IPv6 over Low power WPAN WG (6lowpan)

Chairs:

Geoff Mulligan <geoff@mulligan.com>

Carsten Bormann <cabo@tzi.org>

Mailing List:

6lowpan@ietf.org

Jabber:

6lowpan@jabber.ietf.org

- **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**

✓Blue sheets
✓Scribe(s)

73rd IETF: 6lowpan WG Agenda

09:00	Introduction, Status	Chairs	(10)
00:00	5 – Use cases		(00)
09:10	4 – Routing Requirements	EK	(30)
09:40	2 – HC	JH	(30)
10:10	1 – Bootstrapping/ND optimization	ZS	(50)
00:00	3 – Architecture		(00)
00:00	6 – Security		(00)
11:00	0 – wither 6lowpan	Chairs	(15)

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
- **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)**

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)**

73rd IETF: 6lowpan WG Agenda

09:00	**Introduction, Status**	**Chairs**	**(10)**
00:00	5 – Use cases		(00)
09:10	4 – Routing Requirements	EK	(30)
09:40	2 – HC	JH	(30)
10:10	1 – Bootstrapping/ND optimization	ZS	(50)
00:00	3 – Architecture		(00)
00:00	6 – Security		(00)
11:00	0 – wither 6lowpan	Chairs	(15)

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

73rd IETF: 6lowpan WG Agenda

09:00	Introduction, Status	Chairs	(10)
00:00	5 – Use cases		(00)
09:10	4 – Routing Requirements	EK	(30)
09:40	2 – HC	JH	(30)
10:10	1 – Bootstrapping/ND optimization	ZS	(50)
00:00	3 – Architecture		(00)
00:00	6 – Security		(00)
11:00	0 – wither 6lowpan	Chairs	(15)

Design and Application Spaces for 6LoWPAN

(draft-ietf-6lowpan-usecase-00)

(draft-ietf-6lowpan-usecase-01)

IETF-73 Minneapolis

Tuesday, November 18, 2008

Eunsook Kim, Nicolas Chevrollier, Dominik Kaspar, JP Vasseur

Draft Status

- WG draft (-00 was posted in Octobor)
- Changes (-00 → -01)
  - Addition of 6lowpan applicability for 2 use-cases
- To do
  - 6lowpan applicability is still missing at Home automation

Questions and Future work

- Plan:
  - Want to be ready for WGLC by the next meeting
- WG feed-back on the document very much welcome

73rd IETF: 6lowpan WG Agenda

09:00	Introduction, Status	Chairs	(10)
00:00	5 – Use cases		(00)
09:10	4 – Routing Requirements	EK	(30)
09:40	2 – HC	JH	(30)
10:10	1 – Bootstrapping/ND optimization	ZS	(50)
00:00	3 – Architecture		(00)
00:00	6 – Security		(00)
11:00	0 – wither 6lowpan	Chairs	(15)

Problem Statement and Requirements for 6LoWPAN Routing

(draft-dokaspar-6lowpan-routreq-07)
(draft-dokaspar-6lowpan-routreq-08)

IETF-73 Minneapolis

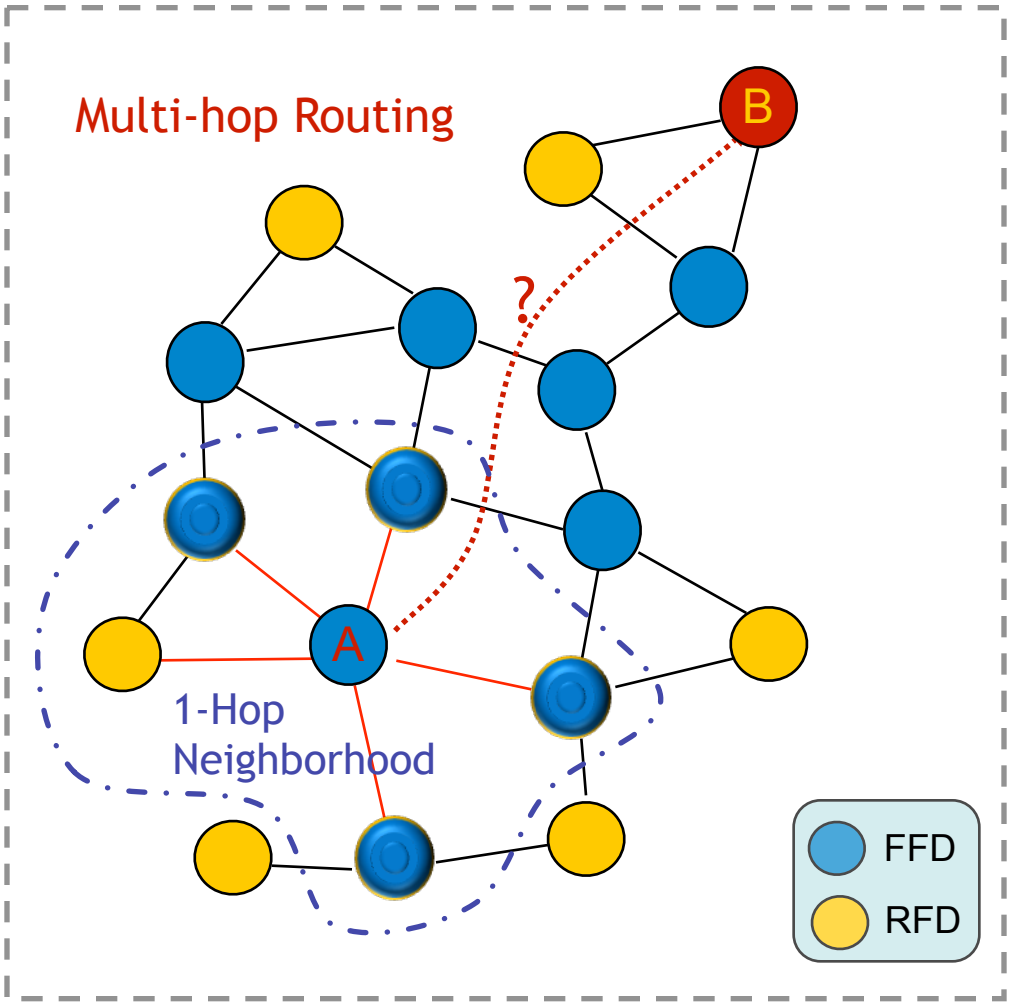
Tuesday, Nov.18, 2008

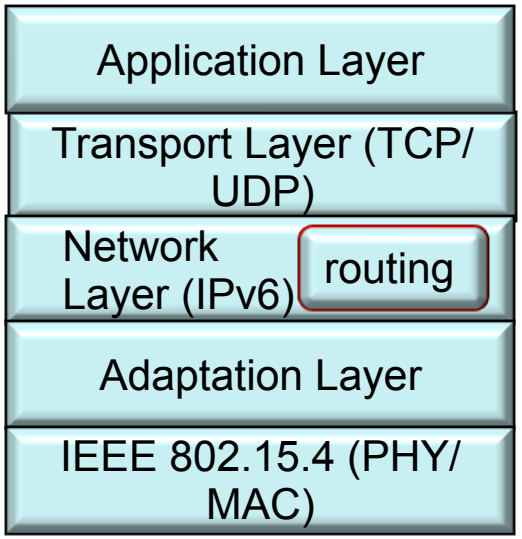
Eunsook Kim, Dominik Kaspar, Carles Gomez, Carsten Bormann

