IETF 116 ROLL (Routing over low Power and Lossy Networks)

28 March 2023

Chairs: Dominique Barthel, Ines Robles

Secretary: Michael Richardson

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Welcome John to ROLL :-) :-) :-) :-)









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 - Minute takers: **Please volunteer, thank you :)**
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Agenda

6:30 - 07:30 UTC - Tuesday Session III - 28th March

| Time (UTC) | Duration | Draft/Topic | Presenter |
|---------------|----------|--|------------------|
| 06:30 - 06:38 | 8 min | WG Status | Ines/Dominique |
| 06:38 - 06:46 | 8 min | Discuss draft-ietf-roll-aodv-rpl | Ines/Author |
| 06:46 - 06:54 | 8 min | Discuss draft-ietf-roll-dao-projection | Ines/Author |
| 06:54 - 07:02 | 8 min | Discuss draft-ietf-roll-nsa-extension | Dominique/Author |
| 07:02 - 07:10 | 8 min | Discuss draft-ietf-roll-rnfd | Dominique/Author |
| 07:10 - 07:18 | 8 min | Discuss draft-ietf-roll-mopex | Ines/Author |
| 07:18 - 07:30 | 12 min | Open Floor | Everyone |

Draft status

| Common Ancestor Objective Function and Parent Set DAG Metric Container Extension draft-ietf-roll-nsa-extension-10 | Back to the WG, discussed today |
|--|---|
| Supporting Asymmetric Links in Low Power Networks: AODV-RPL draft-ietf-roll-aodv-rpl-16 | WGLC'ed, discussed today |
| Root initiated routing state in RPL draft-ietf-roll-dao-projection-31 | WGLC'ed, discussed today |
| Controlling Secure Network Enrollment in RPL Networks draft-ietf-roll-enrollment-priority-07 | Addressing Open Issues |
| Mode of Operation extension draft-ietf-roll-mopex-05 | waiting for attention, , discussed today |
| RPL Capabilities draft-ietf-roll-capabilities-09 | waiting for attention |
| RNFD: Fast border router crash detection in RPL <u>draft-ietf-roll-rnfd-01</u> | New Work adopted by the WG, , discussed today |
| RPL Storing Root-ACK draft-jadhav-roll-storing-rootack-03 | WG adoption to be called |

Milestones

Milestones

| Date | Milestone |
|-----------|---|
| Nov 2023 | Initial submission of Fast Border Router Crash Detection in RPL to the IESG |
| Nov 2023 | Recharter WG or close |
| Nov 2023 | Initial submission of a proposal to augment DIS flags and options to the IESG |
| Nov 2023 | Initial submission of a proposal for Source-Route Multicast for RPL to the IESG |
| Nov 2023 | Initial submission of a YANG model for MPL to the IESG |
| Jun 2023 | Initial submission of Capabilities for RPL to the IESG |
| Nov 2022 | Initial submission of Mode of Operation extension for RPL to the IESG |
| Sep 2022 | Initial submission of Controlling Secure Network Enrollment in RPL networks draft to the IESG |
| /lay 2022 | Initial submission of a root initiated routing state in RPL to the IESG |

Done milestones

| Date | Milestone | |
|------|---|---|
| Done | Initial submission to the IESG of mechanism to turn on <u>RFC8138</u> compression feature within a RPL network | |
| Done | Initial submission of Common Ancestor Objective Functions and Parent Set DAG Metric Container Extension to the IESG | |
| Done | Initial submission of routing for RPL Leaves draft to the IESG | |
| Done | Initial submission of a reactive P2P route discovery mechanism based on AODV-RPL protocol to the IESG | |
| Done | Initial Submission of a proposal with uses cases for RPI, RH3 and IPv6-in-IPv6 encapsulation to the IESG | Ì |
| Done | Initial submission of a solution to the problems due to the use of No-Path DAO Messages to the IESG | |

Discuss draft-ietf-roll-aodv-rpl

AODV-RPL Supporting Asymmetric Links in Low Power Networks -

- Reactive P2P route discovery for hop-by-hop and source routing
- Routes from OriginNode to TargetNode are established on-demand
- Enable the discovery of two routes:
 - One from OrigNode to TargNode and
 - Another from TargNode to OrigNode.
- Routes discovered by first forming a temporary DAG rooted at the OrigNode.
 - RREQ-Instance is formed by route control messages from OrigNode to TargNode
 - Data is transmitted from TargNode to OrigNode
 - RREP-Instance is formed by route control messages for OrigNode to TargNode
 - Data is transmitted from OrigNode to TargNode.

