Virtual ring routing

Some slides from http://research.microsoft.com/en-us/um/people/antr/rrr-sigcomm06.ppt
VRR: the virtual ring

topology-independent node identifiers, e.g., MAC address

each node maintains a virtual neighbor set (vset)

nodes organized into virtual ring by increasing identifier value
VRR: routing paths

nodes only maintain paths to virtual neighbors:
• vset-paths are typically multi-hop
• vset-paths are maintained proactively
VRR: forwarding table

<table>
<thead>
<tr>
<th>endpointA</th>
<th>endpointB</th>
<th>nextA</th>
<th>nextB</th>
<th>pathId</th>
</tr>
</thead>
<tbody>
<tr>
<td>8F6</td>
<td>90E</td>
<td>ME</td>
<td>F42</td>
<td>31</td>
</tr>
<tr>
<td>910</td>
<td>8F6</td>
<td>10E</td>
<td>ME</td>
<td>10</td>
</tr>
<tr>
<td>14A</td>
<td>140</td>
<td>F42</td>
<td>10E</td>
<td>2</td>
</tr>
<tr>
<td>8F6</td>
<td>F42</td>
<td>ME</td>
<td>F42</td>
<td>FF</td>
</tr>
</tbody>
</table>

forwarding table for node 8F6

- vset-paths recorded in forwarding tables along path
- forwarding table contains
  - vset-paths between node and vset members
  - vset-paths between other nodes that go through node
  - paths to physical neighbors
VRR: forwarding

• forward message destined to $x$ by
  – picking endpoint $e$ numerically closest to $x$
  – forwarding message to next hop towards $e$
• deliver message to node with id closest to $x$

• how does this work?
  – can find $x$ because nodes are connected in a ring
  – low stretch because of additional forwarding state
  – many alternate paths to route around failures
VRR: example routing

physical network Topology
VRR: example routing

physical network Topology

there may be some stretch
Node joining

broadcast hellos to find physical neighbors

send setup request to 16E (itself) through proxy (19A)
Node joining

16E sends setup requests to nodes in received vset

164 sends setup to 16E with its vset

16E adds node to vset when it receives setup
Size of routing table

- Assume the nodes are randomly placed, each vpath
Simulation experiments in ns-2

• ran experiments with 802.11b MAC
• varied network size, mobility, session lifetime
• compared with DSDV, DSR, and AODV

• VRR performed well in all experiments
  – high delivery ratios even with fast movement
  – significantly lower delays with route instability
Delivery ratio: fast movement
Delay: fast movement

![Graph showing delay vs number of nodes for different routing protocols: DSDV, DSR, AODV, VRR.](image)

- Delay (seconds)
- Number of nodes
- DSDV
- DSR
- AODV
- VRR
Sensor network

• sensor network testbed
  – 67 mica2dot motes in UCB building
• comparison with BVR
• delivery ratio with mote failures
Sensor network: mote failures

![Graph showing the number of nodes and the percentage of packets delivered over time. The graph has three lines: one for the number of nodes, one for VRR delivery ratio, and one for BVR delivery ratio. The number of nodes decreases over time, while the percentage of packets delivered remains relatively stable.](image)
Wireless office testbed

- 30 machines running windows
- communicate using 802.11a
- throughput comparison with LQSR using ttcp
Wireless office testbed: throughput
Why a virtual ring?

- Alternatively, use an Euler tour to define coordinates on the sensor nodes.
  - An Euler tour is a cycle that visits every vertex.
  - Can be constructed by a depth-first tour on a spanning tree.
  - Also use shortcuts for greedy routing.