Multihop wireless networks

Adhoc / fixed mesh.

Key issues: routing and forwarding

Challenge: performance issues

Broadcast $\Rightarrow$ contention

Losses

Reliability $\rightarrow$ not an issue in fixed mesh networks such as that discussed in the paper

How to build good routing protocols

1. Try to get hop-by-hop routing similar to wired but get the right metric

2. Rethink routing from the ground up.

Define what drives the design of the metric?

- hops $\Rightarrow$ poor performance due to contention.
- many links are lossy.
- links are also asymmetric.

Options: hop count is a bad idea.

Delivery ratio is not a great idea either.

1. Need to account for link layer ruminations and contention.
\[ \text{ETX} = \text{New metric} \]

\[ \text{minimize total transmissions per packet} \]

\[ \text{link throughput} = \frac{1}{\text{link ETX}} \]

\[ \text{Pr (TX success)} = \text{Pr (Data)} \times \text{Pr (Ack)} \]

\[ \text{link ETX} = \frac{1}{\text{Pr (TX success)}} \]

\[ \text{Route ETX} \quad \text{(for short routes)} = \text{sum of link ETX} \]

ETX metric can be combined with other routing protocols (e.g. DV) to compute end-to-end paths.

- Shown to improve performance of traditional approaches.

- Prob: 1. Abstracts radio link to look like a wire with a certain property / ability of delivery.

- 2. Identify a route, forward over links.

But radios are not wires.
- Every packet is broadcast.
- Reception is probabilistic.

EXOR: 1. Exploit the opportunities that broadcast and probabilistic reception offer.

- Decide who gets to forward after reception.

- Goal: closest recipient should forward.
challenges: acquire efficiently and avoid duplicate transmissions.

Why does this impact throughput?

1. Traditional routing:

   $\frac{1}{0.25} + 1 = 5 \text{ TX.}$

   Ex: $\frac{1}{1-(1-0.25)} = 25 \text{ TX.}$

2. Exploit lucky long receptions
   or salvage unlucky receptions $\rightarrow$ thereby ensuring partial progress.

Protocol details:

1. Batching for efficiency $\rightarrow$ batch preparation
2. Forward a list using ETX measurements.
3. Packet reception and batch map update $\rightarrow$
   $\rightarrow$ gossip mechanisms carrying reception info from high priority nodes to low priority nodes
4. Scheduling transmissions.
   - Remember the last-sent fragment
   - Use ERMA to update send rate
   - Readjust retries to avoid based on expected completion time.
Salient features:
1. Explicit using all ending opportunities
2. Sending static estimation facilitates fairness

Issues:
- How often - Use batches, and not per packet
- Who should participate - Too many causes overhead to be high
- When to forward - Schedule to avoid simultaneous transmission
- What to forward - Avoid duplicate transmission
- How and when does process complete - When leftover of batch is small enough that overhead supersedes benefit

Issues:
Static → no mobility is considered
ETX → works for short paths.
Applications → need batching → file download.
What about cross traffic → hard to estimate transmission time of others?
ETX → costly, needs probing.
What about changes in ETX? Is this an issue?