DADR: Distributed Autonomous Depth-first Routing Protocol in LLN draft-iwao-roll-dadr-00.txt

Sung Lee

sung.lee@us.fujitsu.com

July 28, 2009

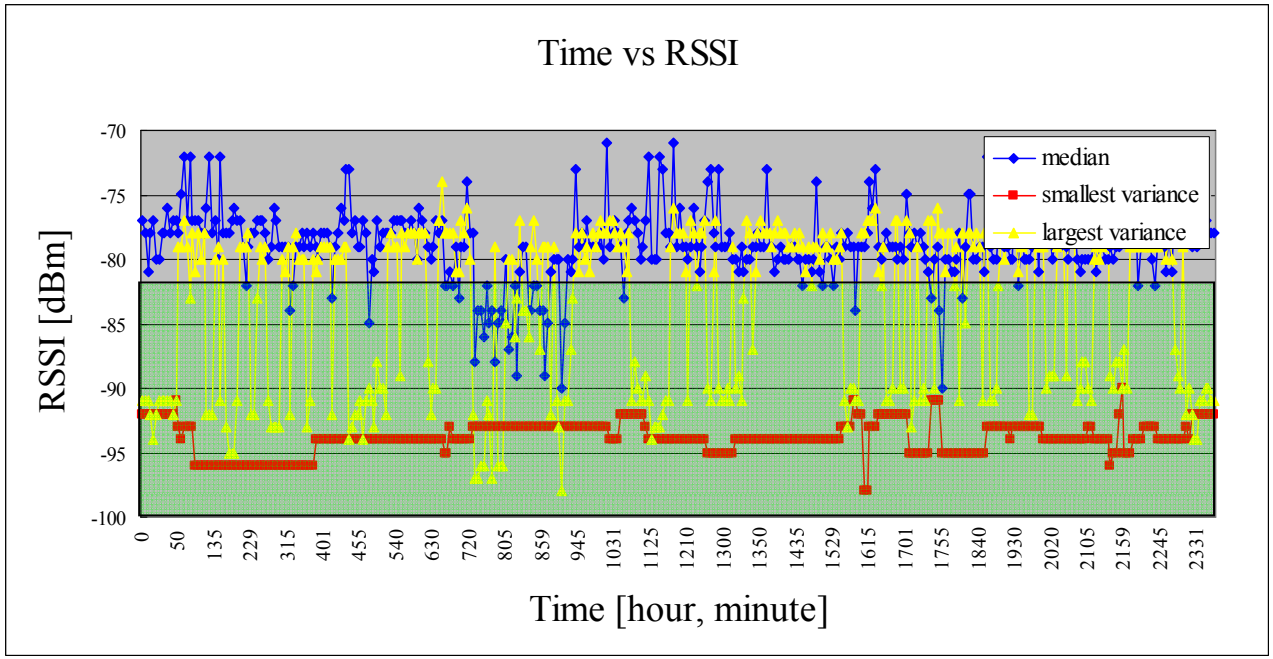
Target Applications

- Targeted for applications described in
  - RFC 5548: Routing Requirements for Urban Low-Power and Lossy Network
  - http://tools.ietf.org/html/draft-ietf-roll-indus-routing-reqs-06: Industrial Routing Requirements in Low Power and Lossy Networks

"Our system has successfully demonstrated its ad-hoc network capability at a field test using approx. 1500 wireless (WLAN) nodes in an urban environment."

