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# Improving Broadcasting Performance by Clustering with Stability for Inter-Vehicle Communication

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# Outline

- Introduction
- Related works
- The Clustering Algorithm
- The Broadcasting Algorithm
- Simulation results
- Conclusions

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# Introduction(1 / 2)

- Vehicular Ad Hoc Networks (VANETs), an outgrowth of traditional Mobile Ad Hoc Networks (MANETs), provide one of the basic network communication frameworks.
  - Vehicles provide a robust infrastructure for the creation of highly mobile networks.
  - Vehicles can easily be equipped with the storage, processing, and sensing devices.

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# Introduction(2/2)

- In both MANETs and VANETs applications, broadcasting is the fundamental process in which essentially a mobile node sends a packet to all the nodes in the network.
  - Flooding is the simplest one, but it could cause the network collisions and contentions.
    - **Broadcast storm problem!!**
- Many researches have been done to design efficient schemes in MANETs, but none of them is specially designed based upon the unique features of vehicle networks.

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# Related work(1/2)

- Probability-based
  - The node rebroadcast with a **predefined probability**.
  - The probability can be adjusted according to the network environment.
- Counter-based
  - On reception of an unseen packet, the node initiates a counter with value of one and sets a timer.
  - The node rebroadcast if the counter is below the **predefined threshold**.

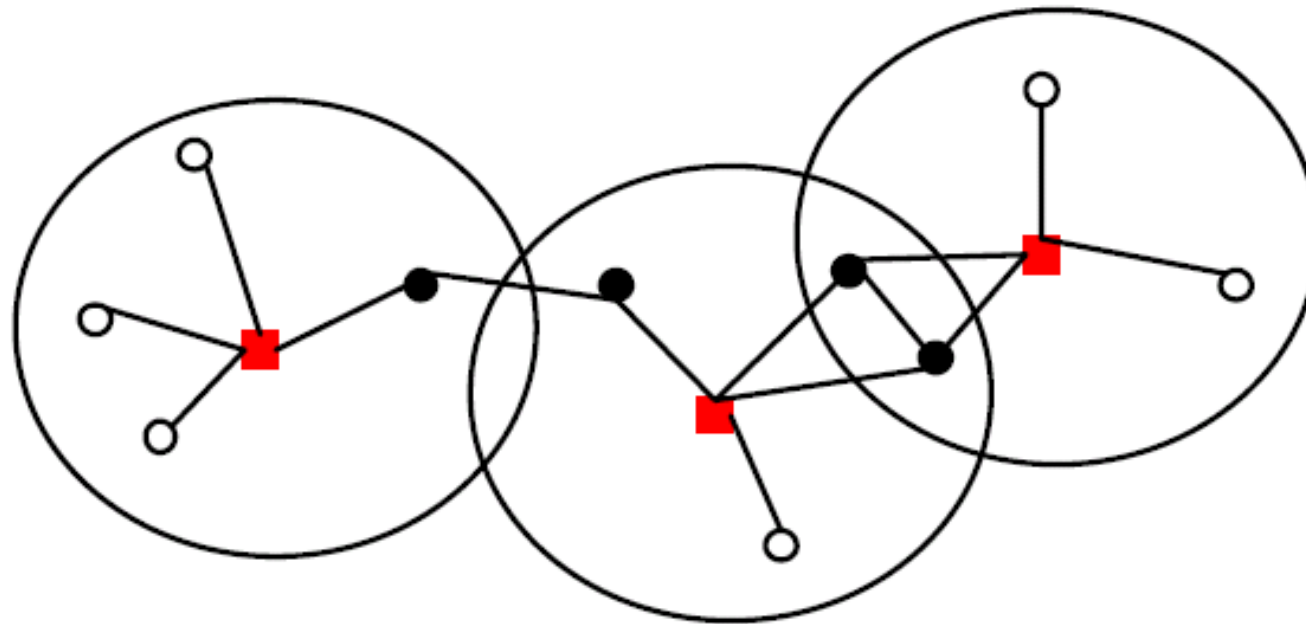
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## Related work(2/2)

- Location-based
  - Each node uses a more accurate method to determine its location such as a Global Positioning System (GPS).
  