AODV-RPL

Supporting P2P (possibly asymmetric) Links in Low Power Networks -Reactive route discovery for both hop-by-hop and source routing

- Introduces AODV-RPL DIO Options:
 - AODV-RPL RREQ (Route Request) Option
 - Present in DIO Messages from OrigNode toward TargNode
 - AODV-RPL RREP (Route Reply) Option
 - Present in DIO Messages from TargNode toward OrigNode
 - AODV-RPL Target (ART) Option
 - Present in RREQ DIO and RREP DIO messages
- Introduces a new multicast address with link-local scope: all-AODV-RPL-nodes
- MOP = 4
 - Does not collide with P2P-RPL (RFC6997)
 - They will operate as different RPL Instances

AODV-RPL Version 16; description of important changes

- Version 16 published on Feb 2023
 - Addressed John Scudder readability discuss: comments
 - Addressed Ben Kaduk protocol discuss: comments
 - Addressed Pascal's and Konrad's reviews.
- Changes v15 \Box v16:
 - Citations provided to support claims of routing improvement
 - Rank function does not necessarily involve costs to/from root
- Changes v14 \Box v15:
 - Multiple interfaces treated as independent interfaces
 - We do not specify selection of symmetric vs. asymmetric

WGLC - Directorate reviews

- WGLC concluded March 11
- Routing Directorate Review:
 - Open Issues: <u>https://github.com/roll-wg/aodv-rpl/issues/6</u>
 - Request for more terminology (OF, RREQ, RREP, ...)
 - Better description for "associating" Instances, handling errors
 - Always select the most recent Sequence number
- Security Review done for version 10



• Address the Routing Directorate Review, after that submit to the IESG.

Discuss draft-ietf-roll-dao-projection

Goal of draft-ietf-roll-dao-projection

- Goal:
 - The RPL Root can install and maintain Projected Routes (P-Routes) within its DODAG for a chosen duration.
 - The specification expects that the main DODAG is operated in Non-Storing Mode. The Root knows the whole DODAG Topology (parent-child relationship), thus, this draft add the capabilities of the nodes to advertise additional sibling information to complement the awareness of the Root. ´→ Root inform to the PCE → PCE can build better paths that traverse those siblings.
- Extends RFC 6550, RFC 6553 and RFC 8138

- To enable the Root to install "East-West" routes inside a DODAG that is operated in Non-Storing Mode.
 - Projected DAO (P-DAO)
 - Projected DAO ACK (P-DAO-ACK)
 - Via Information Option (VIO)
 - Sibling Information Option (SIO)
 - P-DAO Request (PDR) and P-DAO Request Acknowledgment (PDR-ACK)
 - Amending the RPI
 - Additional Flags in the RPL DODAG Configuration Option

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 - Projected DAO (P-DAO)
 - Projected DAO-ACK
 - Via Informa
 - Sibling Info
 - P-DAO Req
 - Amending t
 - Additional F

The root issues a P-DAO message to the track ingress, that contains new Via Information Option that installs a strict or loose sequence of hops (P-Route) to form a Track Segment or a Track Lane

- To enable the Root to install East-West routes inside a DODAG that is operated in Non-Storing Mode.
 - Projected DAO (P-DAO)
 - Projected DAO ACK (P-DAO-ACK)
 - Via Information Option
 - Sibling Information option
 - P-DAO Request
 - Amending the RPI
 - Additional Flags in the RPI

The P-DAO Destination node issues a P-DAO Acknowledgment message

- To enable the Root to install East-West routes inside a DODAG that is operated in Non-Storing Mode.
 - Projected DAO (P-DAO)
 - Projected DAO-ACK
 - Via Information Option (VIO)
 - Sibling Information option
 - P-DAO Requ
 - Amending the
 - Additional F

Extends the Control Message Option to create new objects called VIO.