Trials and lessons learned

- AODV, but encountered issues that are very difficult to overcome
- What we learned:
  - RSSI fluctuates rapidly
  - Packet size did matter
  - Local changes have global impact (flooding)
- Pre-computing routes with control messages didn't help with data transmission



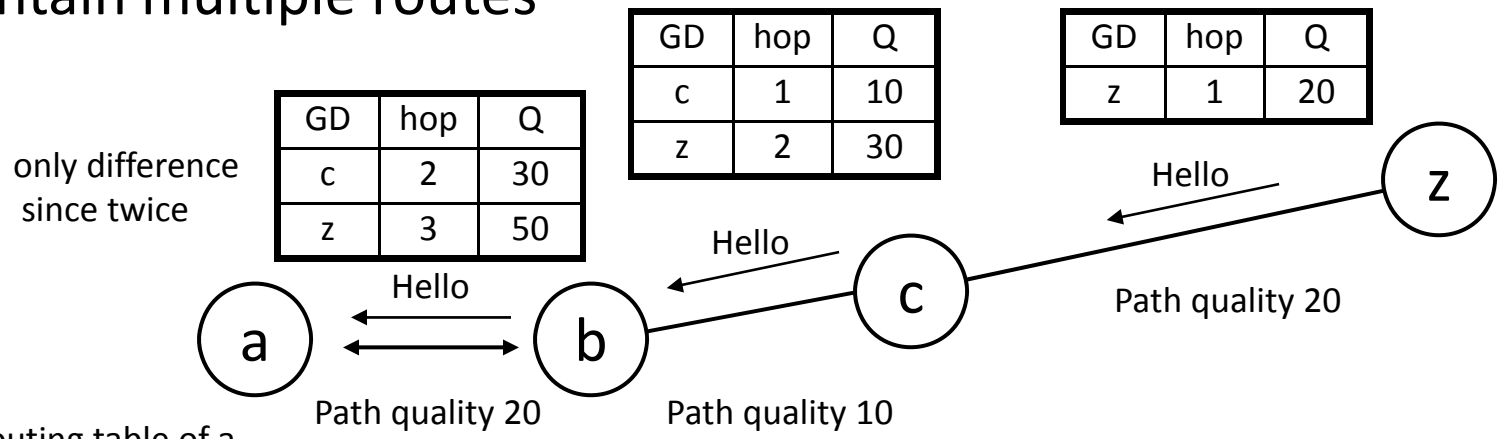
DADR

- Modified proactive approach
- Via Hello Messages, sent at a regular interval, route information is exchanged
  - Route table contains multiple next hop for each destination, hop count, path quality, weight, evaluation
- Data forwarding finalizes the path, refining route information
  - Loop detection
  - Backtrack
  - Path avoidance

} Packet transmission information is maintained

Loose construction of routes via Hello Messages

- Relay information from node to node (next hop neighbor)
- Upon receiving Hello Message, the node updates the local information and sends the updated info out to its next hop at next Hello Interval
- Maintain multiple routes

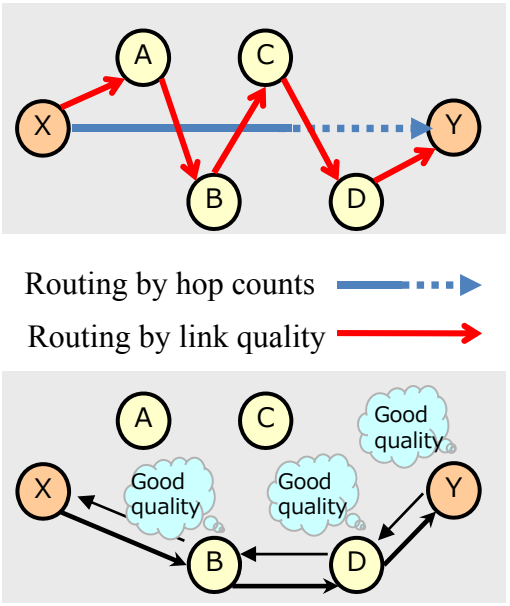


Routing table of a

GD	LD	hop	Q	W	Eval
b	b	1	20	50	20
c	b	2	30	50	30
z	b	3	50	50	50

GD: Global Destination
LD: Local Destination
Q: Distance
W: Data Transmission Success Rate Weight
Eval: Evaluation