- Cluster-based
  - Only cluster heads (CHs) and gateways rebroadcast the packets.
  - Cluster's maintenance must be effective.

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# The Cluster Formation



■ head      ○ member      ● gateway

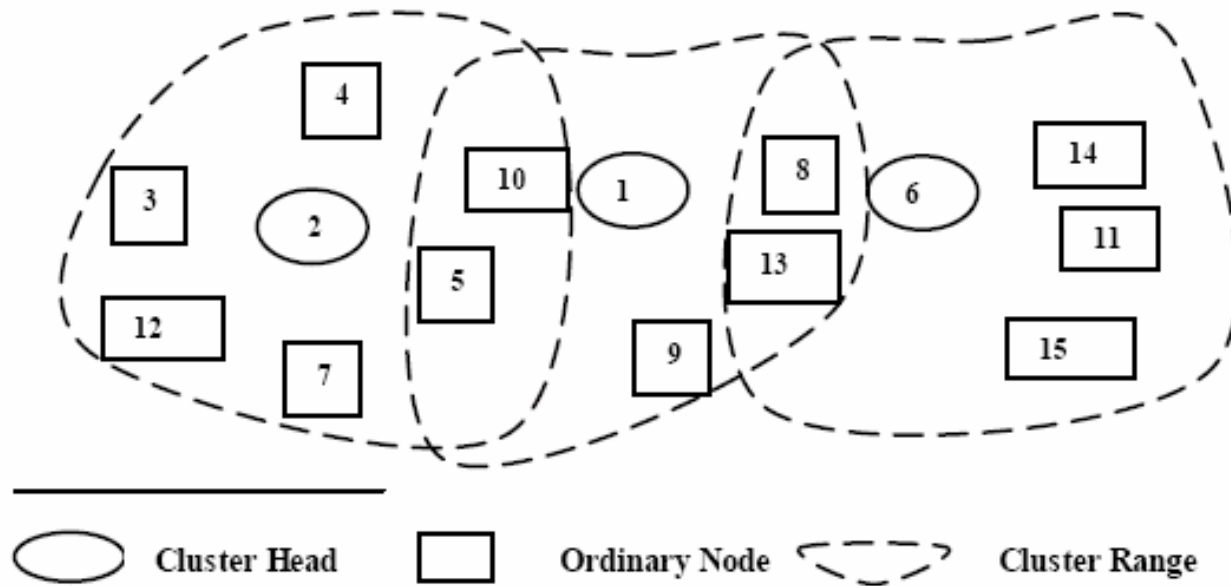
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# The Clustering Algorithm

