Budapest University of Technology and Economics

HSN Lab

A Simple Neighbour Discovery Procedure for Bluetooth Ad Hoc Networks

Authors:

Miklós Aurél Rónai, Eszter Kail

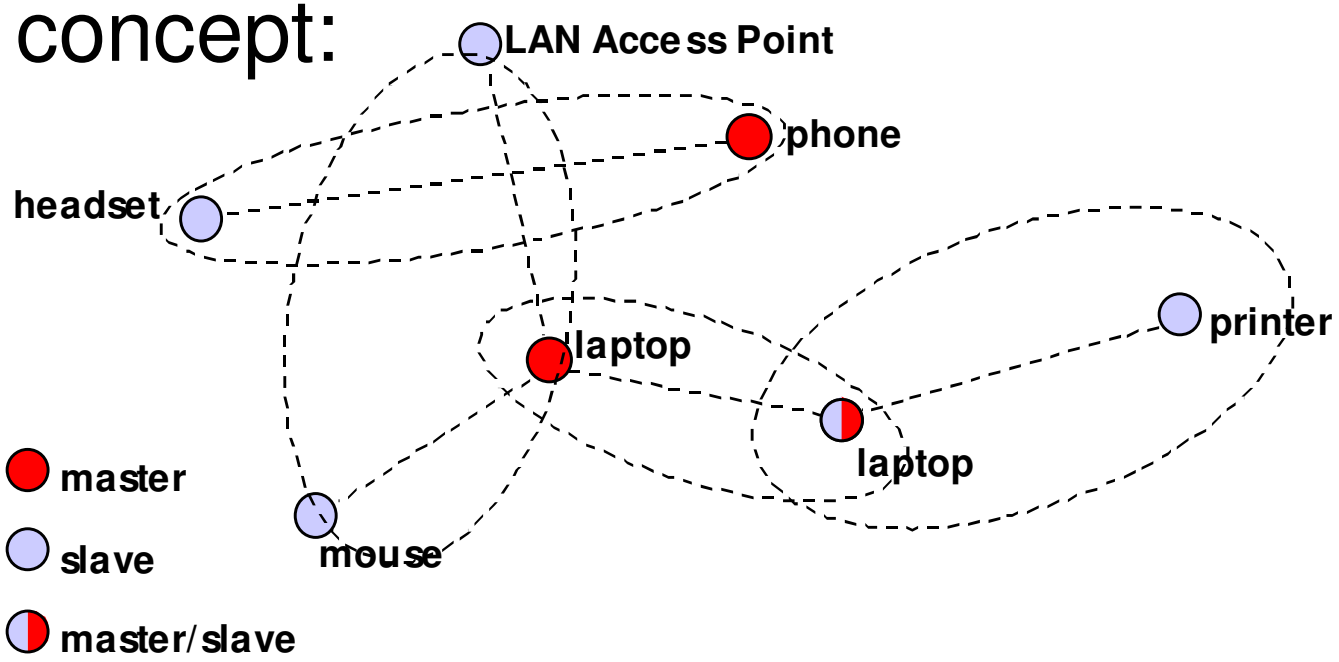
BUTE, High Speed Networks Laboratory

Overview

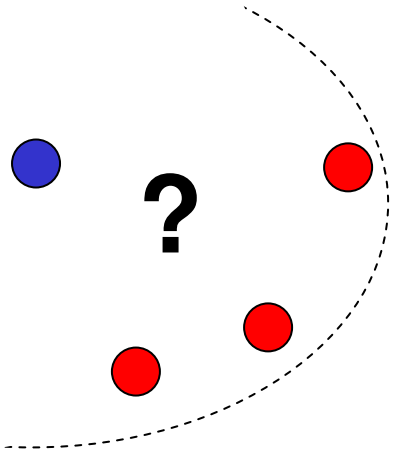
- Bluetooth & Neighbour Discovery
- Inquiry procedure
- Simple Neighbour Discovery (SND)
- Comparison of SND and Inquiry
- Analysis of SND
- Conclusion

Bluetooth

- Piconet concept:

