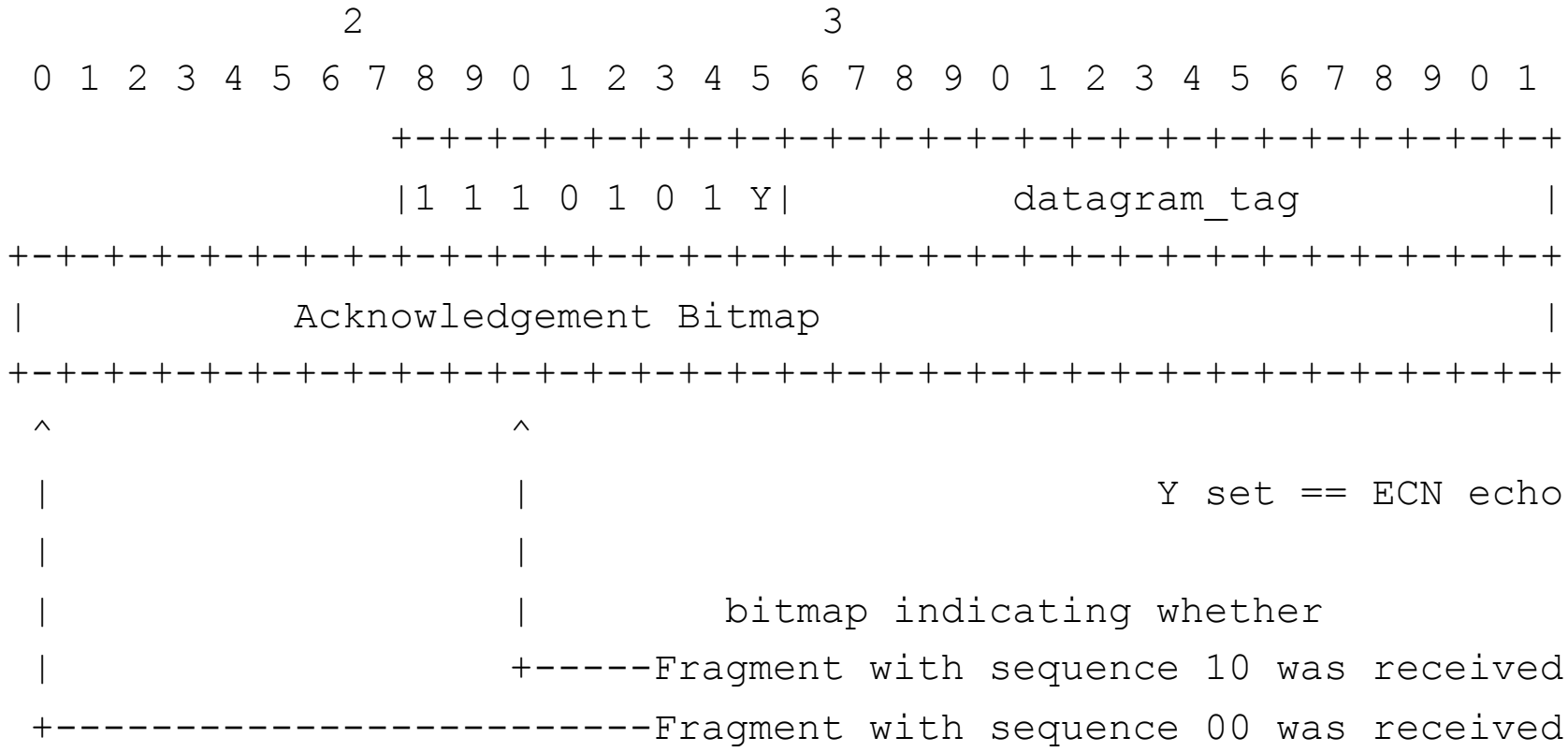
When set, the sender requires an Acknowledgement from the receiver

Sequence

The sequence number of the fragment.

Fragments are numbered [0..N] where N is in [0..31].

Fragment Acknowledgement Dispatch type and Header



????? Questions ?????

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