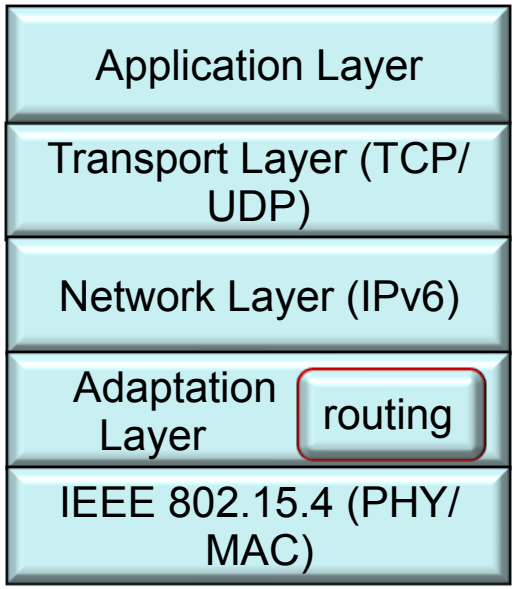
Draft status

- Status
  - Target document for 6LoWPAN routing requirement work
- 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.
  - This document will be created and owned by this working group but is expected to be reviewed by the ROLL WG.
- This work was intended to be done at Sep. 2008

Problem to solve







Major Changes (06→07→08)

- Restructuring
- Improvement with details and examples through the whole text
- 3 requirements are added
  - Probability of delivery
  - Latency requirement
  - Link asymmetry
- 2 requirements are deleted

Routing Requirements (-08)

- Support of 6LoWPAN Device Properties
  - [R01] Code size and routing state
    - code size considering typical node memory size
    - routing table up to 32 entries
  - [R02] Power consumption due to routing messages and routing of data
    - Some example value, transmission consumes about 20 to 30mW, reception consumes about 15 to 20mW.

Routing Requirements (-08)

- Support of 6LoWPAN link properties
  - [R03] fragmentation from routing control messages
    - Max of 6lowpan frame is 81 octets.
    - Use of semantic fragmentation and/or algorithm that can work on small increments of routing info.
  - [R04] Probability of Packet delivery
    - max no of transmission attempts in reliable mode
  - [R05] Latency
    - To meet specific latency requirement for applications, 6lowpan link latency can be considered (e.g., 2.4 GHz channel of 802.15.4 is between 2.4ms and 6.02ms (64bit addr., unreliable mode)
    - Latency can be used for path selection
  - [R06] Robustness to dynamic loss
  - [R07] Link asymmetry

Routing Requirements (-08)

- Support of 6LoWPAN Network characteristics
  - [R08] Consideration of sleeping nodes
    - Feedback from the lower layer may be considered to enhance the power-awareness of 6lowpan routing protocols
  - [R09] Routing metrics
    - Several input can be used including LQI, LDR, RSSI, etc.
    - the discussion how the parameters can be used is included
  - [R10] Scalability and minimality
    - Scale from 2 ~ 10^x to nodes, with limited routing table
  - [R11] Routing repair
    - To avoid premature depletion, even in case that impairs other reqt.
  - [R12] Dynamic topology
    - Consideration
      - Mobile nodes changing their location inside a 6LoWPAn
      - Movement of a 6loWPAN wrt other (inter)connected 6LoWPANs
      - Nodes permanently joining or leaving the 6LoWPAN
    - inform the coordinator about intention to disassociate, when nodes leaving the network
  - [R13] traffic pattern
    - p2p, p2m, m2p

Routing Requirements (-08)

- Support of Security
  - [R14] Secure delivery
    - Minimum: IEEE 802.15.4 AES-based security mechanisms (up to 21 additional bytes)
- Support of mesh forwarding
  - [R15] support of 16-bit and 64-bit addresses
  - [R16] Avoidance of "Hello" messages
    - Use of layer 2 acknowledgement
  - Use of nodes with coordinator role
    - [R17] the coordinators MAY take the role of keeping track of node association and de-association within the 6LoWPAN
    - [R18] the coordinators MAY be a relay point of group-targeting message

Next Steps

- We focus on 6LoWPAN's own requirements
- WG FEED-BACK on the document TEXT very much welcome
- Ready for WG draft?
- We intend this work to be done within this year

73rd IETF: 6lowpan WG Agenda

09:00	Introduction, Status	Chairs	(10)
00:00	5 – Use cases		(00)
09:10	4 – Routing Requirements	EK	(30)
09:40	2 – HC	JH	(30)
10:10	1 – Bootstrapping/ND optimization	ZS	(50)
00:00	3 – Architecture		(00)
00:00	6 – Security		(00)
11:00	0 – wither 6lowpan	Chairs	(15)

Compression Format for IPv6 Datagrams in 6LoWPAN Networks

(draft-ietf-6lowpan-hc-03.txt)

Jonathan Hui
Pascal Thubert

6LoWPAN WG Meeting
73rd IETF Meeting
Minneapolis, Minnesota

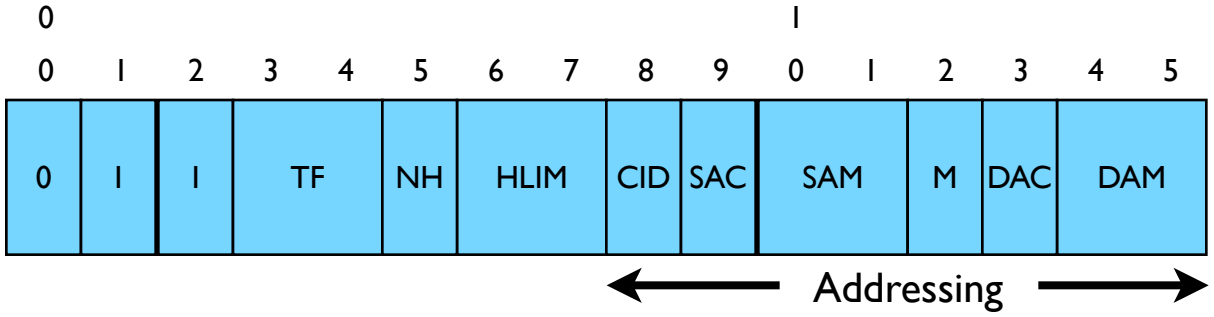
Background

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

Changes from draft-00

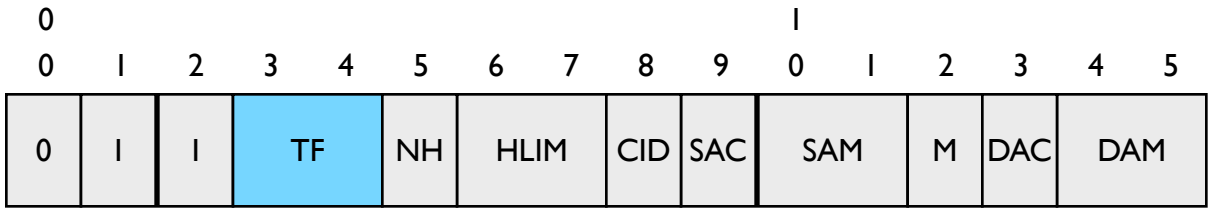
- IP Header Compression
  - Traffic Class and Flow Label compression
  - Multicast address compression
  - Unspecified Address compression
  - Support for up to 16 contexts
- UDP Header Compression
  - Port compression alignment
  - Checksum compression

IPv6 Header Compression

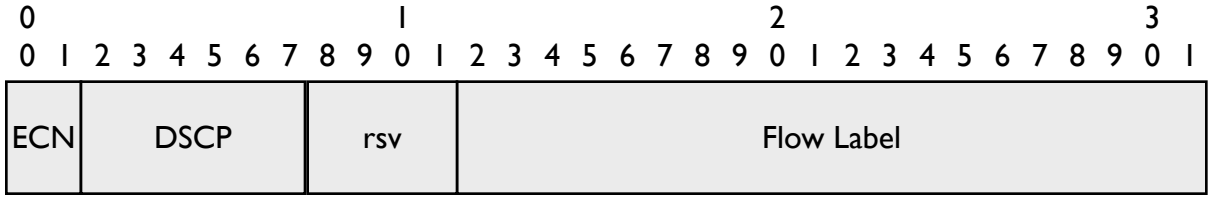


TF	2 bits	Traffic Class and Flow Label
NH	1 bit	Next Header
HLIM	2 bits	Hop Limit
CID	1 bit	Context Identifier Extension
SAC	1 bit	Source Address Context
SAM	2 bits	Source Address Mode
M	1 bit	Multicast Address Compression
DAC	1 bit	Destination Address Context
DAM	2 bits	Destination Address Mode