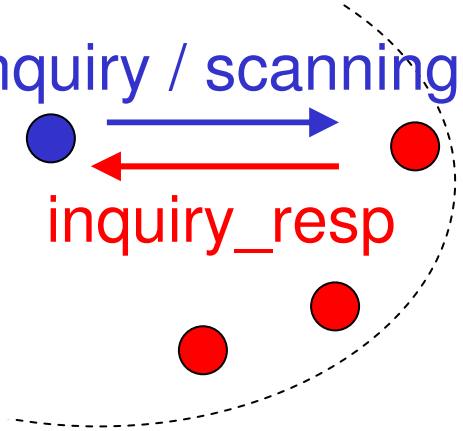


- Neighbour discovery:
  - Called inquiry in Bluetooth;
  - Find other nodes in radio range;
  - Refresh information about nodes

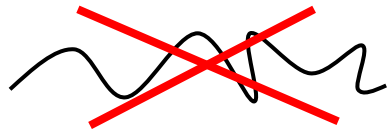


Bluetooth inquiry

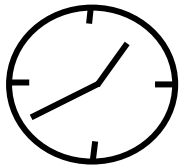
- Mechanism:
  - One node sends inquiry message;
  - Other nodes reply with inquiry_response;



- Features:
  - Primarily designed for cable replacement;
  - Discovers all devices in fixed time;

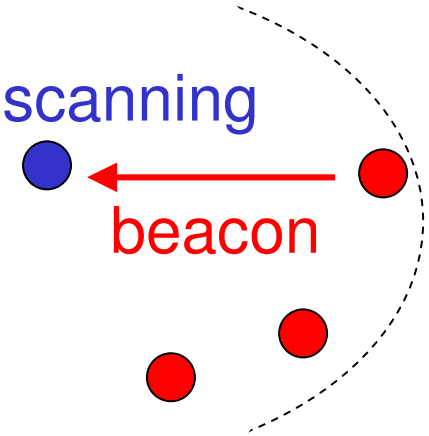


- Drawbacks in ad hoc scenario:
  - Takes lot of time;
  - Complex (Inq, Inq_scan, Inq_resp);
  - Inefficient with parallel data transmissions;
  - Nodes play asymmetric roles



Simple Neighbour Discovery Proc.

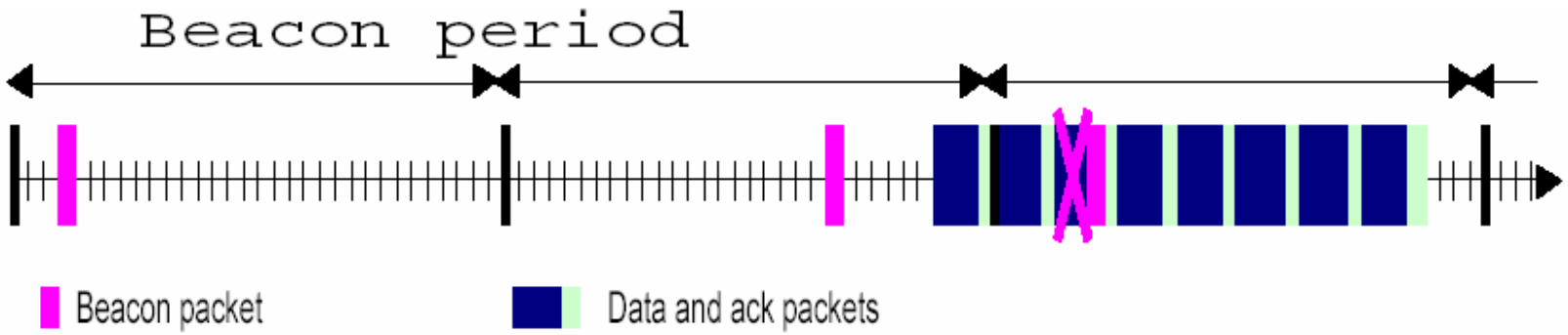
- Mechanism:
  - nodes **send beacon** packets regularly;
  - nodes perform **scanning** for beacons;



- Differences between SND and inquiry:
  - **symmetric** roles (all nodes perform both scanning and sending beacons);
  - nodes that want to be discovered send messages;
  - performed when data communication allows

SND details: sending beacons

- Sending beacons
  - **Beacon period** (parameter) -> how often send beacons;
  - **Timeslot** inside the period and radio **frequency** chosen **pseudo-randomly** from the clock and address of the node -> other nodes can take it into account;
  - **Priority** over base band data packets;
  - **32** frequency is used from 79;
  - beacon is **one slot** long

