Weak State Routing for Large Scale Dynamic Networks

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Outline

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Introduction

- In a large scale dynamic networks (large scale MANET), traditional routing protocols require high overhead to keep some information.
- This paper proposes Weak State Routing to solve this problem.
- The state information is weak, i.e. interpreted not as absolute truth, but as probabilistic hints.
- Nodes only have partial information about the region a destination node is likely to be.

Assumptions

- All nodes know their positions on a 2-D plane(GPS).
- By using single hop beacon messages, the nodes also know their neighbors and their positions.
- All nodes have uniform omnidirectional antennas.
- There is no ACK after transmitting.

Weak State Routing

- Weak State Routing (WSR) is based on link-state geographic routing protocol.
- WSR doesn’t maintain the state of each node, since there are many and large size beacon messages.
- It only maintains the state of each region.

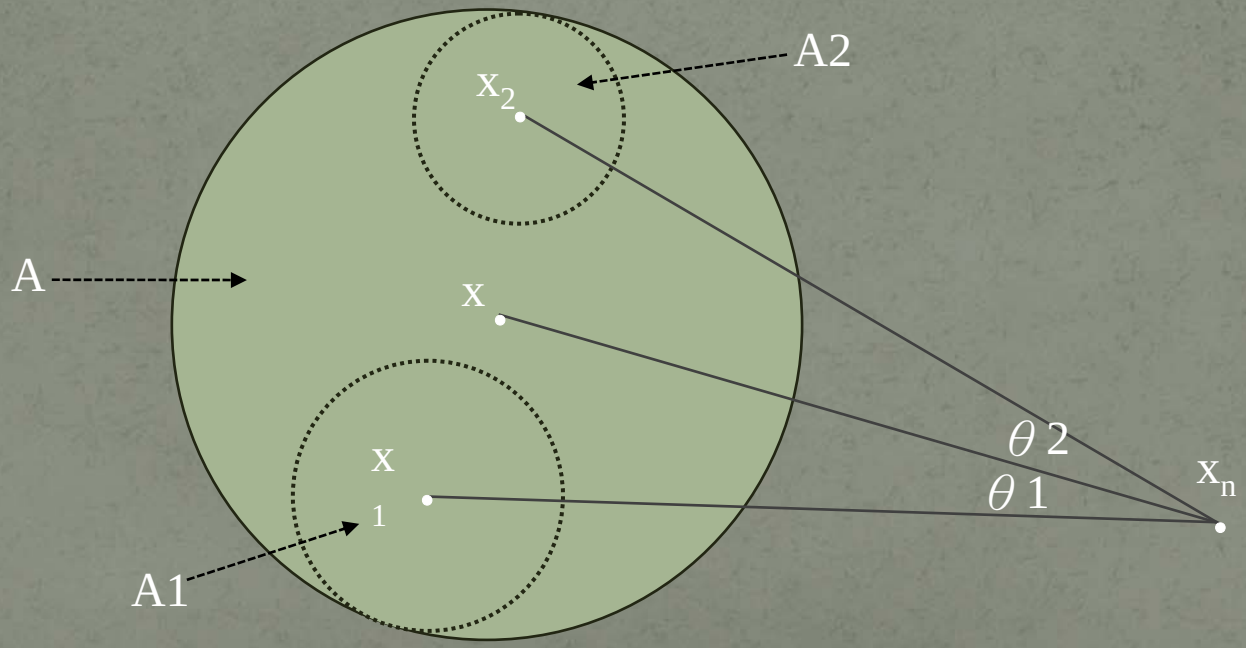
Weak State Routing

- Every node has a table which maintains the states of the entire network.
- A weak state is composed of four parts：

Component Notation	Description
S	Weak Bloom Filter containing the SetofIDs portion
X	X coordinate of the center of the GeoRegion
Y	Y coordinate of the center of the GeoRegion
R	Magnitude of the radius of the GeoRegion