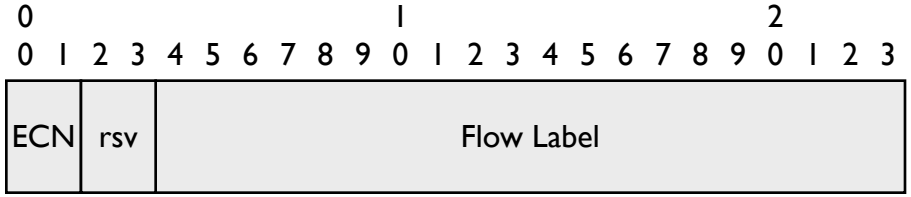
Traffic Class & Flow Label



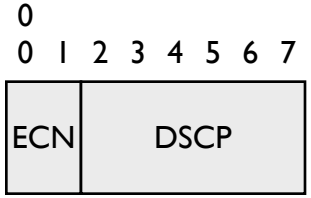
TF = 0



TF = 1

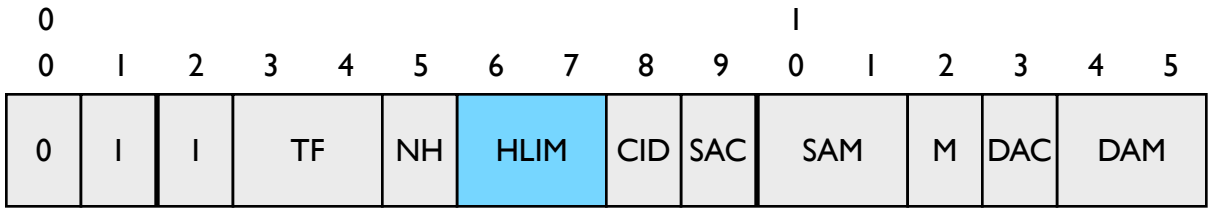


TF = 2



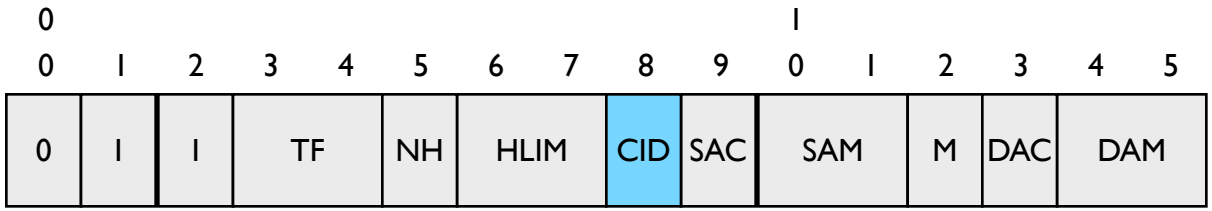
TF = 3 Traffic Class and Flow Label elided.

Hop Limit

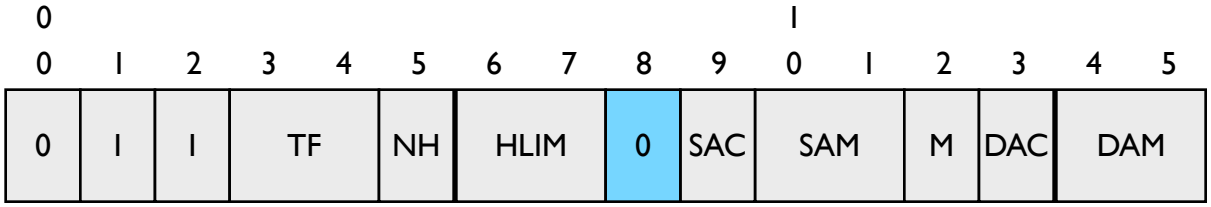


0	Hop Limit carried in-line.
1	Hop Limit = 1 and elided.
2	Hop Limit = 64 and elided.
3	Hop Limit = 255 and elided.

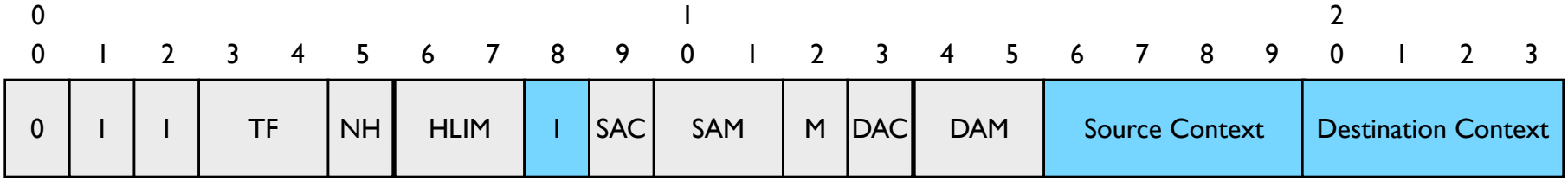
Context Identifier Extension



- CID = 0: Default context

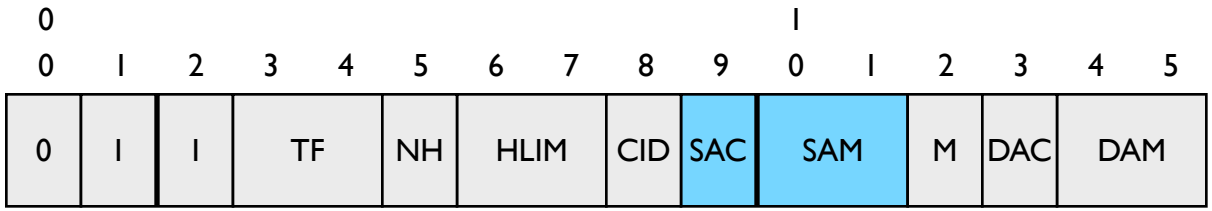


- CID = 1: Context identifier extension



- Number of contexts actually used is out of scope.

Source Address



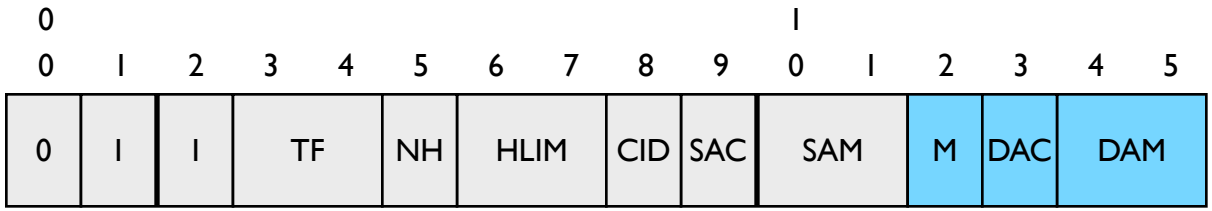
SAC = 0: Stateless compression for link-local communication

- 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

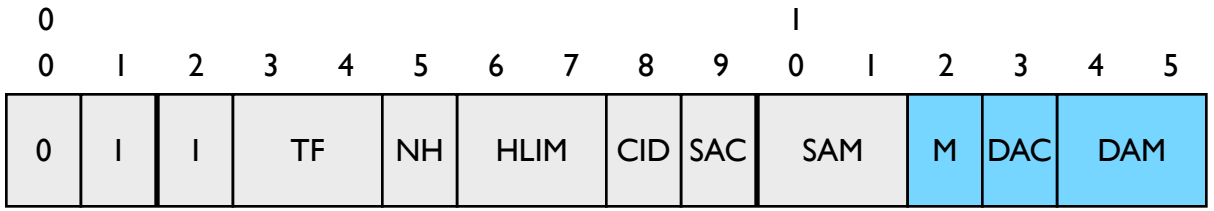
SAM = 0 — Full 128-bit Address

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)

