Efficient and Guaranteed Routing in Wireless Sensors Networks

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DRAKKAR - Systèmes Répartis, Calcul Parallèle et Réseaux

The Constraints in a Wireless Sensors Networks

- The routes
  - **Creation** — how to compute them?
  - **Reliability** — the problem of loops
  - **Maintenance** — it's a dynamic problem
- The network
  - **Losses** — temporary perturbations
  - **Saturation** — low traffic load
  - **Variability** — changing environment
- The platforms
  - **Energy** — battery-powered
  - **QoS** — not reliable in time
  - **Asymmetry** — not exactly the same devices

A routing protocol, at a time light, reliable, and tolerant?

The Lightweight Routing Protocol (LRP)

Collection Tree — traffic extraction out of the network

- Distributed Bellman-Ford (Fig. 1)
  - **Sequence number** (temporal indication) ; **metric** (link cost)
- Avoid loops in the tree
  - **Never go backwards** (get rid of count-to-infinity situations)
- Tree maintenance
  - **Global** repair (sink initiative) *v.s.* **local** repair (host initiative, *cf.* Fig. 2)

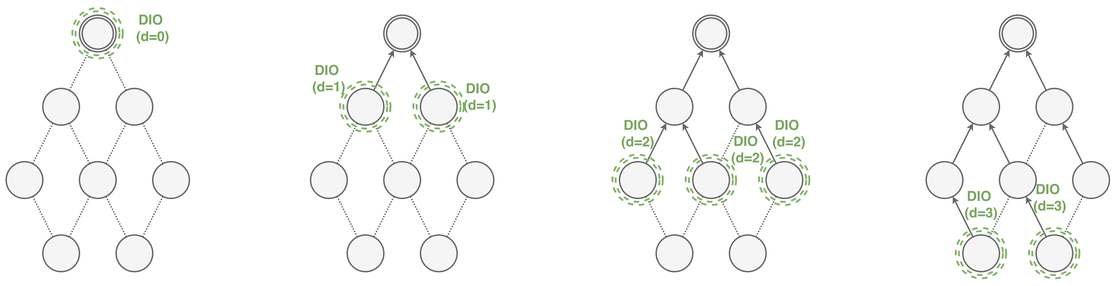


Figure 1: Collection tree construction using the Bellman-Ford algorithm. This mechanism is used in global repair, by the sink (highest node).

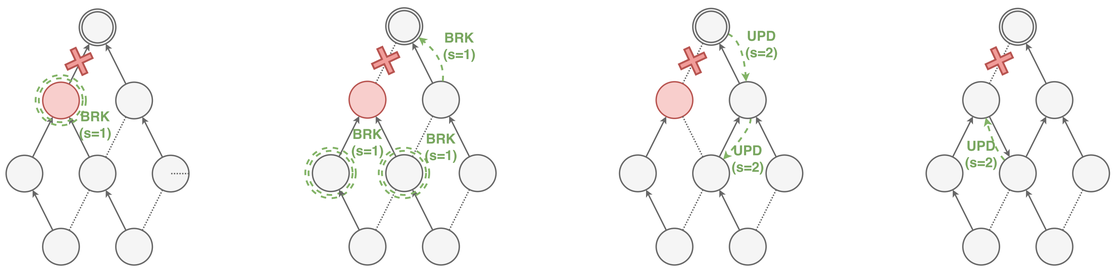


Figure 2: Local repair, after a link was lost. The detached node will reverse a link to one of its predecessors, to be able to reach the sink again.

Host Routes — traffic distribution inside the network

- Host route establishment (Fig. 3)
  - **Proactively** — host initiative, spontaneous creation
  - **Reactively** — sink initiative, looking for the host
- Avoid the loops when routing
  - **Detection** — more and more precise routes (Fig. 4)
  - **Elimination** — whole destruction to the sink