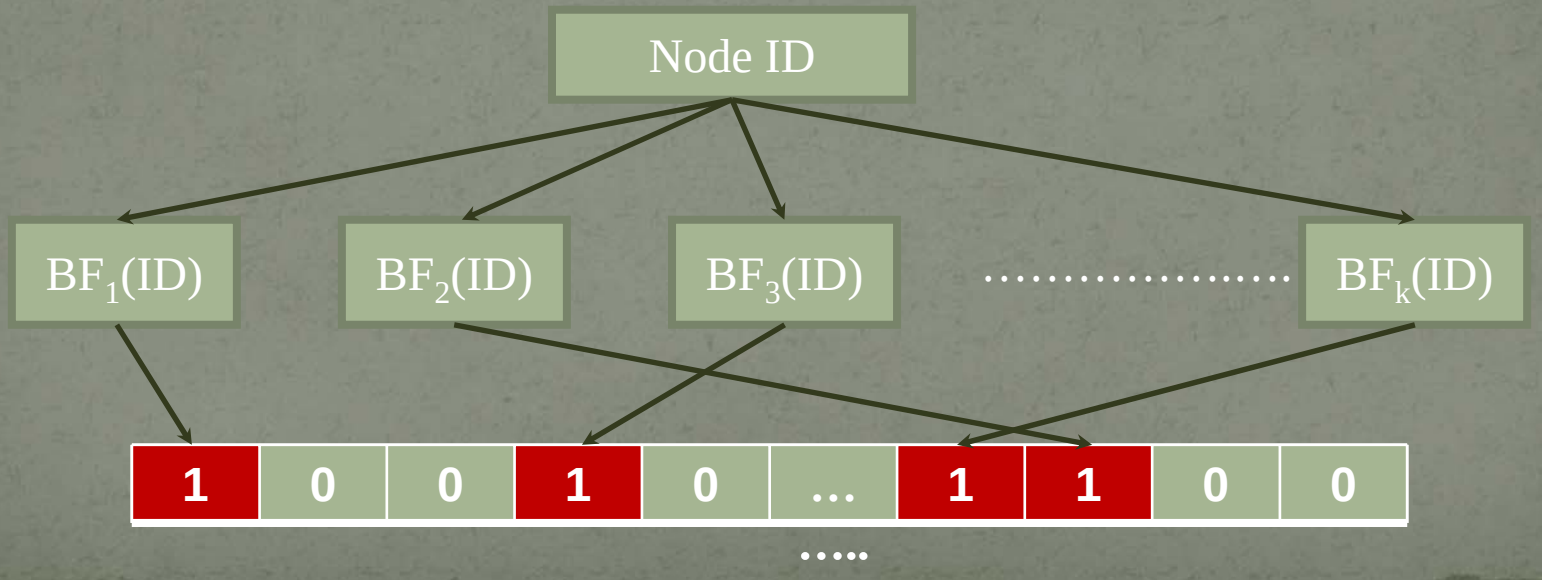
Weak State Routing

- In order to decrease the beacon message overhead, it decreases the size of the message by using bloom filter and tries to combine some states to one state.