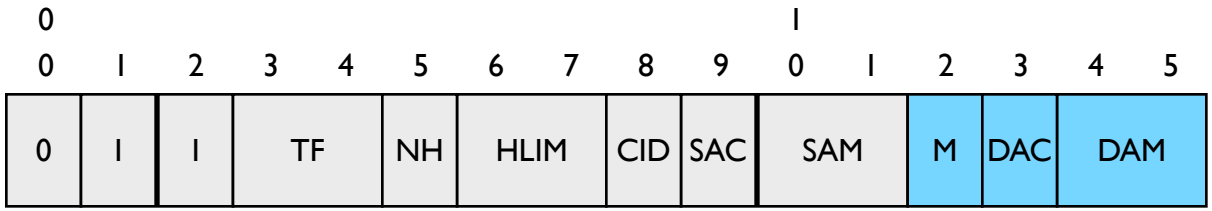
SAM = 2 | Scope | Group ID (12 bits) | 2 bytes (Flags = 0)

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

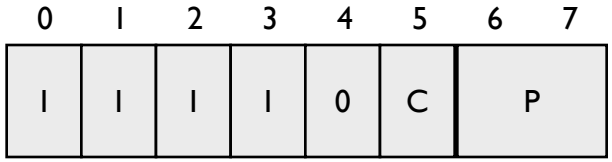
6 bytes

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

SAM = 2 Reserved

SAM = 3 Reserved

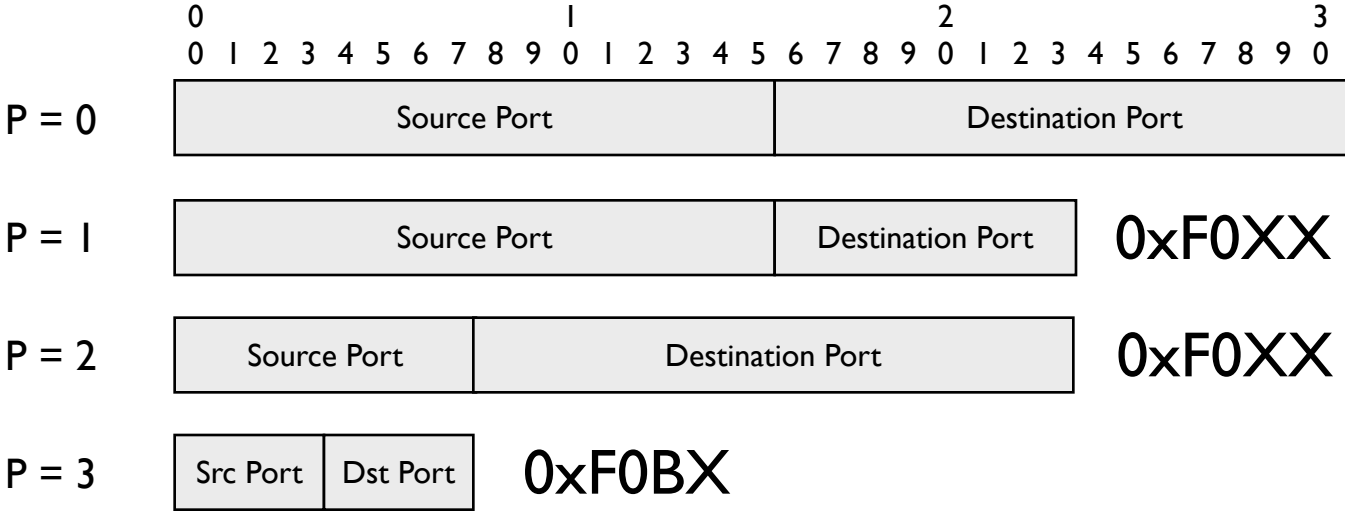
UDP



Checksum Compression

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

Port Compression



Summary of Changes

- IP Header Compression
  - Traffic Class and Flow Label compression
  - Multicast address compression
  - Unspecified Address compression
  - Support for up to 16 contexts
- UDP Header Compression
  - Port compression alignment
  - Checksum compression

73rd IETF: 6lowpan WG Agenda

09:00	Introduction, Status	Chairs	(10)
00:00	5 – Use cases		(00)
09:10	4 – Routing Requirements	EK	(30)
09:40	2 – HC	JH	(30)
10:10	1 – Bootstrapping/ND optimization	ZS	(50)
00:00	3 – Architecture		(00)
00:00	6 – Security		(00)
11:00	0 – wither 6lowpan	Chairs	(15)

draft-shelby-6lowpan-nd-01

Authors:
Zach Shelby (ed.)
Jonathan Hui
Pascal Thubert
Samita Chakrabarti
Erik Nordmark

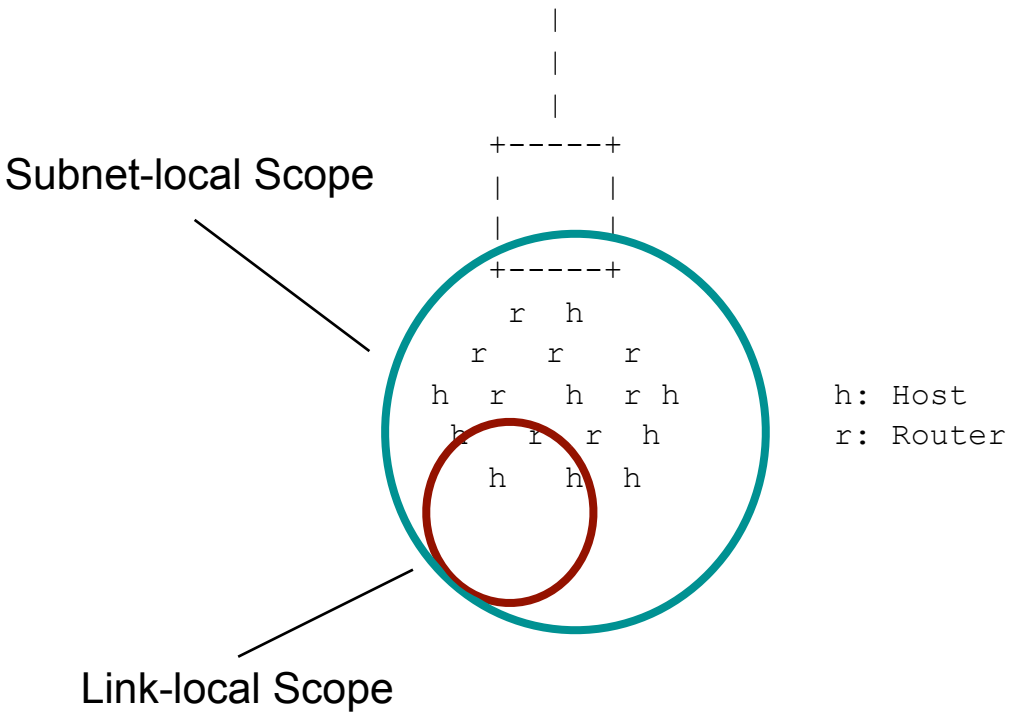
Background

- Design team formed in Dublin
- Based on ideas from 5 ND related drafts:
  - draft-chakrabarti-6lowpan-ipv6-nd-05
  - draft-thubert-6lowpan-backbone-router-01
  - draft-hui-6lowpan-nd-00
  - draft-nordmark-6lowpan-reg-00
  - draft-bormann-6lowpan-cbhc-00
- Note: -01 posted yesterday

