Scalable Ad Hoc Routing in Large, Dense Wireless Networks Using Clustering and Landmarks

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Outline

- Introduction
- Dense networks and passive clustering
- Large networks and landmark aggregated routing
- Performance evaluation
- Summary

Introduction

- On demand routing scheme vs. Proactive routing scheme
  - When to compute route?
  - Route access latency?
  - QoS guarantee?
  - Scalability?

Introduction (cont.)

- Proactive routing scheme
  - In dense ad hoc networks
    - control packet be broadcast to the entire network via flooding
    - all the neighbors will receive and in turn forward the message
    - this forwarding is often “superfluous”
  - In large scale environment
    - large routing table
    - high control traffic overhead

Dense networks and passive clustering

- Partition the network into clusters
- Clusterhead is elected in each cluster
- Each cluster member is within radio reach of clusterhead
- Two clusterheads cannot hear each other
- Nodes being members of two or more clusters are called gateways

Dense networks and passive clustering (cont.)

- Passive clustering [17] differs from traditional clustering schemes in that it does not use dedicated, protocol specific control packets or signals.
- It opportunistically exploits the neighborhood information carried in the MAC layer.

Dense networks and passive clustering (cont.)

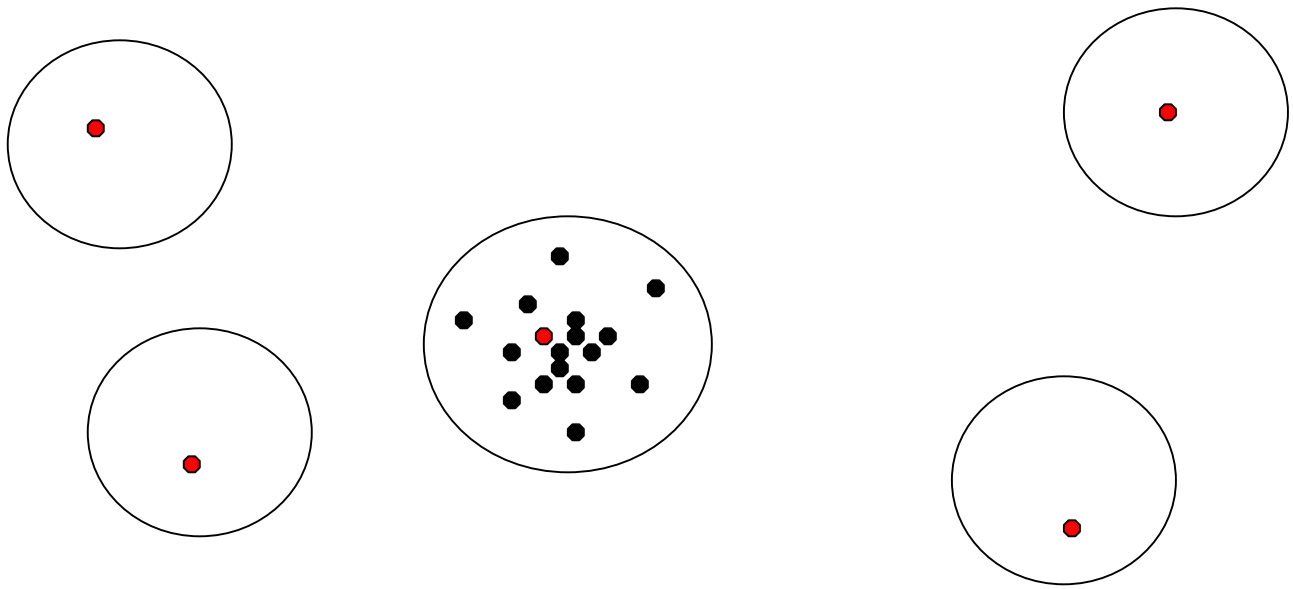
- The passive clustering protocol can dynamically reconfigure clusters in the face of mobility and topology changes.
- Only gateways and clusterheads act as broadcast forwarders.

Large networks and landmark aggregated routing

- Landmark Ad Hoc Routing (LANMAR) [8][9]
  - LANMAR is designed for ad hoc network that exhibit group mobility.
  - We can identify logical subnets in which the members have a commonality of interests and are likely to move as “group”.
  - Each group has a landmark, and LANMAR uses the landmarks to keep track of such logical groups.

Large networks and landmark aggregated routing (cont.)

