The P2P-RPL Routing Protocol for IPv6 Sensor Networks: Health Applications

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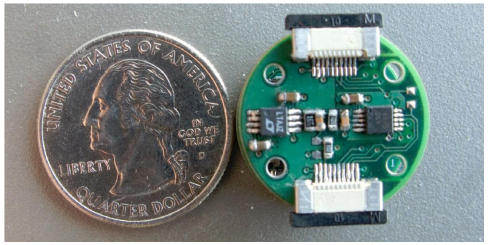
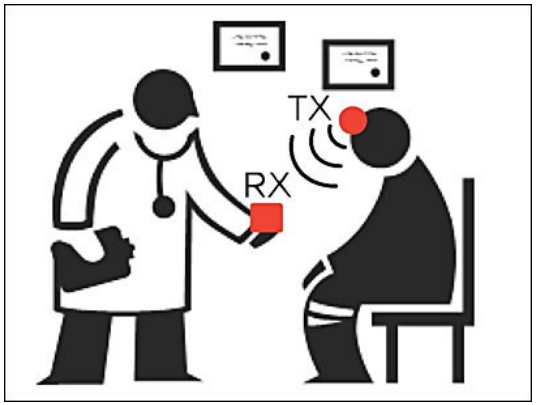
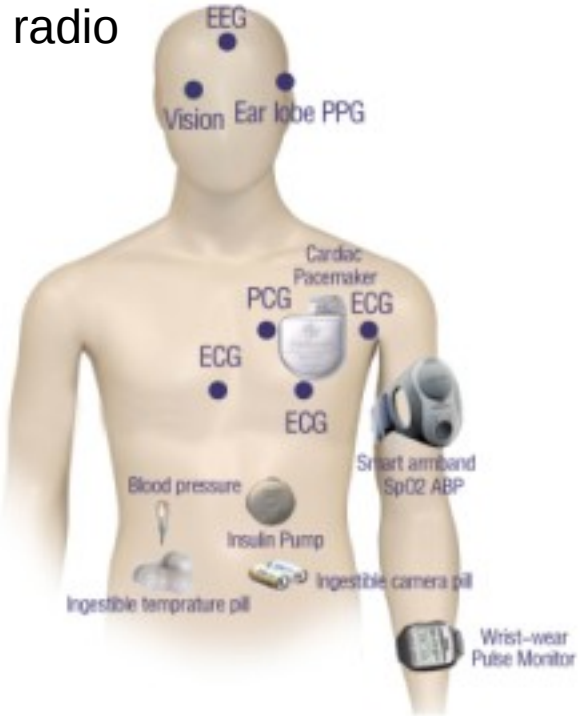
Introduction

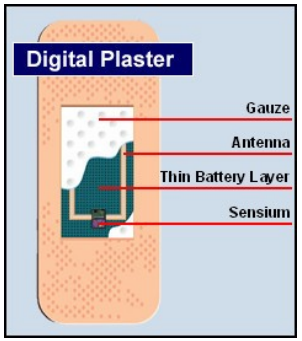


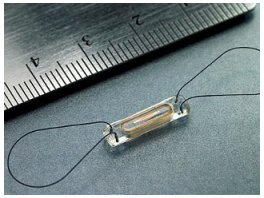


- Wireless sensor networks are a key element in the upcoming Internet of Things
  - Low power and lossy networks (LLNs)
- Large number of devices, interconnected via radio
  - Small form-factor, cheap
  - Limited resources (CPU, memory, energy)



- Health care applications:
  - Body Sensor Networks (temperature, blood pressure, glucose, EKG,EEG, etc.)
  - Assistance with motor and sensory decline
  - Long-term monitoring at home
  - Smart implants