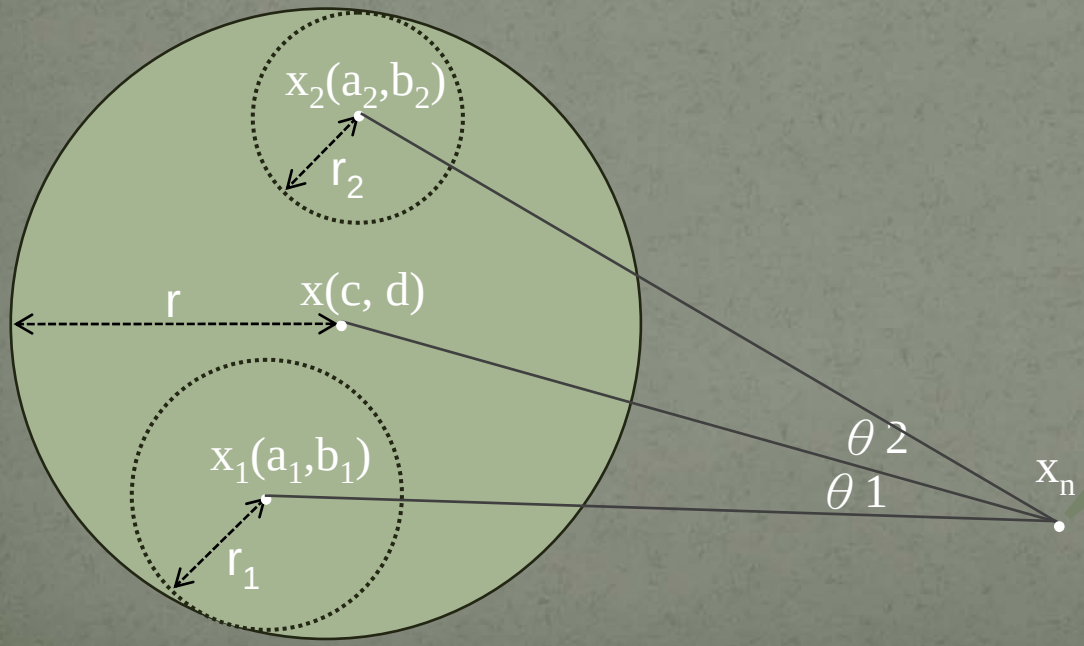
Weak State Routing

- Use bloom filter to calculate the virtual ID (SetofID)：
  - There are k hash functions BF_1~BF_k in each node.
  - Every hash function produces a position in virtual ID(n bits, n>k).
  - Setting the bits at these positions to 1.



Weak State Routing

- If any two states can combine, then：
  - The new SetofID = $SetofID_1$ | $SetofID_2$
  - The new GeoRegion is the smallest circle that contains both GeoRegions.