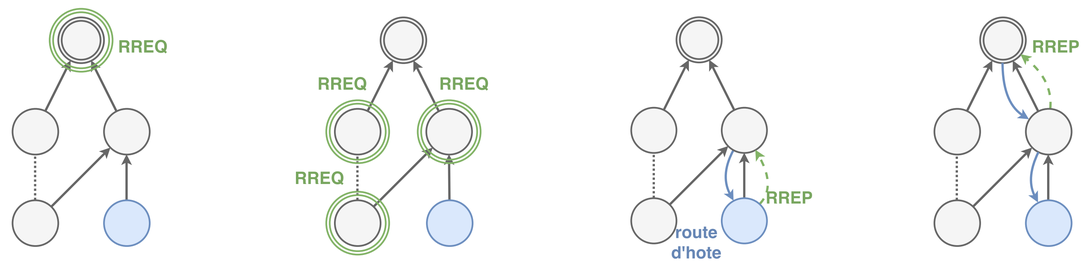
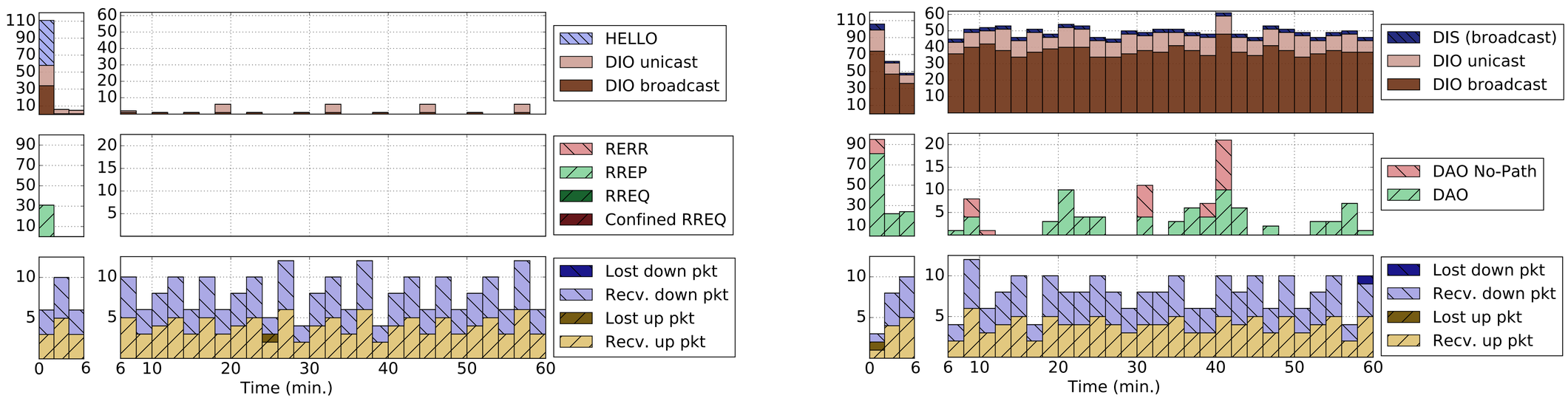


Figure 3: Host route establishment. Looking for the host into the network; then host route establishment. When a host proactively builds its host route, only the two last steps occur.

Figure 4: Routing loop detection. In the last case, the node should use a route which is less precise than the previous one, that is forbidden.

Experimentations — FIT IoT-lab



(a) LRP **(b)** RPL

Figure 5: Messages exchanged between 12 nodes, one among them is deaf (it does not receive the other's messages). A comparison is done between LRP and RPL (RFC 6550). RPL handles this problem very badly.

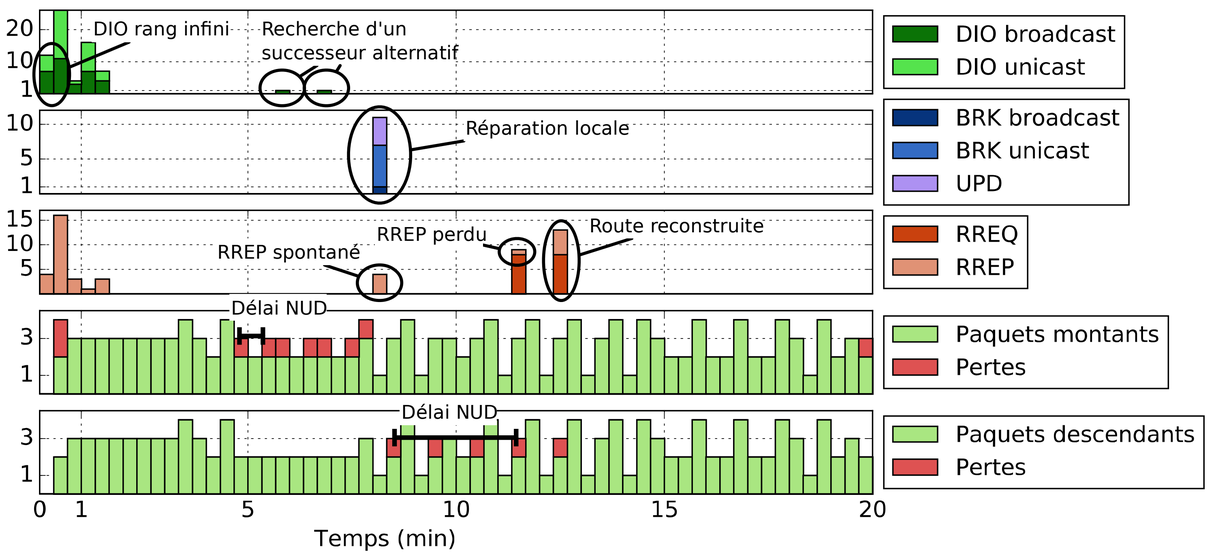


Figure 6: Messages exchanged between 10 nodes. At 4'30, a node among them is shut down.

And now?

- Improve **metric**
  - A **local problem**... — which measure is important?
  - ...and a **global problem** — local choices influence the whole tree
- Use many **prefix sizes** — only one route for many hosts
  - By aggregating routes? Not efficient for random addresses...
  - With a subnet? Not really ad-hoc...
- Use a **backbone** to lighten nodes
  - How sinks may cohabit on the same network?
  - How to ensure connectivity even if backbone is not audible?