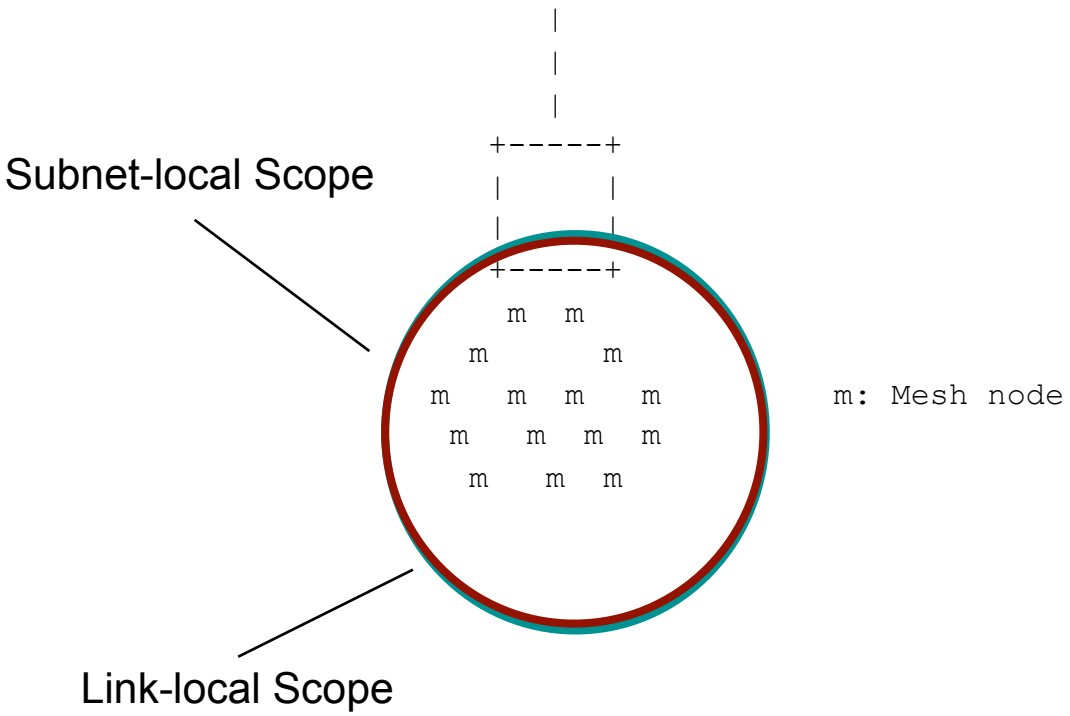
Main goals

- Bootstrapping on a lowpan
- Router and prefix information dissemination
- DAD or NS avoiding multicast
- Stateless address assignment
- Enabling ND over a lowpan or extended lowpan
  - Wireless link model, frequent topology change
- Mesh-under and route-over agnostic