- Each group has a landmark



- LANMAR can works with a local scope routing scheme

Related routing algorithms

- Destination-Sequences Distance Vector (DSDV)[10]
  - DSDV has the advantage of much smaller size of routing entry for each destination than link state protocols.
- Optimized Link State Routing Protocol (OLSR)[15]
  - Using multi-point relays to reduce the number of “superfluous” broadcast packet retransmissions and also to reduce the size of link state update packets.
  - OLSR has the advantage of good performance in dense network.
- Fisheye State Routing (FSR)[5][6]
  - Link state packets are not flooded.
  - Instead, nodes maintain a link state table base on the up-to-date information received from neighboring nodes.

Performance evaluation

- Many evaluation metrics are used:
  - Control overhead
    - The total **bytes** of routing control packets transmitted by a node, averaging over all the nodes.
  - Packet overhead
    - The number of routing control **packets** transmitted by a node, averaging over all the nodes.
  - Packet delivery fraction
    - The ratio between the number of data packets received and those originated by the source

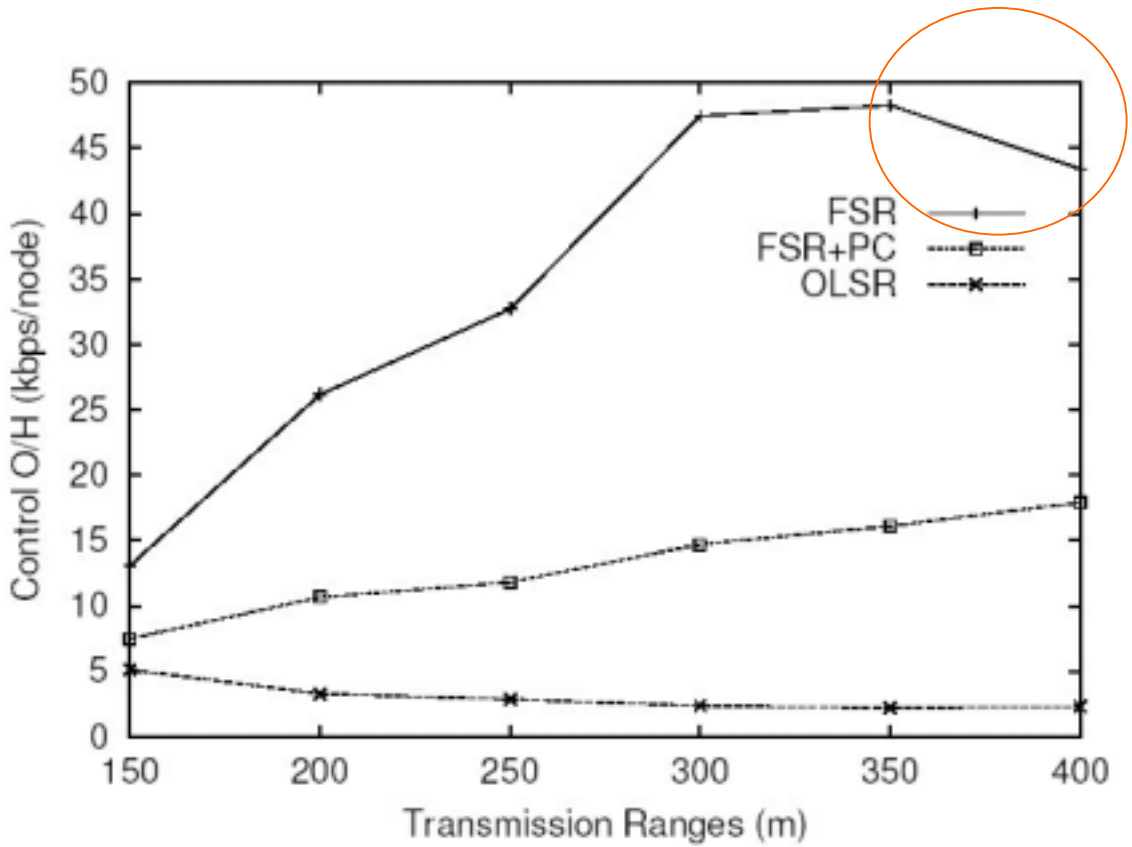
Performance evaluation (cont.)

- Many evaluation metrics are used:
  - Average end-to-end packet delay
    - The time from when the source generates the data packet to when the destination receives it.
  - Throughput
    - The actual throughput achieved at destinations.