S	X	Y	R
10001100	a_1	b_1	r_1
11001001	a_2	b_2	r_2

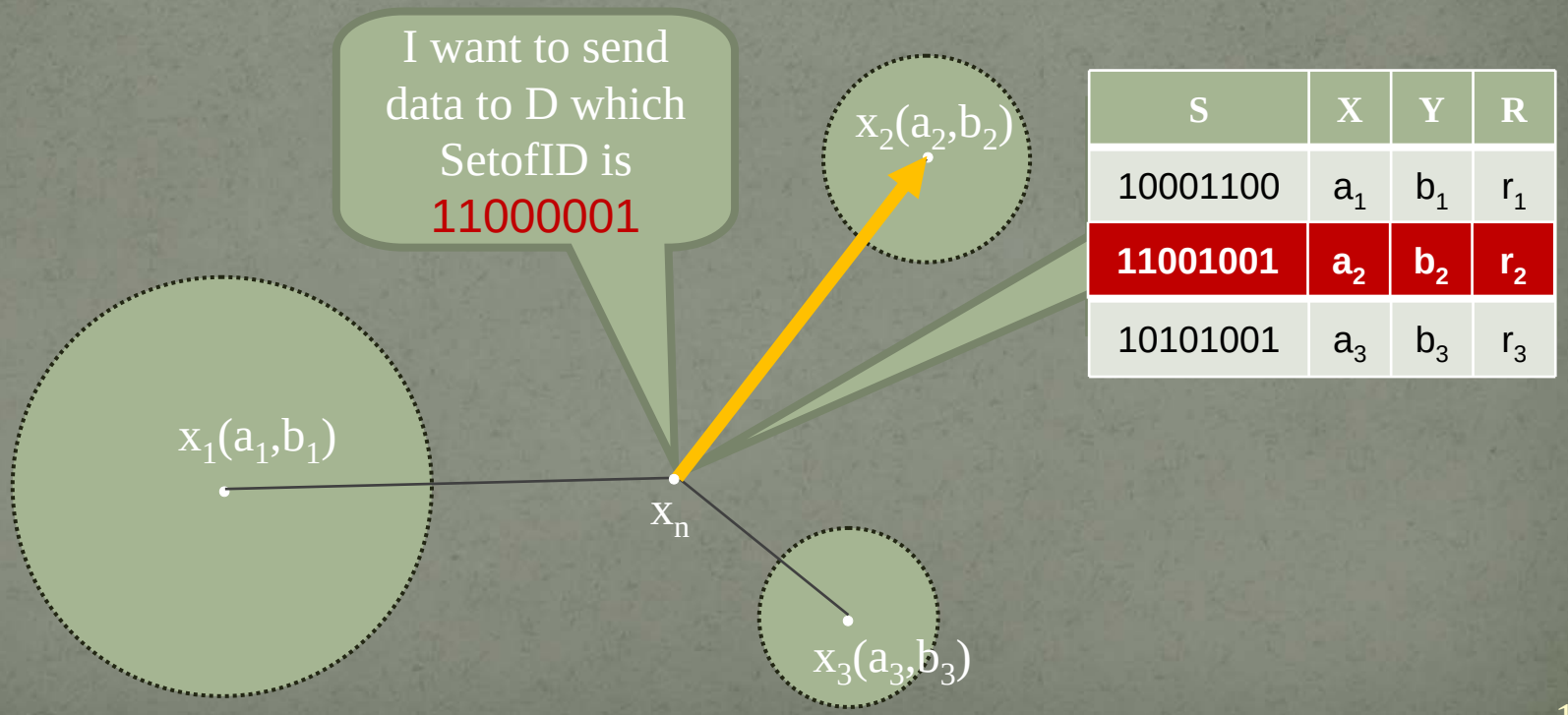
S	X	Y	R
11001101	c	d	r

Weak State Routing

- To combine two states to one state, the two states must satisfy some properties as follows：
  - Checking the GeoRegion radius after combining is smaller than or equal to threshold, R.
  - $\theta_1 + \theta_2$ is smaller than or equal to threshold, θ.
  - Checking the total number of bits set to 1 in SetofID is smaller than or equal to threshold, B.

Weak State Routing