A VIO signals the sequence of nodes to be followed:

SM-VIO: installs a strict hop-by-hop P-Route called a Track Segment

NSM-VIO: installs a loose source-routed P-route called a Track Lane

- To enable the Root to install East-West routes inside a DODAG that is operated in Non-Storing Mode.
 - Projected DAO
 - **Projected DAO-** Extends the Control Message Option to create the sibling information Option
 - Via Information Option
 - Sibling Information Option (SIO)
 - P-DAO Request
 - Amending the RPI
 - Additional Flags in the RPL DODAG Configuration Option

The set of RPL Control messages is extended to include the PDR.

- To enable the Ro The PDR enable a RPL Aware Node to request the establishment of a Track between Non-Storing Moc itself (Track Ingress) and other node (Track Egress).
 - Projected The node makes its request to the Root sending the PDR, which confirm with the PDR ACK
 - Via Information Option
 - Sibling Information optio
 - P-DAO Request (PDR) and P-DAO Request Acknowledgment (PDR-ACK)
 - Amending the RPI
 - Additional Flags in the RPL DODAG Configuration Option

The draft amends RPL to create a new flag that signal that a packet is forwarded along a P-Route.

- To enable the F Non-Storing Mo
 - Projected
 - Projected
 - Via Information Option
 - Sibling Information of
 - P-DAO Request
 - Amending the RPI
 - Additional Flags in the RPL DODAG Configuration Option

Projected-Route 'P': 1-bit flag. It is set to 1 in the RPI that is added in the encapsulation when a packet is sent over a Track. It is set to 0 when a pocket is forwarded along the main DODAG.

- To enable the F
 Non-Storing Mc
 - Projected
 - Projected

- The draft amends RPL to define a new flag Projected Routes Support "D"
 - It is set to 1 to indicate that this spec is enabled in the network and that the F will install the requested tracks when feasible upon a PDR message.
 - It is set to 0 in legacy implementations
- Via Information Option
- Sibling Information option
- P-DAO Request
- Amending the RPI
- Additional Flags in the RPL DODAG Configuration Option



- The RPL Option carries RPL Information in Data-plane Datagrams.
- This specification Amends the RPL Option (RPI) to encode the Projected-Route 'P' flag

- Introducing a new 6LoRH (6LoWPAN Routing Header), the 'P-RPI-6LoRH' that can be used in either Elective (can be ignored and skipped when the router does not understand it) or Critical (packet is dropped when the router cannot process it) 6LoRH form.
- The P-RPI-6LoRH is designed to compress the RPI along RPL P-Routes.

Status

- WGLC passed
- Currently in Review of Routing Directorate
- Security Directorate: Ready
- Next Step: Submission on the IESG after the Routing Directorate review

Discuss draft-ietf-roll-nsa-extension

Status

2022-03-17: AD review done

2021-03-10: submitted to IESG for publication

2023-03-16: returned to WG 2023-03-27: IESG state Dead, draft expired

• Authors

- Aris taking on the challenge of getting the draft through publication
- Pascal willing to help, but was not lead author
- Georgios limited availability
- Next Step?

In a nutshell

- In their DODAG Information Option, RPL routers advertise the Node State and Attribute object including a new TLV, that contains a list of their parents
- A new Objective Function, called Common Ancestor (CA), allows RPL nodes to pick their parents based on the advertised (grand-)parent set.
- Allows for controlled Packet Replication and Elimination through forwarding to a few parents

$$(W) (X) (Y) (Y) (Z) PP(A) = X$$

$$| \langle // | \langle // || \langle /| PP(B) = Y$$

$$| // | // || /| || PP(B) = Y$$

$$| // | // || /| || PP(B) = Y$$

$$| // || /| || /| || PP(B) = Y$$

$$| // || /| || /| PP(C) = Y$$

$$| PP(C) = Z$$

$$| Preferred Parent$$

$$| Potential Alt.$$

Specification

• Specifies the Parent Set (PS) TLV of the DAG Metric Container (RFC6551)

- Specifies the new CA Objective Function as a text delta to the MRHOF (RFC6710) OF
 - Selection of alternate parent is based on advertised Parent Set
 - Actually 3 CA policies (strict, medium, relaxed), choice up to the node
 - Computation of Rank is unchanged compared to MRHOF