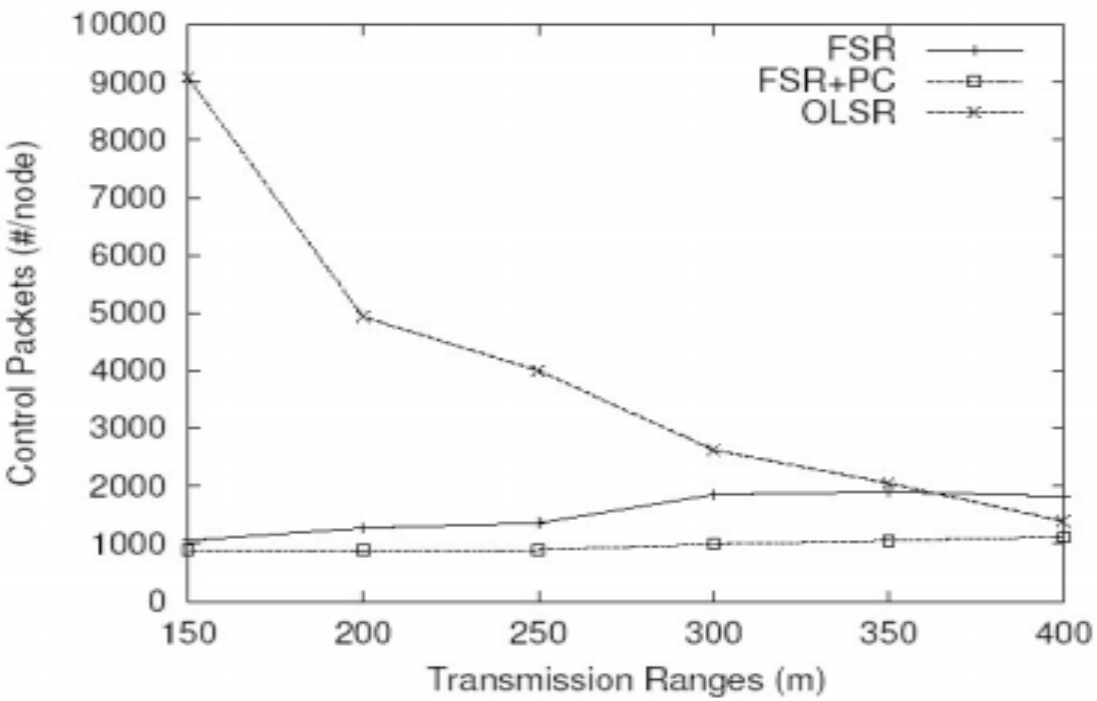
Intervals for routing updates

DSDV	DV Broadcast:1.5S	
FSR	Intra: 0.7S	Inter: 2.2S
OLSR	Hello: 0.9S	TC: 2.2S
LANMAR	LMDV (all variants): 0.7S	

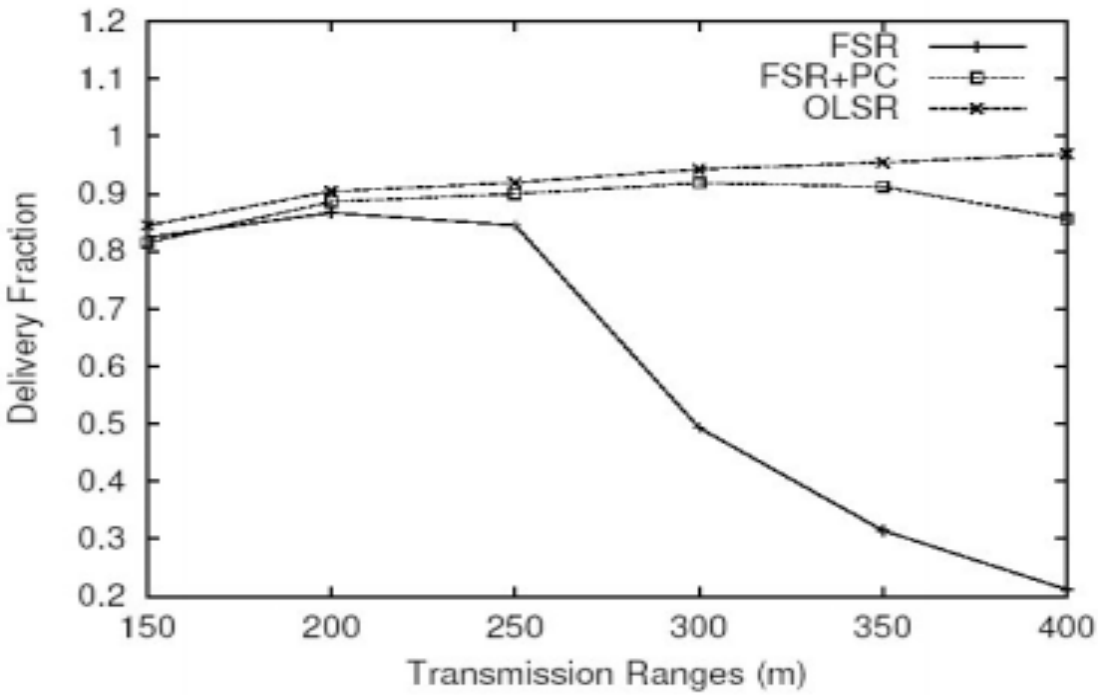
Control overhead with increasing density