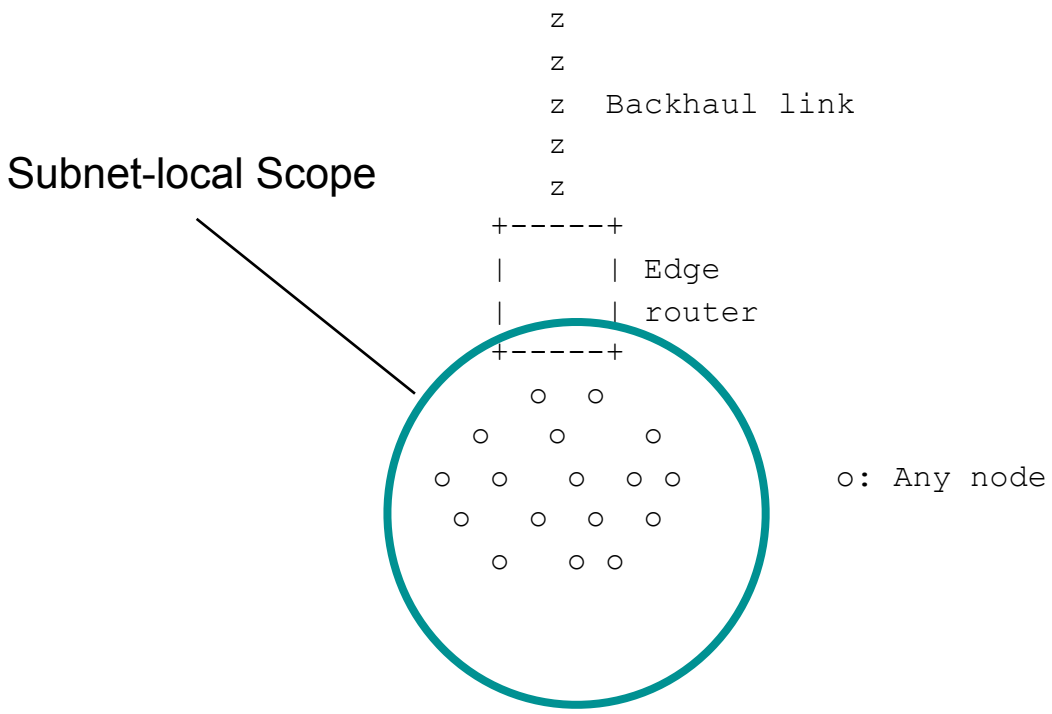
Architecture - Route Over



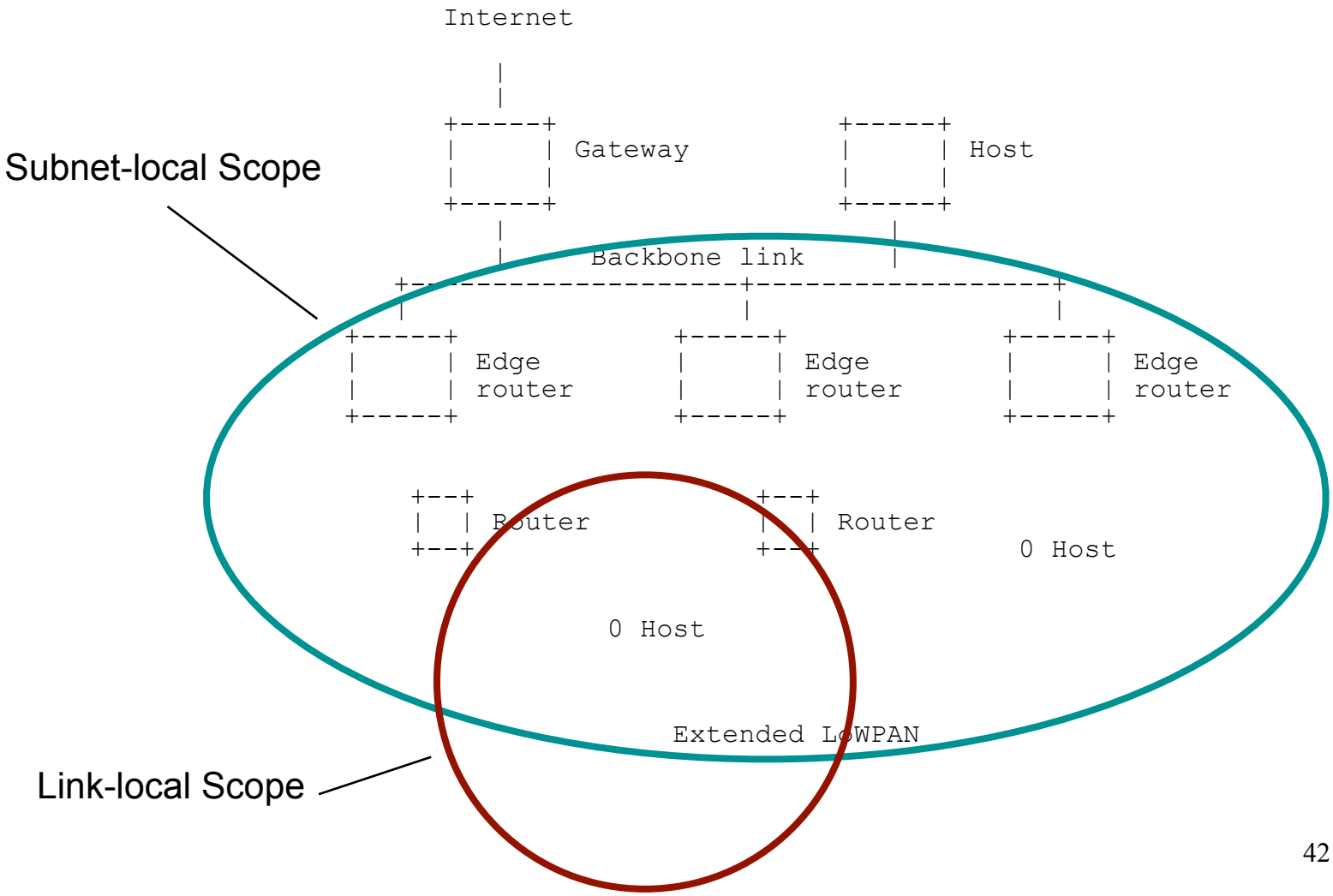
Architecture - Mesh-under



Architecture – Single lowpan



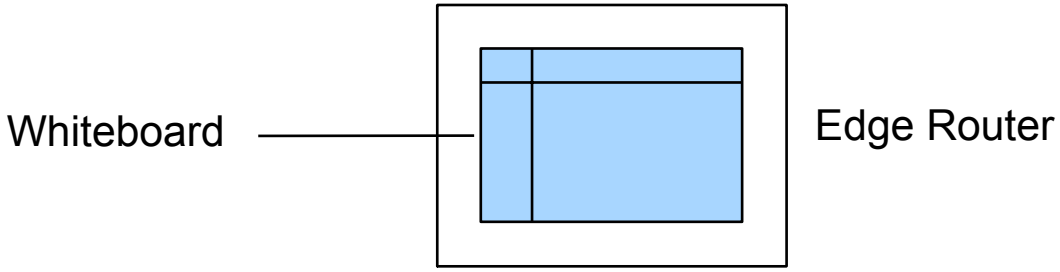
Architecture – Extended lowpan



The solution

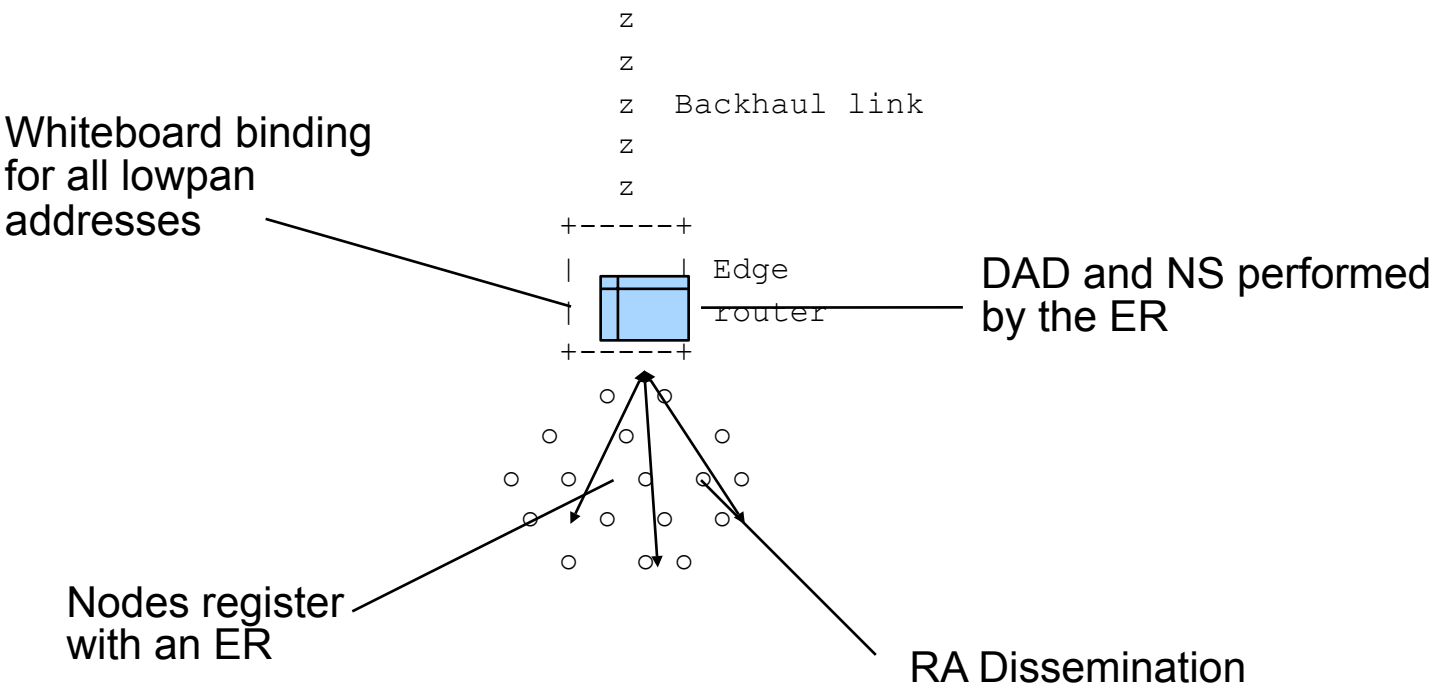
- Simplify and reduce IPv6 ND [RFC4861]
- 6lowpan prefix information dissemination
  - Standard RAs with extra flag (optional)
- Bootstrapping with ND techniques
- Router Registration/Confirmation message (optional)
  - ERs act as whiteboards for their LoWPAN
  - Can be used to get a stateless address
- Support for DAD over extended LoWPANs and proxying across the ER (optional)
  - Can be achieved with ND-Proxy or a routing protocol