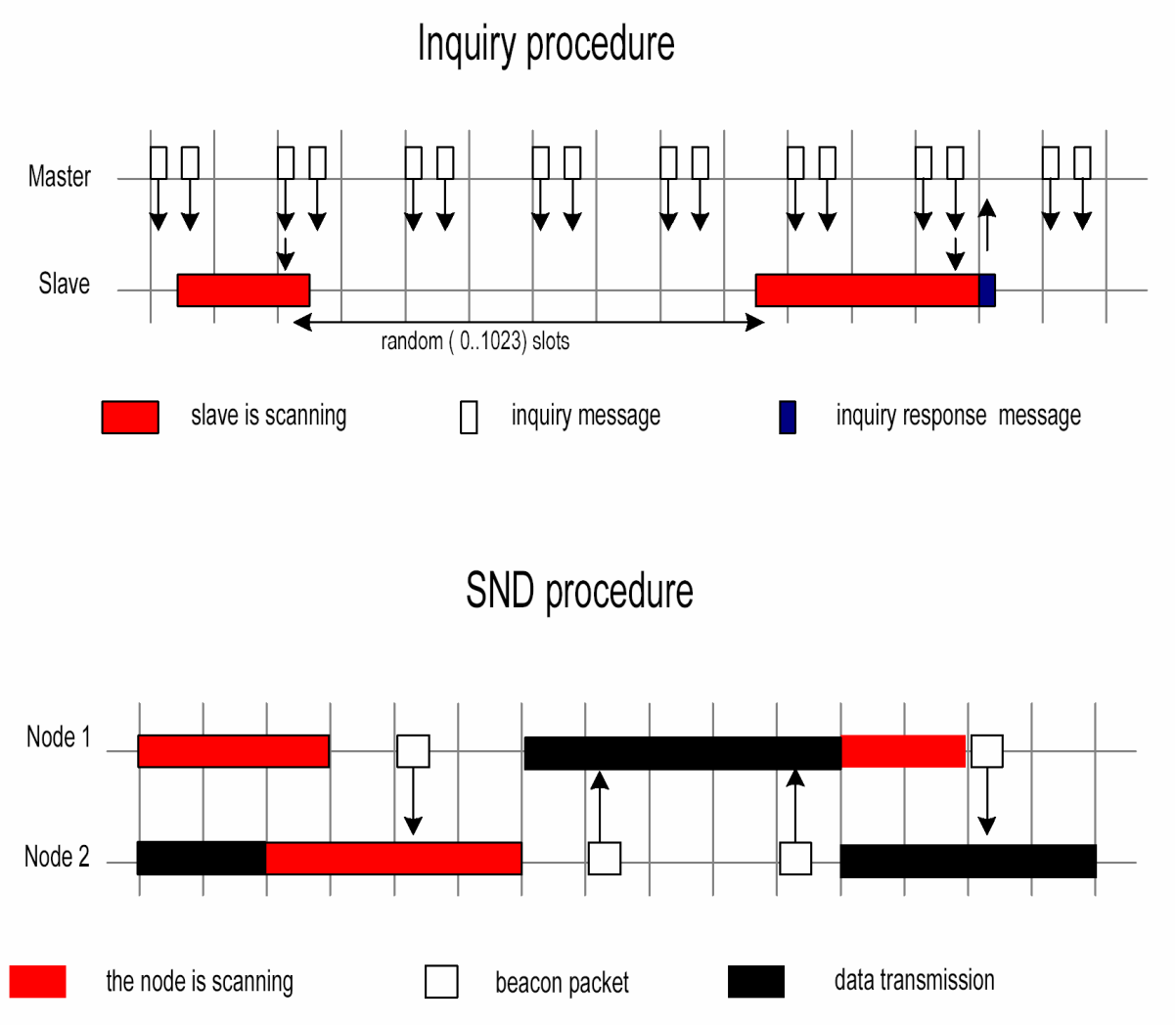


SND details: scanning

- Scanning for beacons:
  - **Scan period** – tunable parameter;
  - Scanning **frequency randomly** selected;

- Beacon packets contain:
  - clock;
  - address;
  - beacon period length of the node