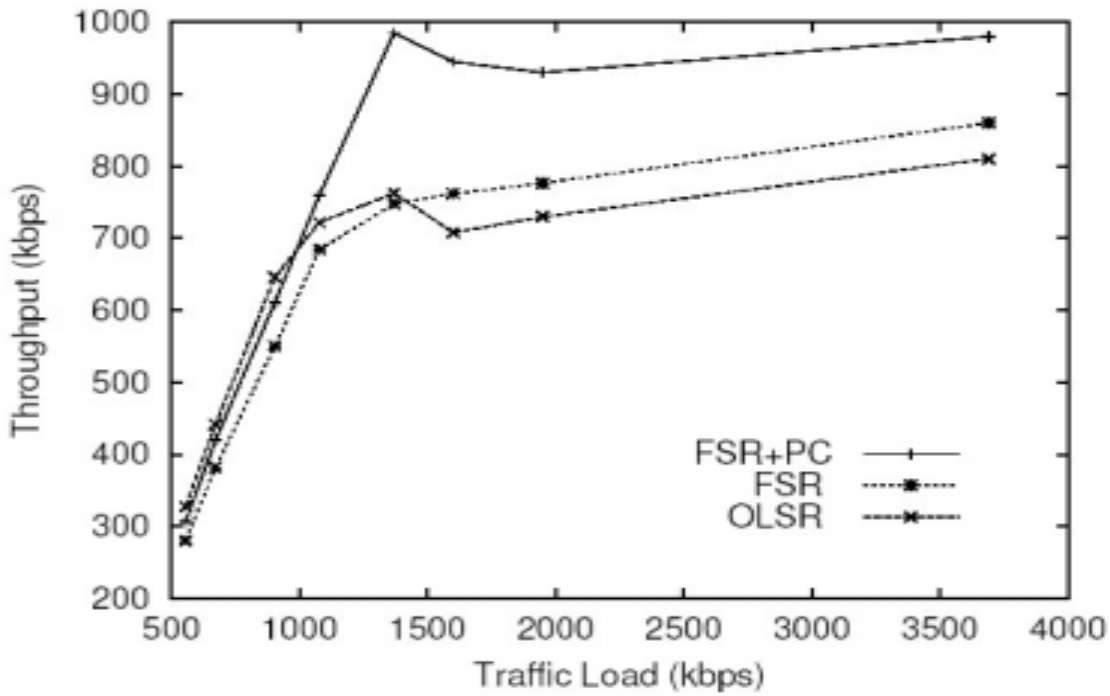
Packet overhead with increasing density



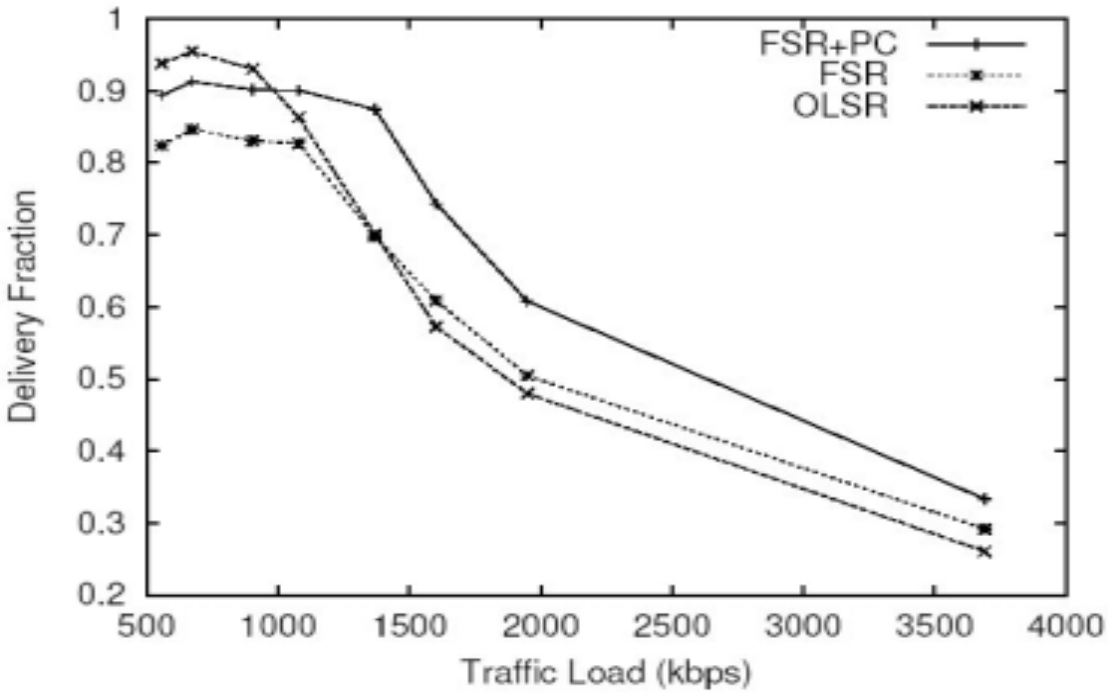
Delivery fraction with increasing density