Whiteboard model

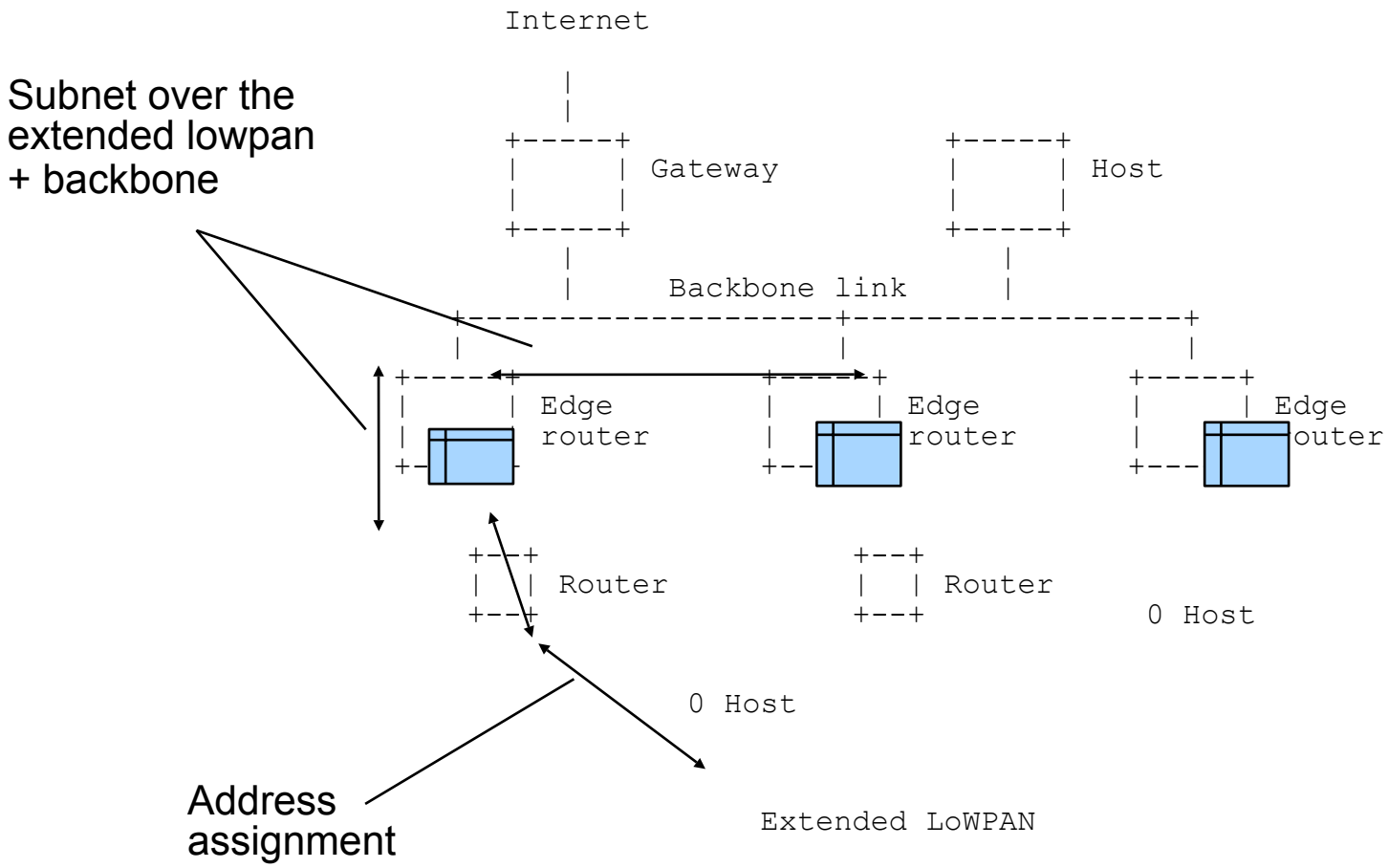


- A whiteboard binding entry has the following fields:
  - `Host Interface Identifier`
  - `IPv6 Address`
  - `Lifetime`
- Bindings are soft
  - Must be refreshed
  - Can be moved between ERs

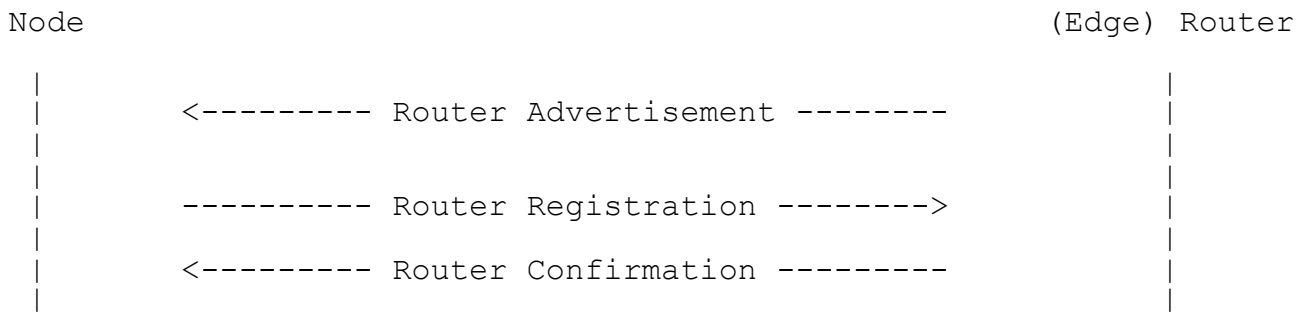
Basic features

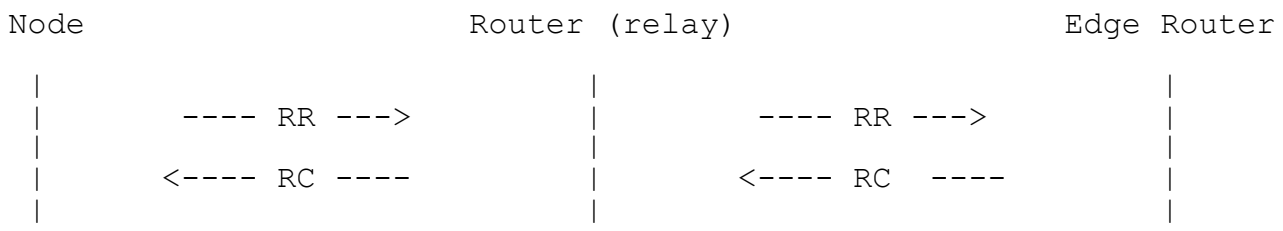


Optional features



Message exchanges

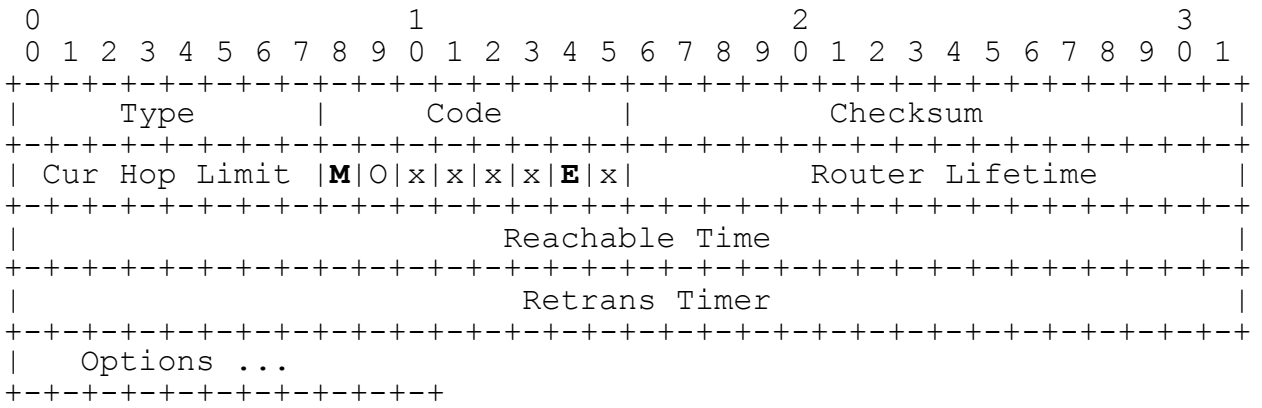




RA dissemination

- ERs initiate the dissemination of network information
- RAs are sent periodically by default
- Optionally trickle could be applied (TBD)
- Routers then disseminate forward
- RAs include
  - Default prefix and HC address contexts (option for each)
  - Multihop information option with sequence number
    - To indicate freshness of information
    - Full list of contexts needs to be sent only rarely

RA message



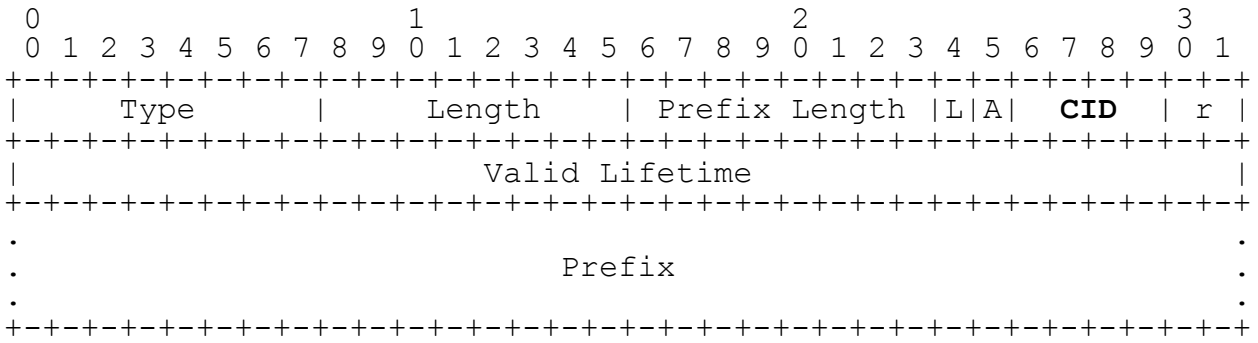
M – Used to indicate that stateless address assignment used.

E - "Edge Router" flag indicating that the routing sending the RA is an Edge Router.