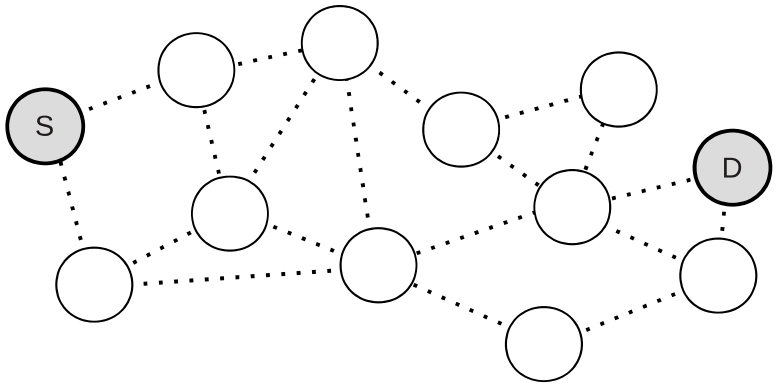


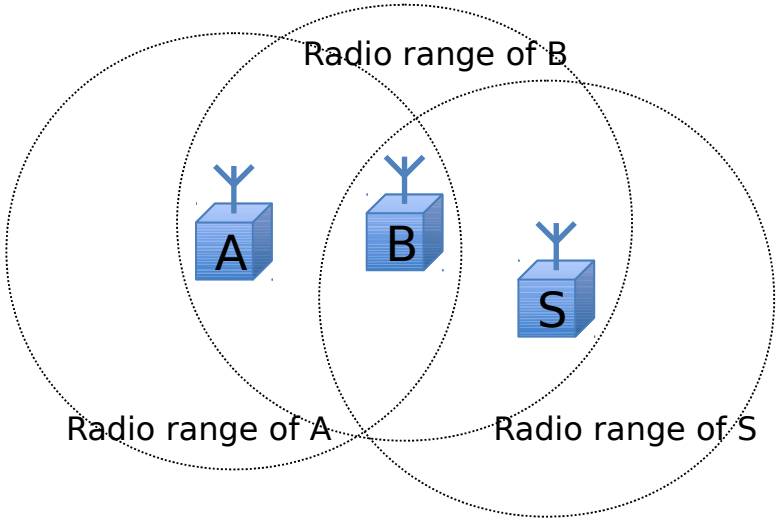


Routing in Low Power Lossy Networks

- Low power radio devices have limited energy and radio range
  - Data needs to be forwarded over multiple hops

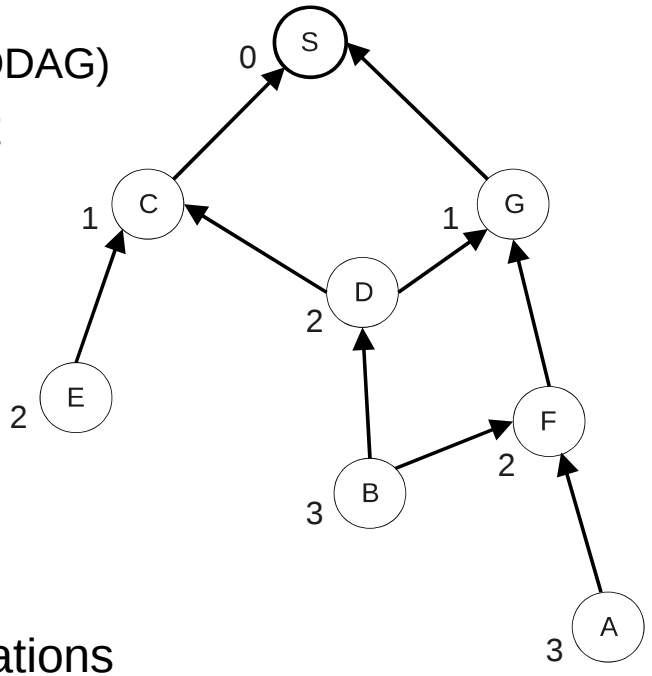
- Routing: find the shortest (best) path from S to D
- Algorithms constrained by hardware limitations
  - Minimize transmissions, calculations, and memory usage
  - While being fast, accurate, and robust against packet loss





RPL: Routing Protocol for LLNs

- Routers are organized along a Destination Oriented Directed Acyclic Graph (DODAG)
- Sink node originates DODAG Information Object (DIO) messages
  - Sent via link-local multicast
  - Contain rank information (depth in the DODAG)
- Routers chose those neighbors as parent that result in smallest rank

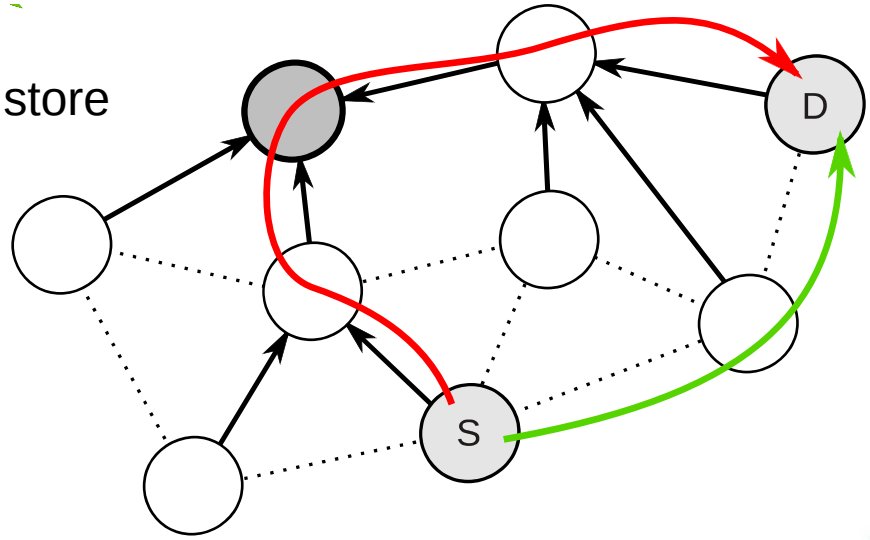


- DIO transmission follows Trickle policy
  - Monitor information consistency between neighbors
  - Exponentially slow communication rate if information (i.e. rank) is consistent
- Downward-paths needed by many applications
  - Periodic Destination Advertisement Object (DAO) messages