- The source transmits data to the next node which is closest to highest confidence area (it's similar to geographic routing).



S	X	Y	R
10001100	a_1	b_1	r_1
11001001	**a_2**	**b_2**	**r_2**
10101001	a_3	b_3	r_3

Weak State Routing

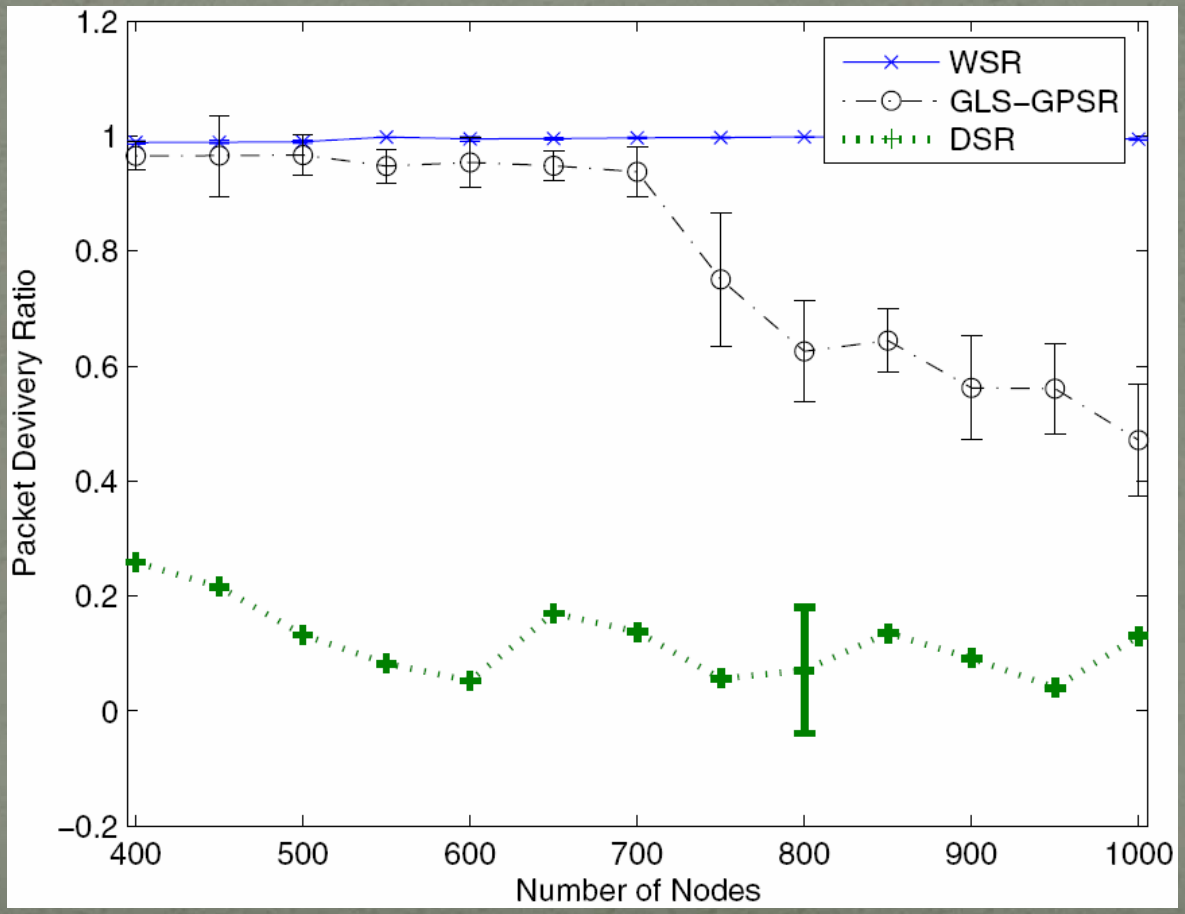
- At each time interval, the bits in each SetofID set to 1 are reset to 0 by a fixed probability p in order to adapt to the dynamic networks.
- Once the number of 1 is below a threshold value, WSR removes the state since the state is too old.
- The data packet is sent to a random direction if there are multiple states which have the same confidence.