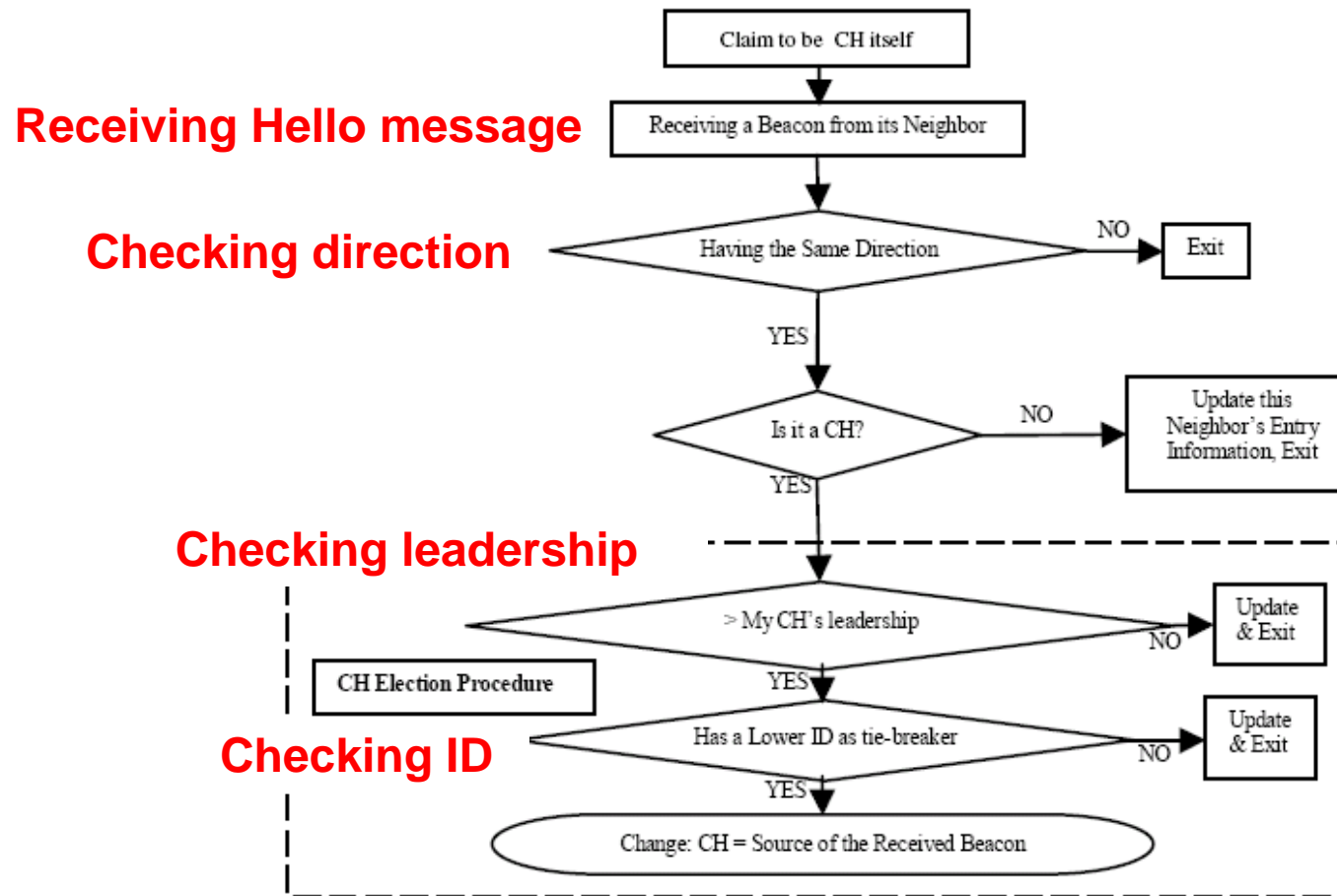
- Each node has an ID initially.
- Each node broadcasts Hello message with its ID to its neighbors periodically.
- CH is determined by three major factors
  - ID, current direction, and leadership duration.



# An example of Lower-ID Clustering



# The Clustering Election Procedure



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# Recovery Mechanism

- If the node has not yet received that beacon within the expiration period, it would indicate the CH has detached from it.
  - Looking for other CHs actively
  - If someone satisfies these three conditions as mentioned above, it becomes the new CH.
  - Otherwise, the node becomes a CH immediately.