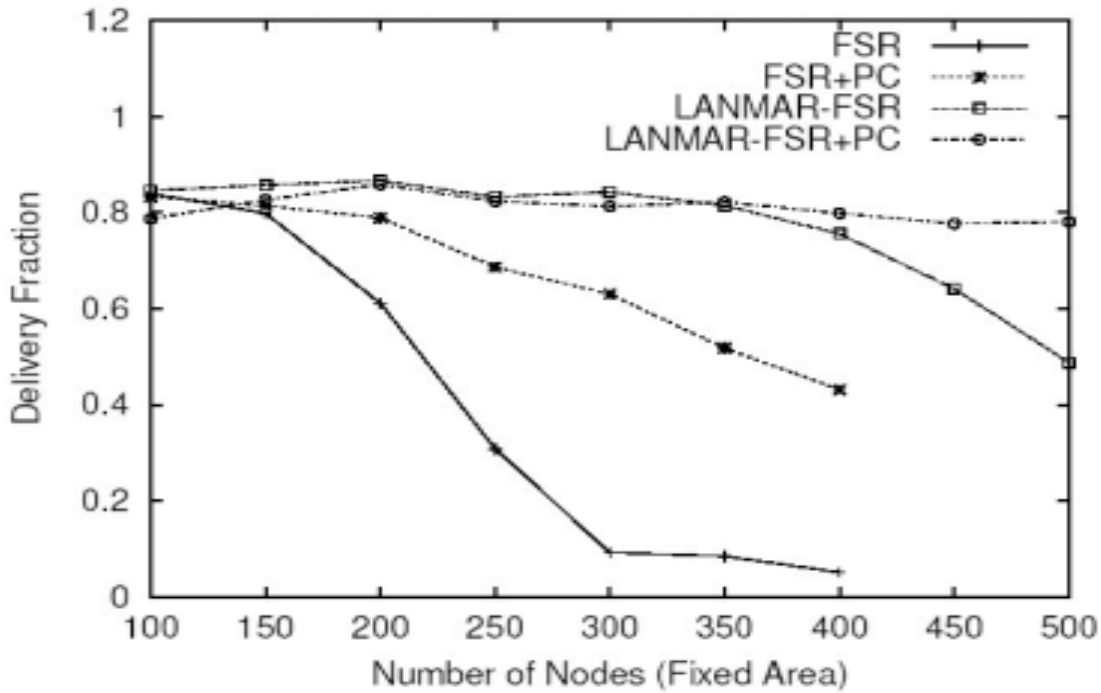
Throughput with increasing load



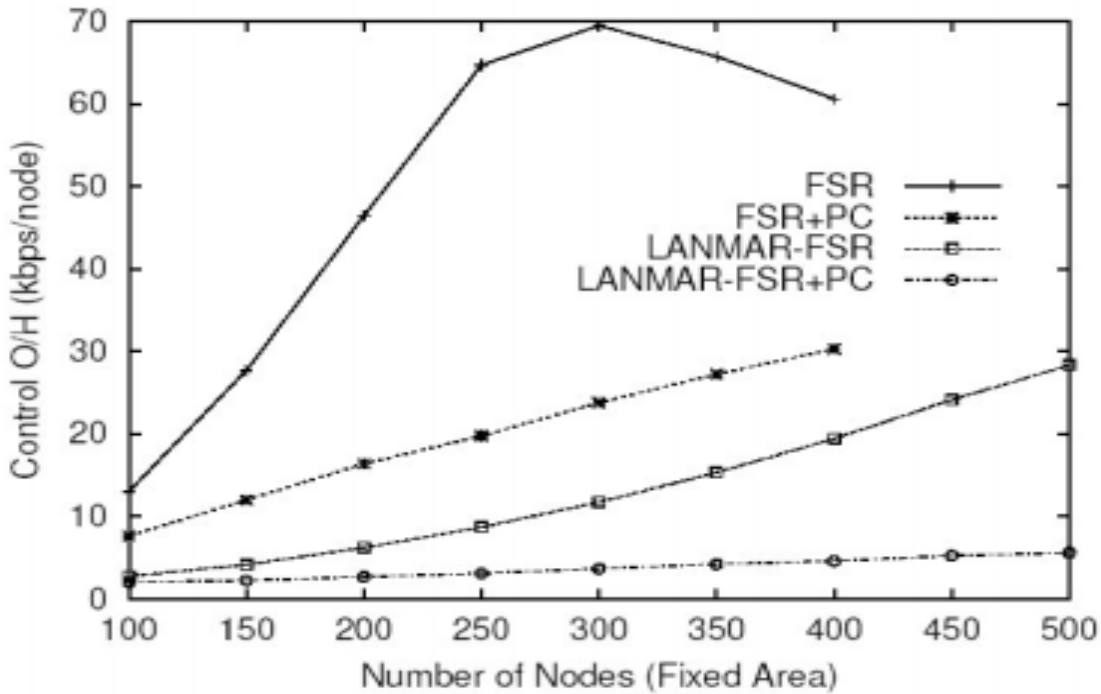
Delivery fraction with increasing load



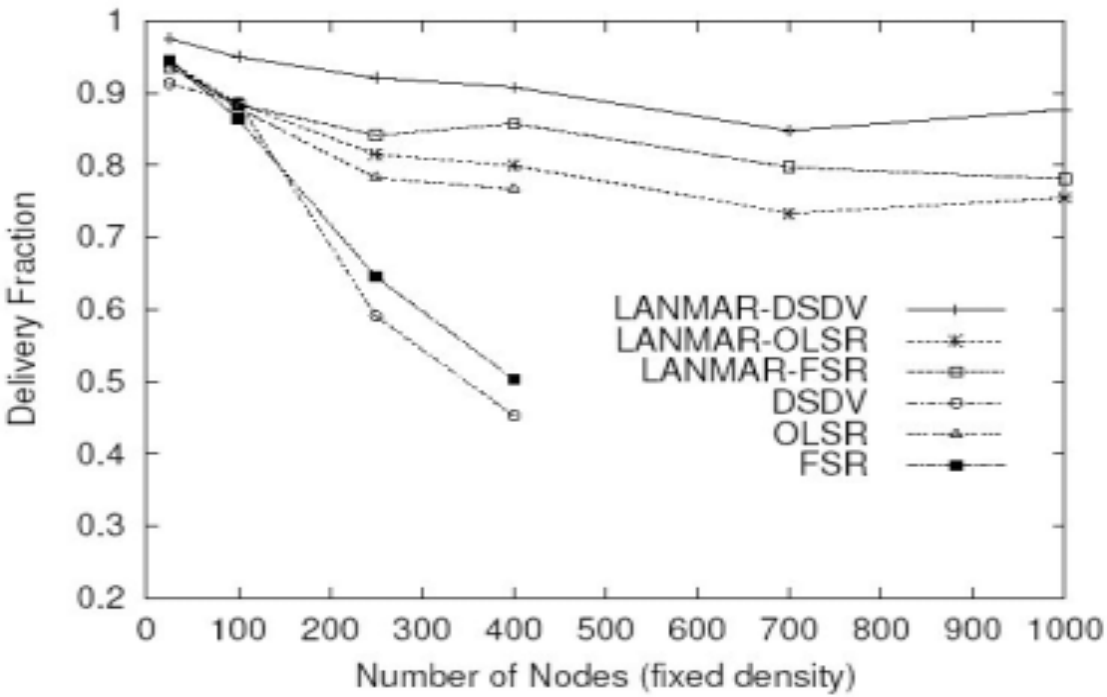