Simulation

- NS2
- 2500m x 2500m
- 500~1000 nodes
- Dynamic networks
- v_{min}=5m/s, v_{max}=10m/s

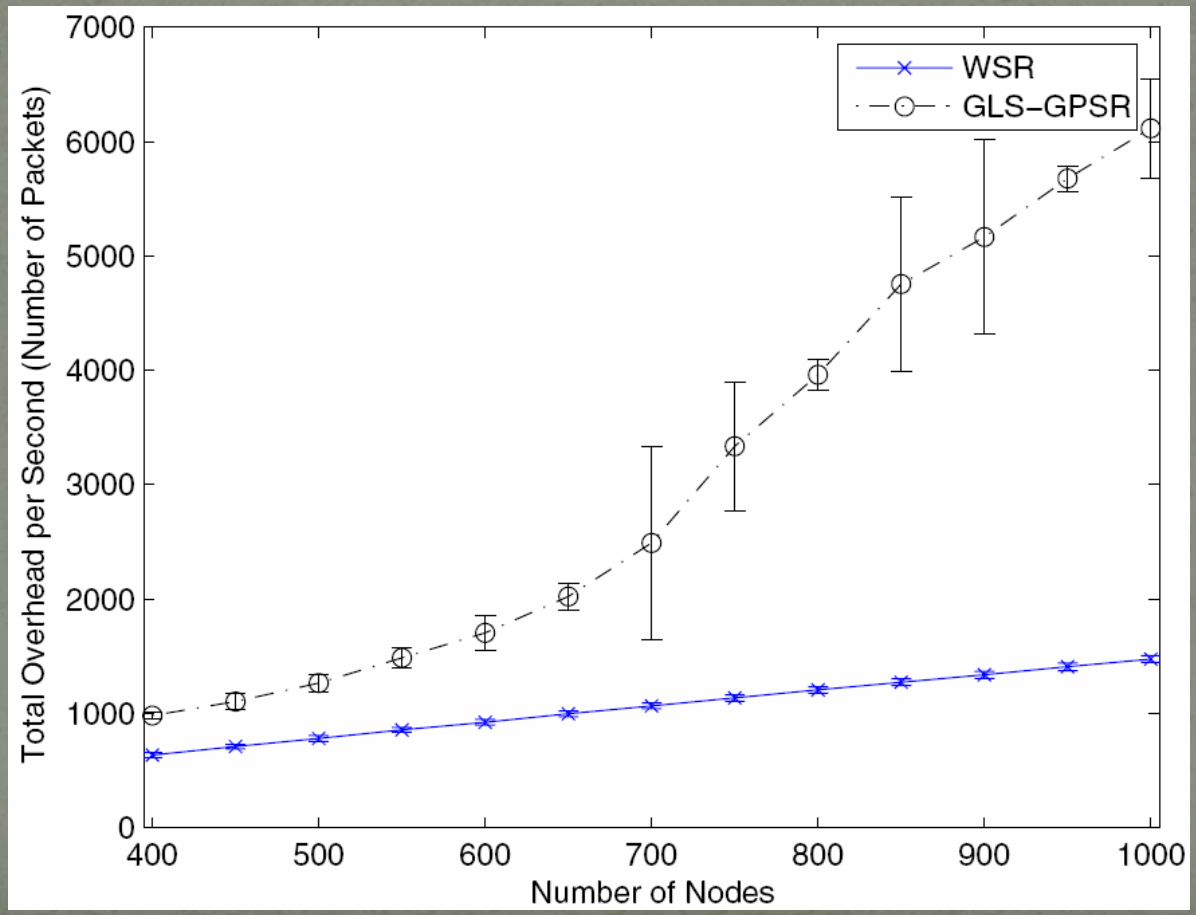
Simulation

- Packet delivery success rate



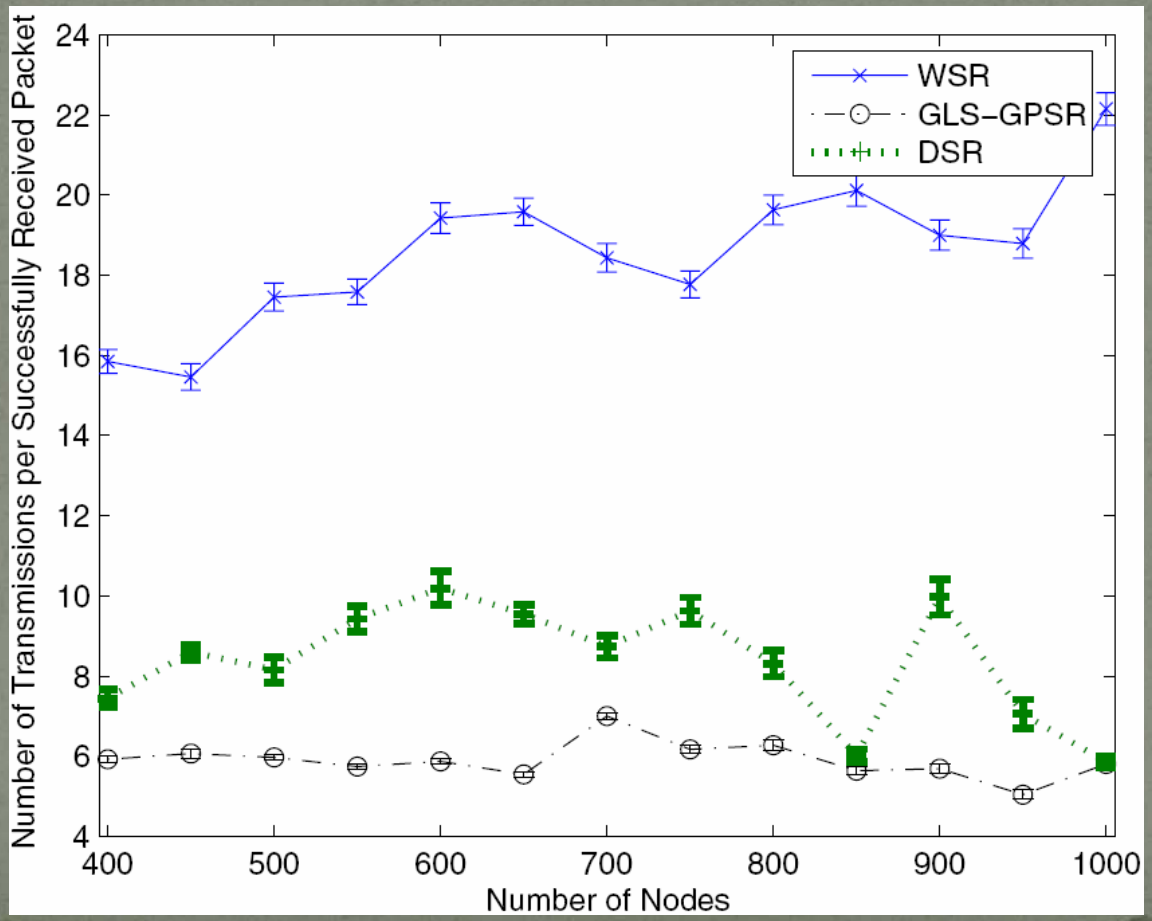
Simulation

- Total overhead per second