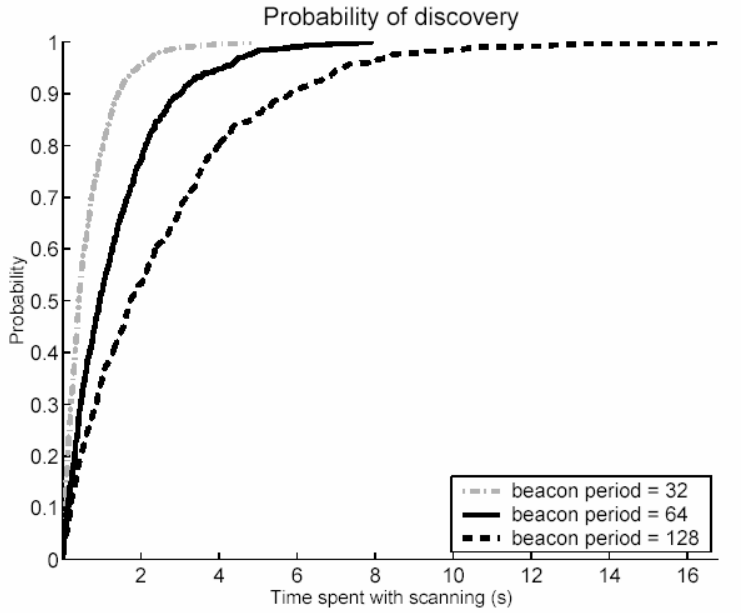
Comparison of SND and inquiry

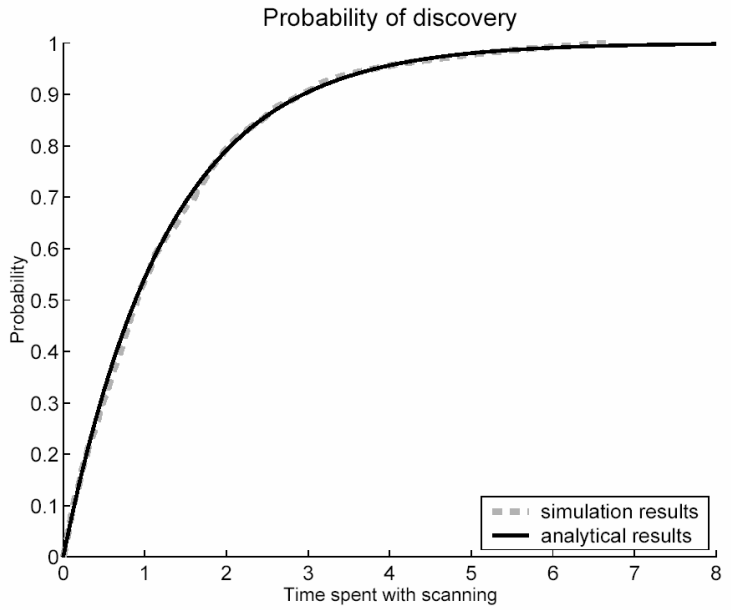


Simulation results

- Plasma: discrete, event driven simulator
- Results:
  - Probability of discovery vs. time spent with scanning
  - Analytical results

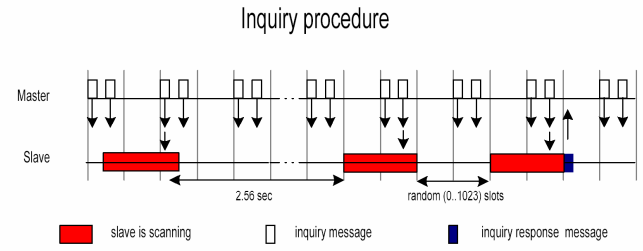
$$P_{disc} = 1 - e^{-P_1 \frac{T_{tot}}{T_{BCN}}}$$