NOTE: Under discussion to replace E flag with RFC4191 Router Preference flags for -02 e.g. With ER = high, Router = medium, Limited Router? = low

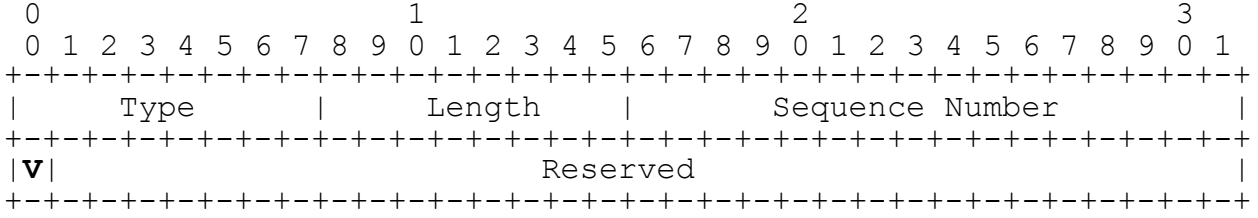
RA options

6LoWPAN Prefix Information Option (A new option!)

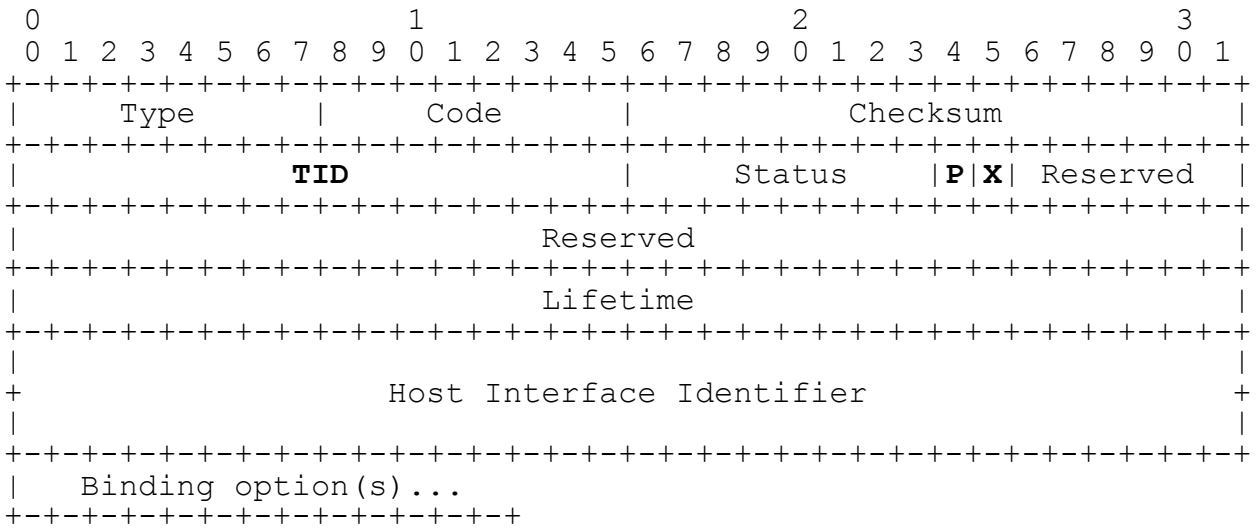


CID – Context Identifier for use in 6LoWPAN HC compression.

Multihop Information Option



RR/RC message



TID – Transaction ID for matching confirmations.

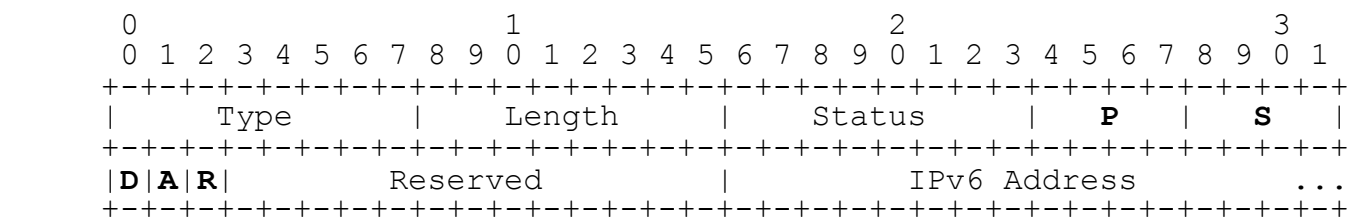
P – Primary flag for using an ER as primary. For use with secondary registrations.

X – Proxy flag in a confirmation to indicate ND-Proxy in use.
NOTE: May not be necessary, could be removed.

HII - Has been suggested to rename HII to Owner Interface Identifier

RR/RC options

Address Option



P/S – Prefix and suffix compression fields.

D – Allow duplicates flag.

A – Address assignment flag.

R – Remove address flag.

Source link-layer address option [RFC4861, RFC4944]

Target link-layer address option [RFC4861, RFC4944]

Changes since -00

- Message structure simplified
  - RR/RC message pair, no separate relay messages
  - Removed Identity Option and 6LoWPAN Addr Opt
  - Address Options under the RR/RC
- Clarified that address assignment is stateless
- Added Ad-hoc LoWPAN and Message Example sections
  - Just placeholders for now
- Editing improvements and better clarity

Open issues with -01

- Replacement of RA E flag with RFC4191
- Trickle algorithm description
- Routing algorithm as ND-Proxy alternative
- Is X flag needed in RC?
- Description of primary/secondary bindings?
- Is an index needed in the Address Option?
- Editorial issues
  - Not all subsections complete
  - Minor editing and consistency

Moving to -02

- Including additional WG feedback
- Message structure stable
- General editorial work
  - Finishing all subsections
  - Cross-referencing with draft-ietf-6lowpan-hc
  - Minor editing and consistency

- Aiming at -02: within 2-3 weeks

Implementation

- From -01 on, encouraging implementation work
  - Many are starting HC implementation work
  - Good time to start ND implementation as well
- We already have an implementation
  - Implementation close to this -01 draft
  - Java simulator also developed for large networks
  - Initial results from testing & simulation good
- If you are working on implementation, let us know

WG Document

Accept draft-shelby-6lowpan-nd-01
as a WG document?

73rd IETF: 6lowpan WG Agenda

09:00	Introduction, Status	Chairs	(10)
00:00	5 – Use cases		(00)
09:10	4 – Routing Requirements	EK	(30)
09:40	2 – HC	JH	(30)
10:10	1 – Bootstrapping/ND optimization	ZS	(50)
00:00	3 – Architecture		(00)
00:00	6 – Security		(00)
11:00	0 – wither 6lowpan	Chairs	(15)

Interesting results nobody noticed

Interesting results nobody noticed

- **HC about Hop Count**
  - **64 is a good default?**
  - **routinely decrementing by more than one?**

Interesting results nobody noticed

- HC about Hop Count
  - 64 is a good default?
  - routinely decrementing by more than one?
- HC about eliding UDP checksums
  - if there is a MIC (which is **NOT** end-to-end)

Interesting results nobody noticed

- HC about Hop Count
  - 64 is a good default?
  - routinely decrementing by more than one?
- HC about eliding UDP checksums
  - if there is a MIC (which is **NOT** end-to-end)
- ND opt may be more generally applicable than to 6lowpan

Interesting results nobody noticed

- HC about Hop Count
  - 64 is a good default?
  - routinely decrementing by more than one?
- HC about eliding UDP checksums
  - if there is a MIC (which is **NOT** end-to-end)
- ND opt may be more generally applicable than to 6lowpan
- RFC 4294 vs. **we don't do no ____ multicast**

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

Architecture

- **Do we distribute/spread the document between**
  - **ND Optimizations (link model)**
  - **Routing Requirements**
  - **Use Cases**

Security

- Is it all about protecting the network?
  - AES hop-by-hop security?
  - Do we have to express preference for some 15.4 AES modes?
- Is manually commissioning keys enough?

So, is there anything left to do?

So, is there anything left to do?

- **... and anybody there willing to commit to doing the work?**

So, is there anything left to do?

- **... and anybody there willing to commit to doing the work?**
- **(We can always do a MIB :-)**