Data Forwarding



- Distance metrics
  - Number of hops
  - Signal strength

  . . .
  - $Q_{i,j}$ (RSSI Avg., RSSI Var., Int. Avg., Int. Var.) for our case where
    - Qi,j is an evaluation of link between i and j
    - Int. is the interval between Hello Messages
    - Summed over the path
- Data forwarding determined based on
  - Q: Distance to the destination
  - **W: Data transmission success rate**

6

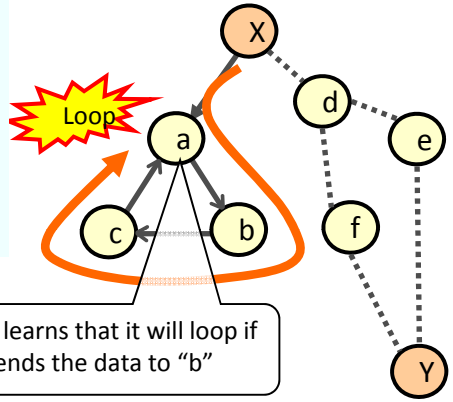
Learning New Route via Data Forwarding

■ Combination of *Loop Detection, Backtrack, and Path Avoidance* helps data reach the destination node

1. Loop Detection

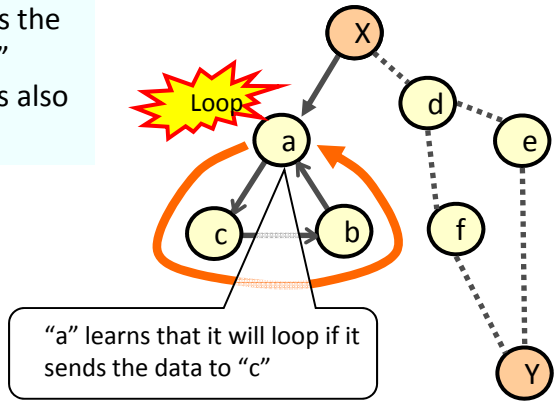
"X" sends data to "Y" via "a."

"a" forwards the data to "b," but "a" receives the data again which indicates that there is a loop.



2. Loop Detection

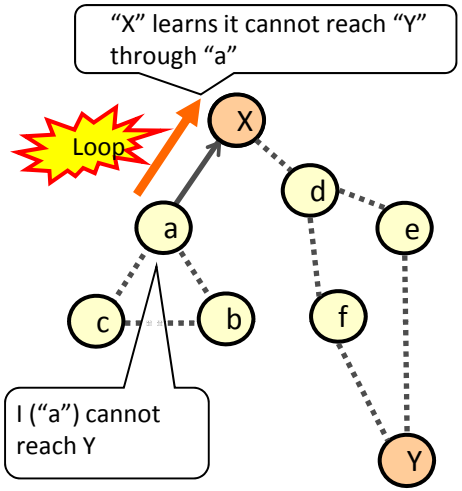
"a," then, forwards the data to "c," but "a" learns that there is also a loop.



3. Backtrack

"a" sends back the data to "X" because both "b" and "c" resulted in loops.

"X" learns it cannot reach "Y" through "a"

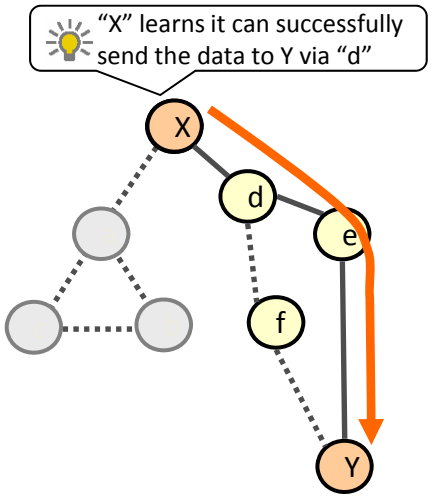


4. Path Avoidance

"X" then sends the data to "d" and the data successfully reaches "Y."

