RNFD: Fast border router crash detection in RPL

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Adopted end of February 2022
Why consider LBR crashes?

An LBR:

- plays a central role in an LLN (DODAG root),
- is typically more involved than a constrained node,
- usually requires a tethered power supply (hard to back up in many deployments).
DODAG Root Failure in RPL
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What happens in practice under an LBR crash?

- Some RPL stacks (with major bugs) enter a chaotic state in which an LLN simply collapses: explosion in control traffic.

- Some others (with minor bugs) do not detect the failure (in reasonable time): node ranks grow unbounded; control traffic is heavier than normally.

- Some are correct but still they require considerable:
  - time and
  - traffic.

to handle an LBR crash.
What happens in practice under an LBR crash?

- All links to the dead LBR have to be detected as down by the LBR's neighbors.
  - Otherwise, the LBR's neighbor with such a link may incorrectly advertise a valid path.
- Link crash detection is typically reactive:
  - In low-data-rate applications, it may take a while.
- Learning by all nodes that none of their links may contribute to a path to the LBR is slow and requires traffic:
  - repeated parent changes due to local repair attempts,
  - routing loops due to inconsistencies between nodes,
  - Trickle timer resets upon parent changes and loop detection.
RNFD Goals

- **RNFD = Root Node Failure Detector**
- Goal: to minimize
  - time and
  - traffic
required to detect a crash of an LBR (a DODAG root).
- Possible empirical improvements:
  - time = a few times, an order of magnitude less,
  - traffic = a few times less.
RNFD Design Principles

• Explicitly coordinating LBR monitoring between nodes.
• Avoiding probing all links to the dead LBR.
• Proactive checking for a possible LBR crash when some nodes suspect such a failure may have taken place.
• Maximizing independence of RPL.
Node Roles in RNFD

- **Sentinel** – DODAG root's neighbor that monitors the DODAG root's status.
  - There are typically multiple of them.
  - Not every neighbor of the root has to be Sentinel.
- **Acceptor** – any node that is not Sentinel and only accepts their observations.
  - The DODAG root itself is also Acceptor.
Node Roles in RNFD

Possible Sentinels
Principal Ideas behind RNFD

• Individual sentinels detect crashes of their links to the DODAG root.

• This information is exchanged in a new option in link-local RPL messages (DIOs and DISs).

• Based on the number of sentinels having their links with the DODAG root down, all nodes consent that the DODAG root has crashed.
Status of the draft

• Adopted by the WG, after a fruitful discussion, at the end of February / beginning of March 2022:
  – The topic is important.
  – The solution need not be the final one.

• Next steps?
  – Michael’s suggestion: Adopt as is as Experimental Draft.
  – Pascal’s earlier remarks about possibility of using DODAG root for the coordination of the detection process.
  – ?