Implementation

• Was implemented in Contiki OS

https://github.com/ariskou/contiki/tree/draft-koutsiamanis-roll-nsa-extension

- Wireshark dissector
- Tested on Cooja simulator

- Other use-cases beyond PRE? Load-sharing, ...? Draft should not be centered on PRE
- Terminology comments
- Pros/cons of each CA policy
- What to do if tie between several Alt. Parent candidate based on CA policy?
- Overhearing is alluded to, not quite explained
- Preferred parent selection
- Formally extending RFC6719?
- path ... SHOULD be set to MAX_PATH_COST: why SHOULD? What happens otherwise?

- Address comments by Alvaro in his AD review
- Republish updated draft within 3 weeks (Aris)
- Then go through WGLC, etc.

Discuss draft-ietf-roll-rnfd

Status

2022-05: discussed at interim 2022-10: republished, questions from interim answered on ML

2022-03: adopted by WG

2021-04: first publication (individual draft)

- Consensus on need for fast border router failure detection
- Next steps
 - does the WG believe that the current solution is adequate?
 - issue WGLC, submit for publication?

- A set of DODAG root's neighbors (Sentinels) monitors the DODAG root's status
 - "UP", "SUSPECTED DOWN", "LOCALLY DOWN" or "GLOBALLY DOWN"
- Other nodes count the number of Sentinels that believe the Root to be "UP" or "DOWN"
- Other nodes only know two states: "UP" or "GLOBALLY DOWN"
- "GLOBALLY DOWN" is a terminal state, nodes stop routing in the current DODAG (no parent, INFINITE_RANK) and will only join a new DODAG instance
- All nodes exchange Positive Counter and Negative Counter in a DODAG Information Option (DIO) extension
- Counters are merged along the DODAG: conflict-free replicated counters (CFRCs)

Specification

• Specifies a new DIO option (see RFC6550): RNFD option

- Recommends allocating a separate Trickle timer for sending the RNFD option
- Specifies the CFRC operations, thresholds, etc.

1. What happens when Sentinels don't hear each other? Does the algorithm detect the crash of the root?

Yes, the decision is made not only by Sentinels but all nodes. There is no requirement for the Sentinels to form a connected graph. In other words, if there is any path connecting the sub-DODAGS of the individual Sentinels and enough individual Sentinels consider the root as down, the entire network will eventually come to a decision that the root has crashed.

2. What if most of the direct links to the root fail but the root is in fact alive?

If most of the direct links to the root fail, then Sentinels monitoring those links will consider the root as dead. Since the root takes part in the communication, it will be aware that the number of such Sentinels increases. It will react by initiating a new DODAG version.

3. Is rebuilding the DODAG in such a case desirable?

If the majority of links to the root that have once formed a DODAG are currently down, then the DODAG should probably look different than for the network with those links up. Rebuilding the DODAG, at least in my opinion, makes a lot of sense in such a case. Furthermore, the threshold describing how large the majority is is configurable. Depending on whether one wants to prioritize speeding up root failure detection or slowing down DODAG rebuilding, different values can be chosen.

4. Why can't Sentinels ask the root whether it is dead?

In fact they do. If a Sentinel observes that an increasing number of other Sentinels considers the root as dead, it may perform verification by trying to contact the root via a direct link.

Implementations

- One implementation by Konrad's team
- Publicly available?

Consensus call

- Is the current solution adequate?
 - Pascal: communication between Sentinels goes around Root. Why not ask the Root directly?
 - Konrad: a suspecting Sentinel can always probe the Root (not part of this draft) to make its opinion
- Further comments/discussions to be had before WGLC?

Discuss draft-ietf-roll-mopex

Mode of Operation extension

- RPL operates with a given "Mode of Operation" (MOP) determining the minimum and mandatory set of primitives to be supported by all the participating nodes.
- The 3-bit value is already exhausted
- This document reserves the existing MOP value 7 to be used as an extender. DIO messages with an MOP value of 7 MUST refer to the Extended MOP (MOPex) option in the DIO message.
- Next for WGLC:
 - Rtg Review
 - Security Review
 - Shepherd document
- Voluntary for reviewing the document?



AOB