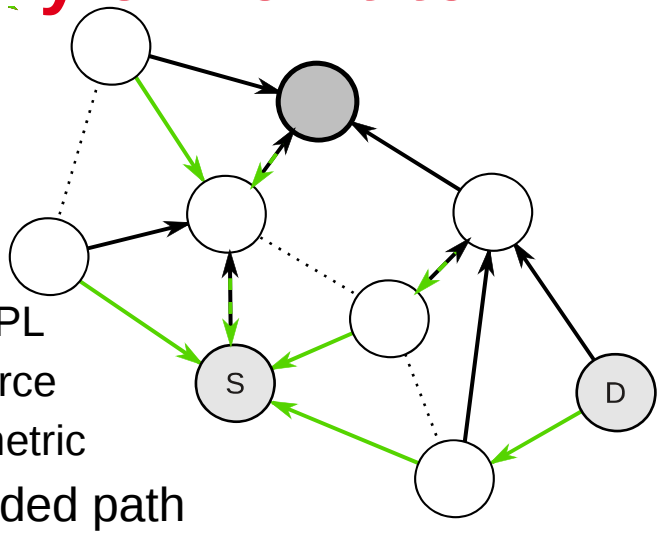
RPL Tradeoffs

- Only indirect routes between arbitrary router pairs
  - Through the sink (non-storing mode)
  - Through the first common ancestor (storing-mode)
- Resulting paths are longer than shortest available
- Likely traffic congestion near DODAG root

- Pro-active nature of RPL not suitable for reactive applications
- High memory requirements to store routes that are not needed



P2P-RPL: Reactive Discovery of Point-to-Point Routes with RPL

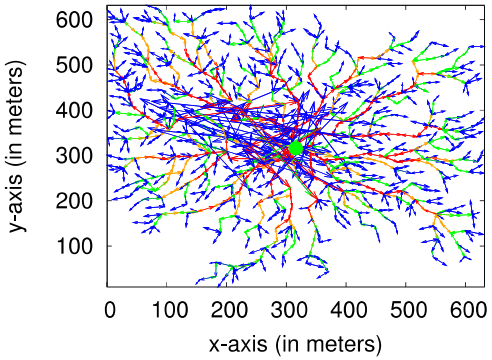


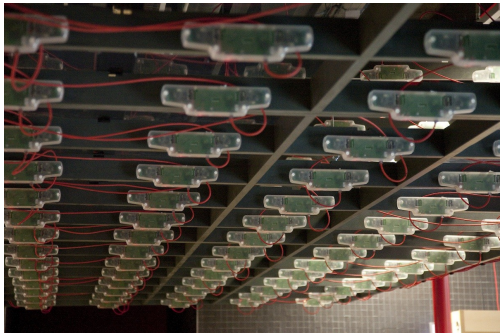
- Source initiates route request
  - Piggy-backed on DIO messages
  - Uses Trickle-based dissemination from RPL
  - Creates temporary DODAG rooted at source
  - DIO records traversed routers and path metric
- Destination sends route reply along recorded path
  - Destination checks whether route complies with metric constraints
  - Destination may send multiple replies for different paths
  - Reply message establishes routing state for hop-by-hop route or returns source route
- Temporary DODAG expires

- Implemented for Contiki operating system
  - Provides IPv6 stack with 6LoWPAN and implementation of basic RPL

Evaluation of P2P-RPL

- Currently standardized by the Internet Engineering Task Force (IETF)
- Extensive simulation studies and testbed experiments
  - Comparison with DODAG-based routing in RPL





- P2P-RPL provides considerably shorter paths
  - Factor 2 (small networks), up to factor 15 (large networks)
  - Decreases delay and overall energy consumption
- P2P-RPL significantly reduces traffic density at the root
  - Factor 4 – 5 (small networks)
  - Prevents congestion and imbalanced battery drain around the root

Conclusion

- P2P-RPL provides efficient routing in wireless sensor networks
  - Future Internet standard, IPv6
- Health care may benefit from wireless sensor networks in many applications, e.g:
  - Wireless monitoring of vital signs
  - Assistance with motor and sensory decline
  - Smart implants

- Future work:
  - Continue standardization towards RFC
  - Evaluation in further application scenarios (e.g. health care)
  - Compare to other reactive protocols e.g. AODV

Thank You!

Questions?

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