Delivery fraction



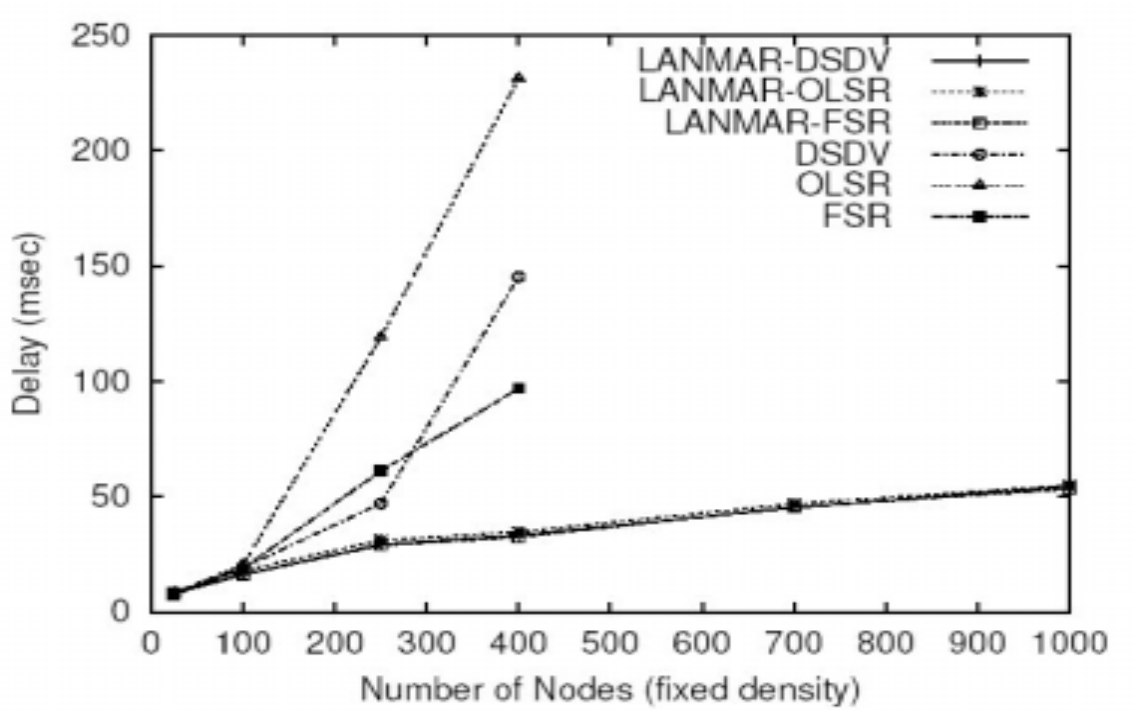
Control overhead



Delivery fraction when network grows



Delay when network grows



Packet overhead when network grows