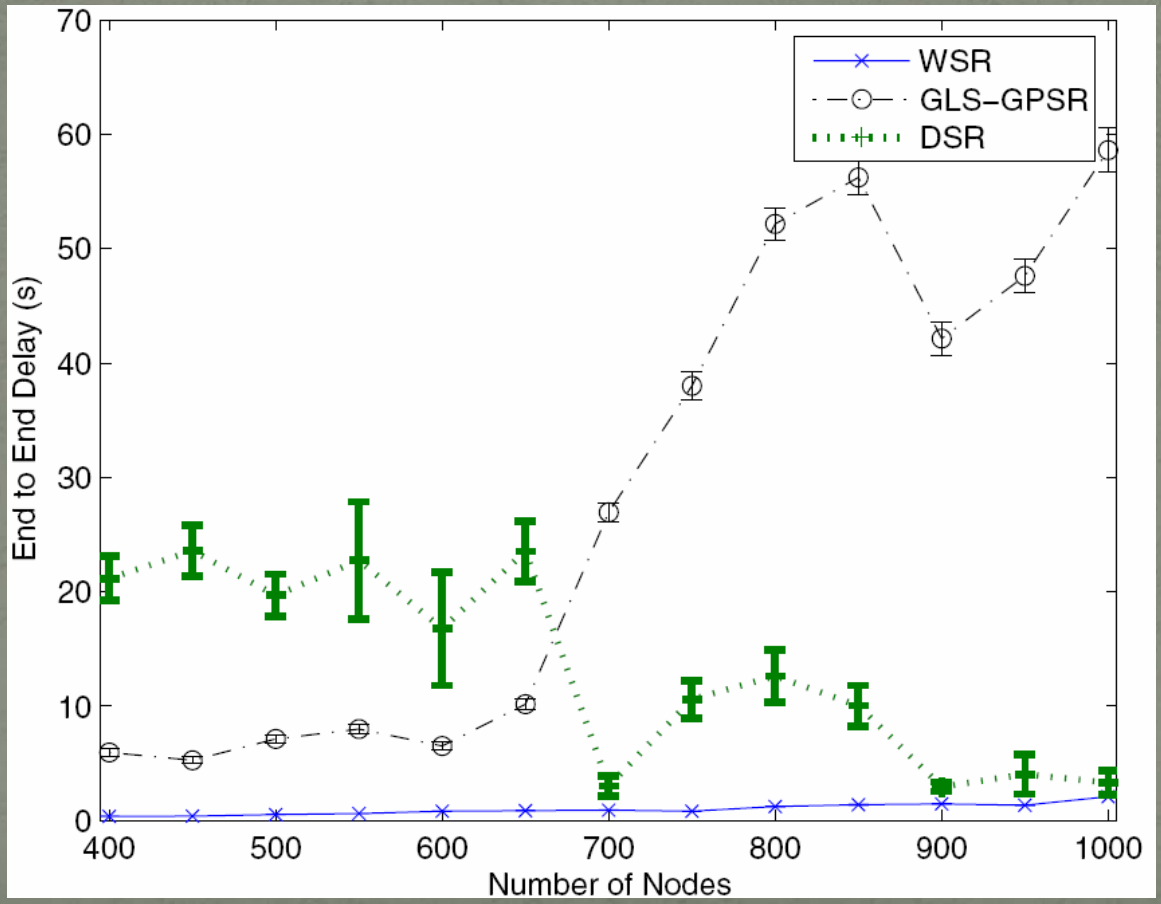
Simulation

- Number of transmissions per successfully received packet



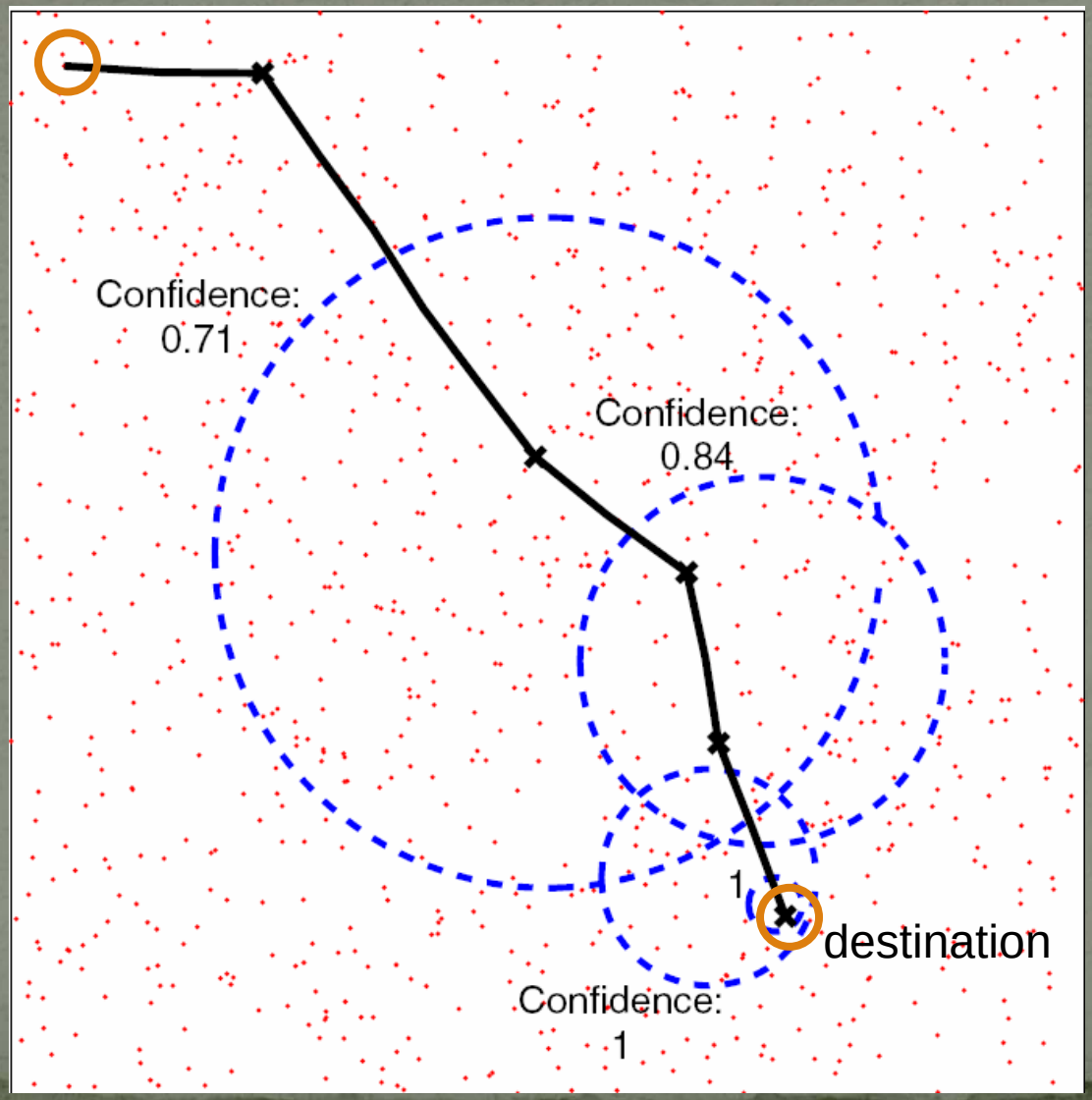
Simulation

- End to end delay



Simulation

source



Conclusions

- WSR decreases the size of beacon messages and adapts to large scale dynamic networks.
- Using bloom filter, this mechanism reduces the size of the table which every node maintains.
- In simulation, WSR offers a high packet delivery ratio, more than 98%.
- It also retains high reachability, low overhead and delay.