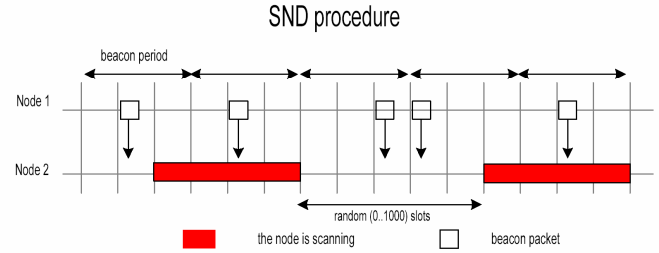


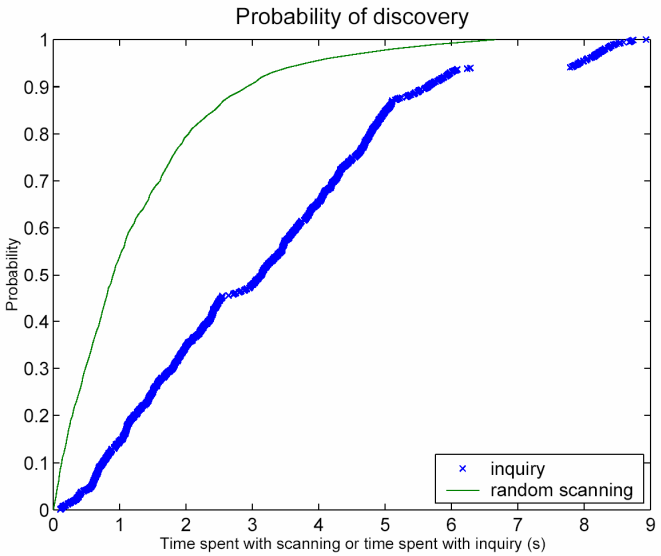


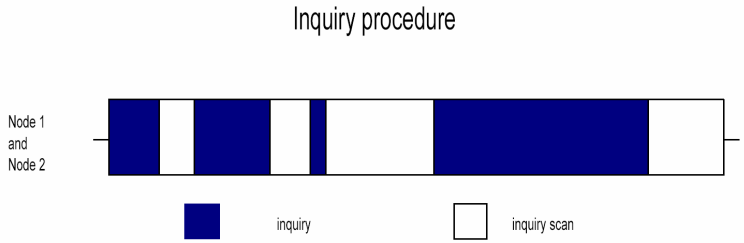
Comparing SND and inquiry

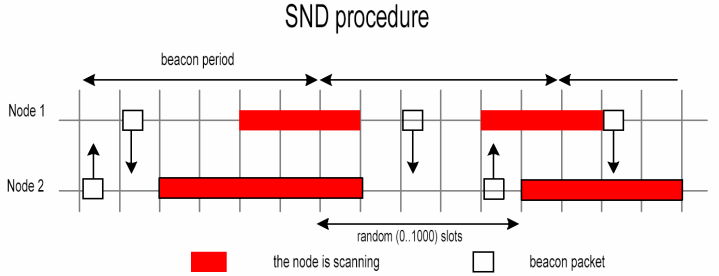
Asymmetric roles

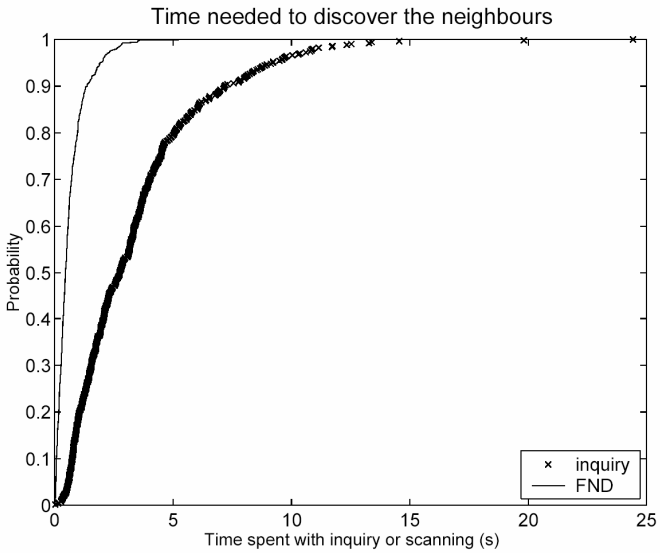












Symmetric roles

Conclusion

- Proposing SND in ad hoc scenarios
  - Assumes **symmetric** roles;
  - **Better fits** to data transmissions;
  - **Configurable** - discovery time vs. overhead (power consumption);
  - **Simple**
- Discovery time depends on the **total time spent with scanning** and not depends on time between scanning periods;
- SND can be performed **faster** than inquiry

Thank you!

Questions?

Formulas

$$T_{SCAN} >= 2T_S$$

$$T_{SCAN} < T_{BCN}$$

$$P_1 = \left(\frac{1}{N_{BCN}}\right)\left(1 - \frac{2T_S}{T_{bcn}}\right)(1 - P_{err}),$$

$$P_{disc} = 1 - \left[1 - \frac{T_{SCAN}}{T_{BCN}} P_1\right]^{\frac{T_{tot}}{T_{SCAN}}}$$

$$P_{disc} = 1 - e^{-P_1 \frac{T_{tot}}{T_{BCN}}}$$

Periodic vs. random scanning

- Scanning periods chosen:
  - Periodically
  - Randomly