"X" learns it is best to go through "d" to send the data to "Y."

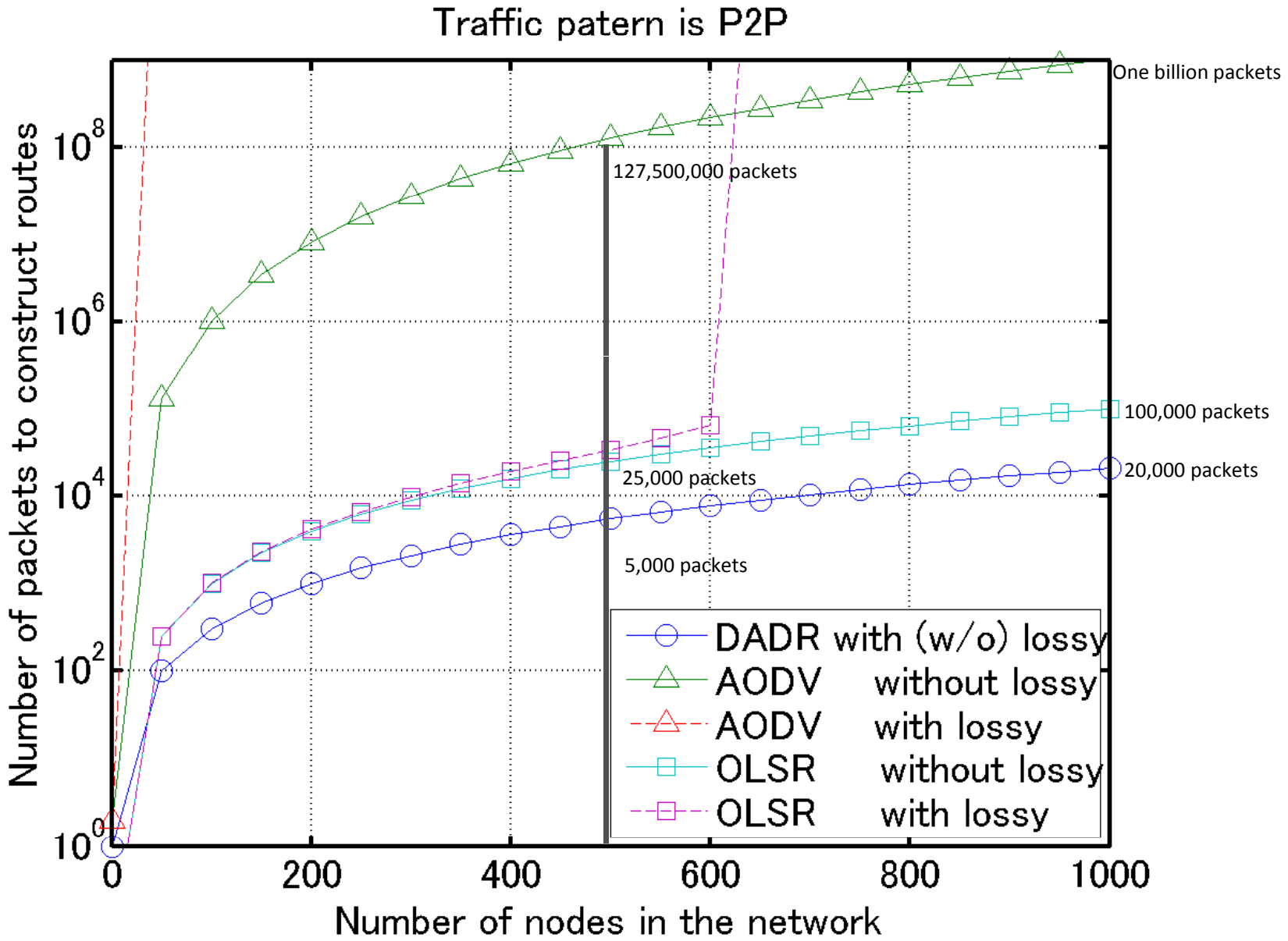
After this, "X" avoids "a" and sends the data to "d."