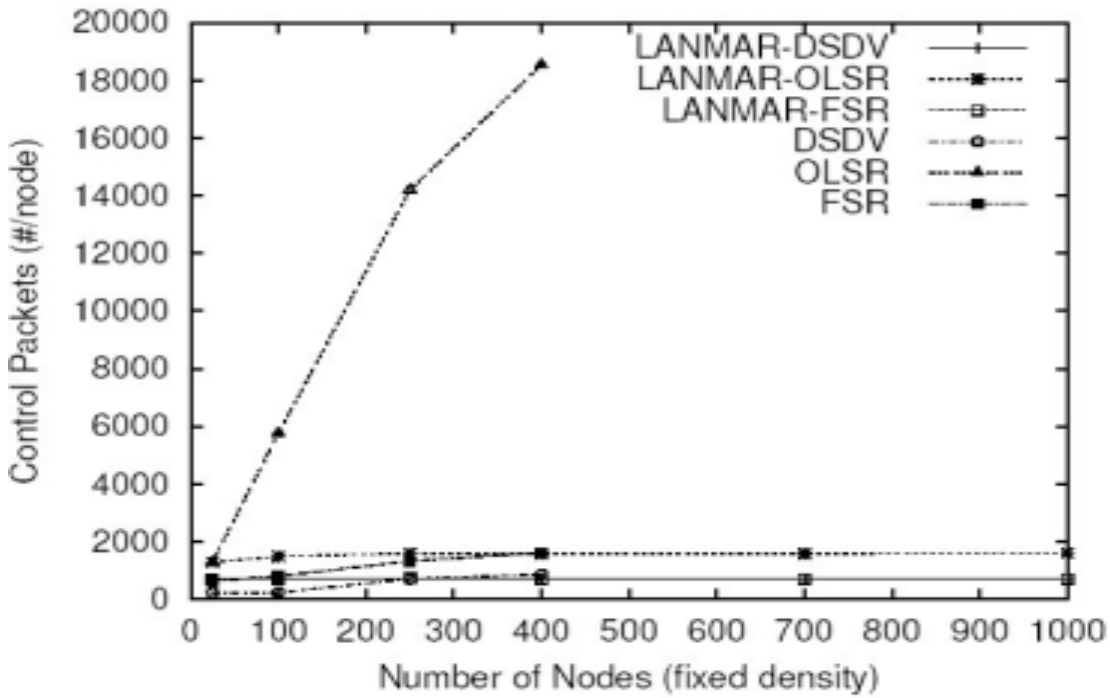
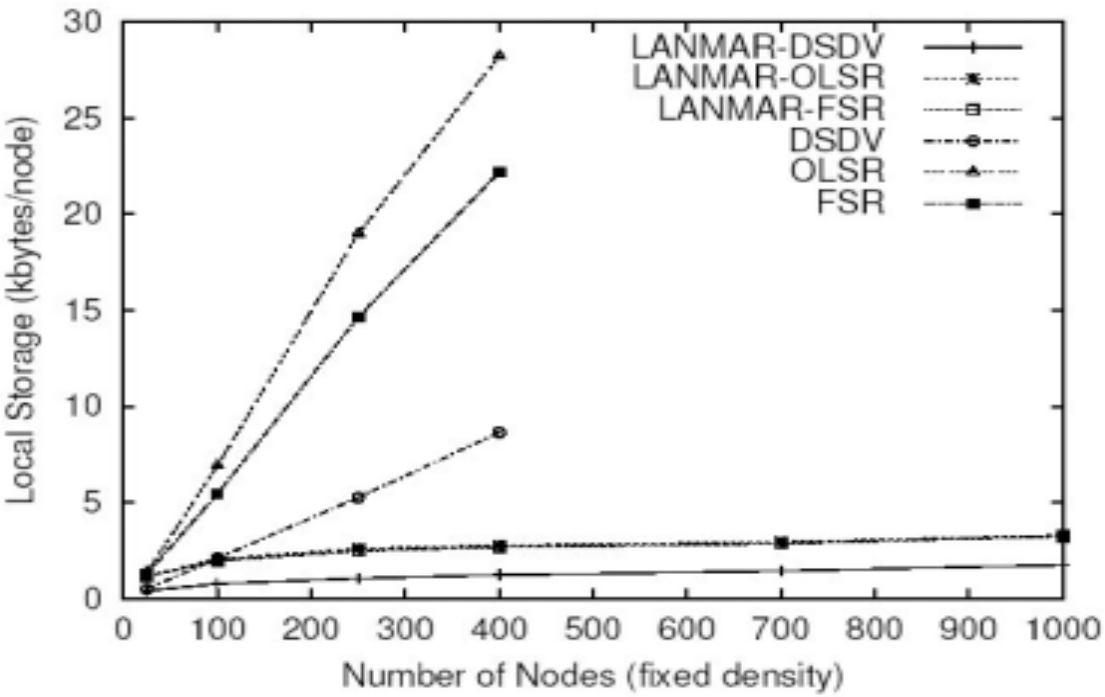


Table sizes when network grows



Summary

- Using passive clustering can reduce routing overhead caused by high nodal density.
- LANMAR-DSDV reduce the size of control packets required for local accurate routing.
- LANMAR-OLSR reduces the control overhead by only selecting a subset of neighbors for topology construction.