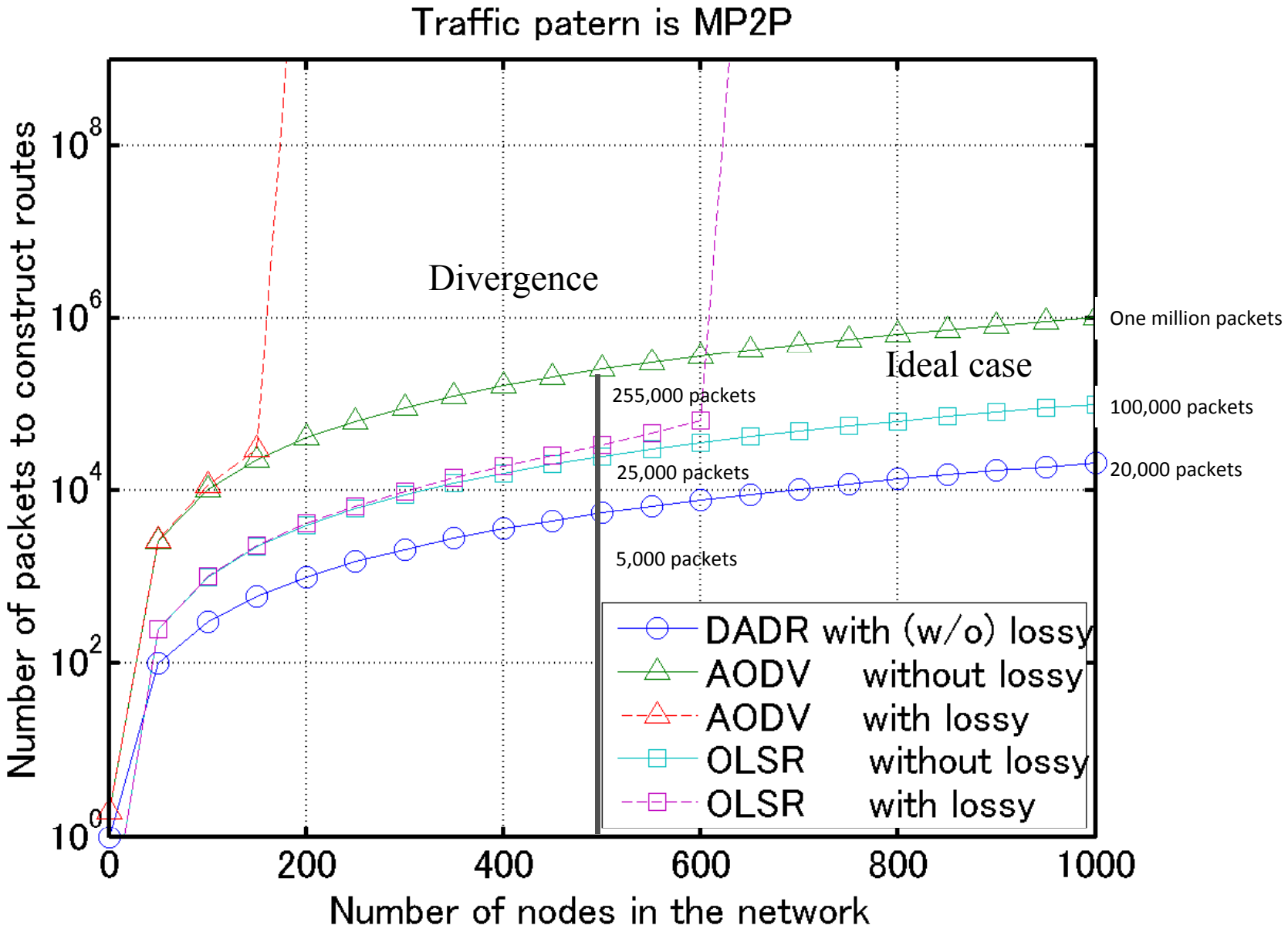
Strength and Weakness

- Strength
  - Adaptive to topology changes
  - Without increasing control messages
  - Loops can be detected at data forwarding time
  - Integrated security mechanism
- Weakness
  - Packet transmission information must be kept
  - Requires a network-wide clock synchronization for security

Comparison of DADR, AODV and OLSR regarding necessary number of control packets against number of nodes

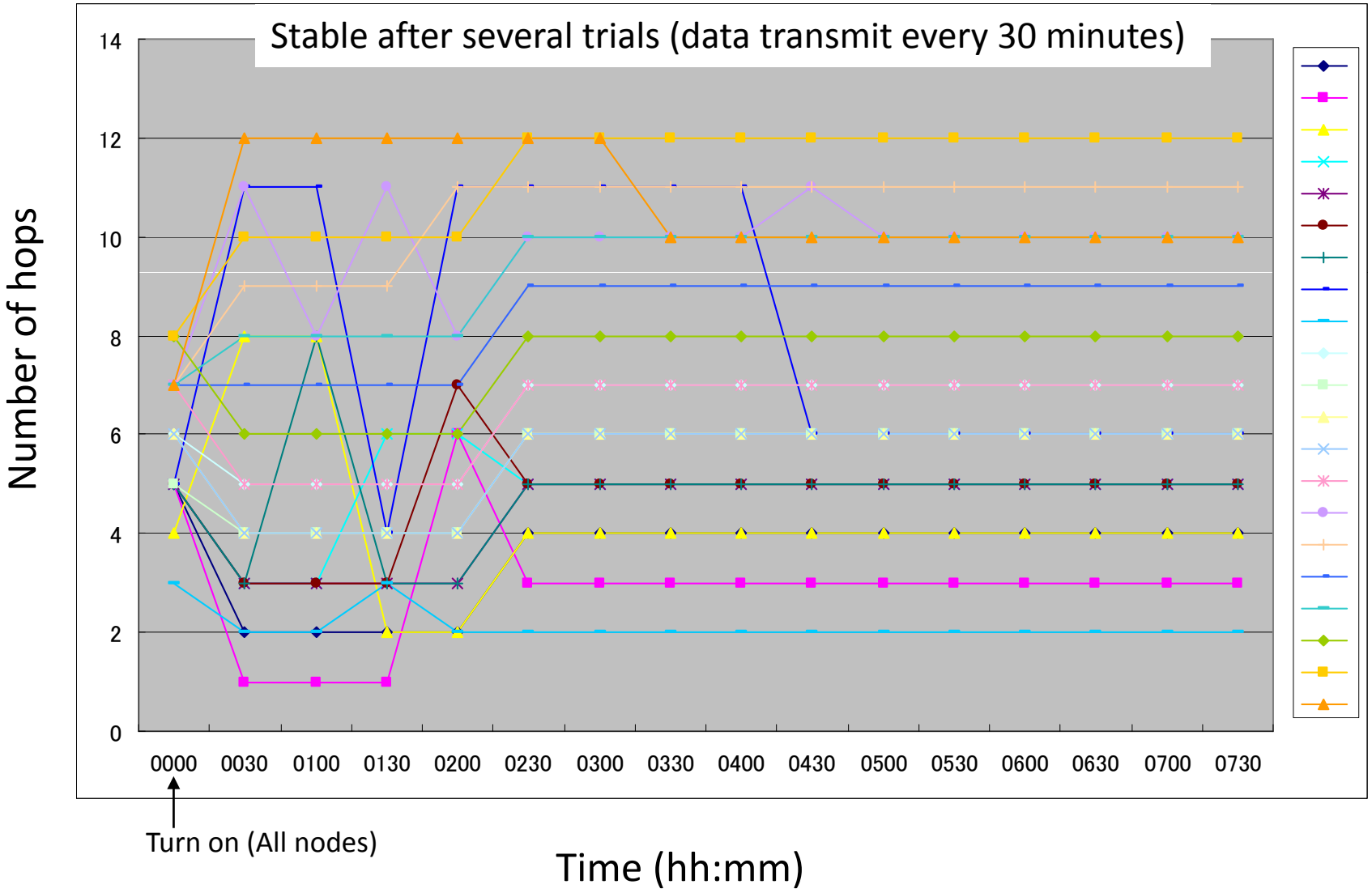


Comparison of DADR, AODV and OLSR regarding necessary number of control packets against number of nodes



Convergence after Disturbance

Number of node : 100
Area : 320m x 160m



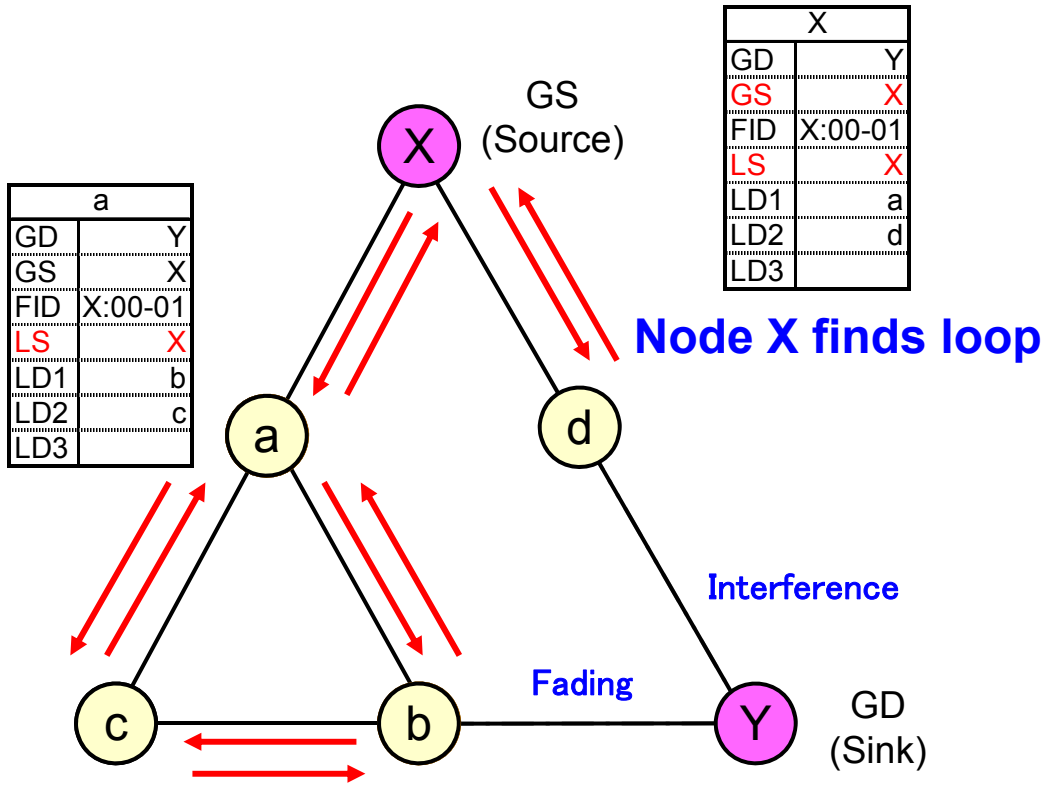
Summary

- Already applied or planned to be applied
  - Not necessarily perfect for every applications, but it is working for important applications
- Routing for dynamic and unstable wireless communications
- Scalable security incorporated

Backup

Loop Detection

1. GS creates unique Frame ID (FID)
2. Each node registers FID to Data Management Table
3. Loop detected by GS when all possible paths are unreachable



Packet Error Rate