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# The Broadcasting Algorithm

- At first, the source broadcasts the packet.
- Other nodes receive the packet
  - If the node is CH
    - Rebroadcast the packet immediately
  - If the node is gateway
    - If the packet is from “outside”
      - Rebroadcasts the packet immediately
    - Else, initializes a counter to count redundant packets
      - If the counter is less than threshold, rebroadcasts the packet

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## Simulation results

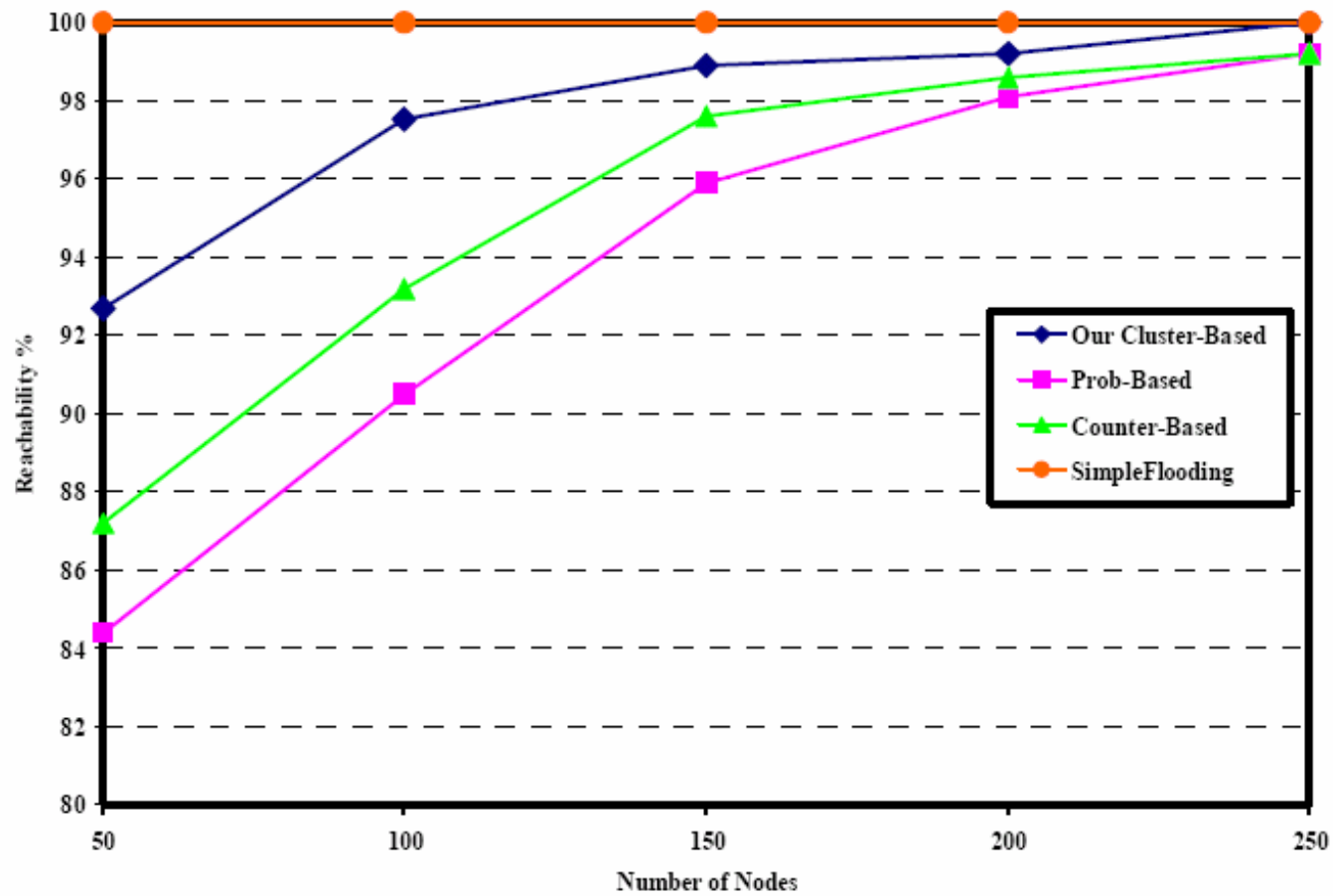
- JIST/SWANS simulator
- Number of nodes = 50~250
- Transmission range = 150m
- Packet size = 64 bytes
- Data rate = 20 packets/sec

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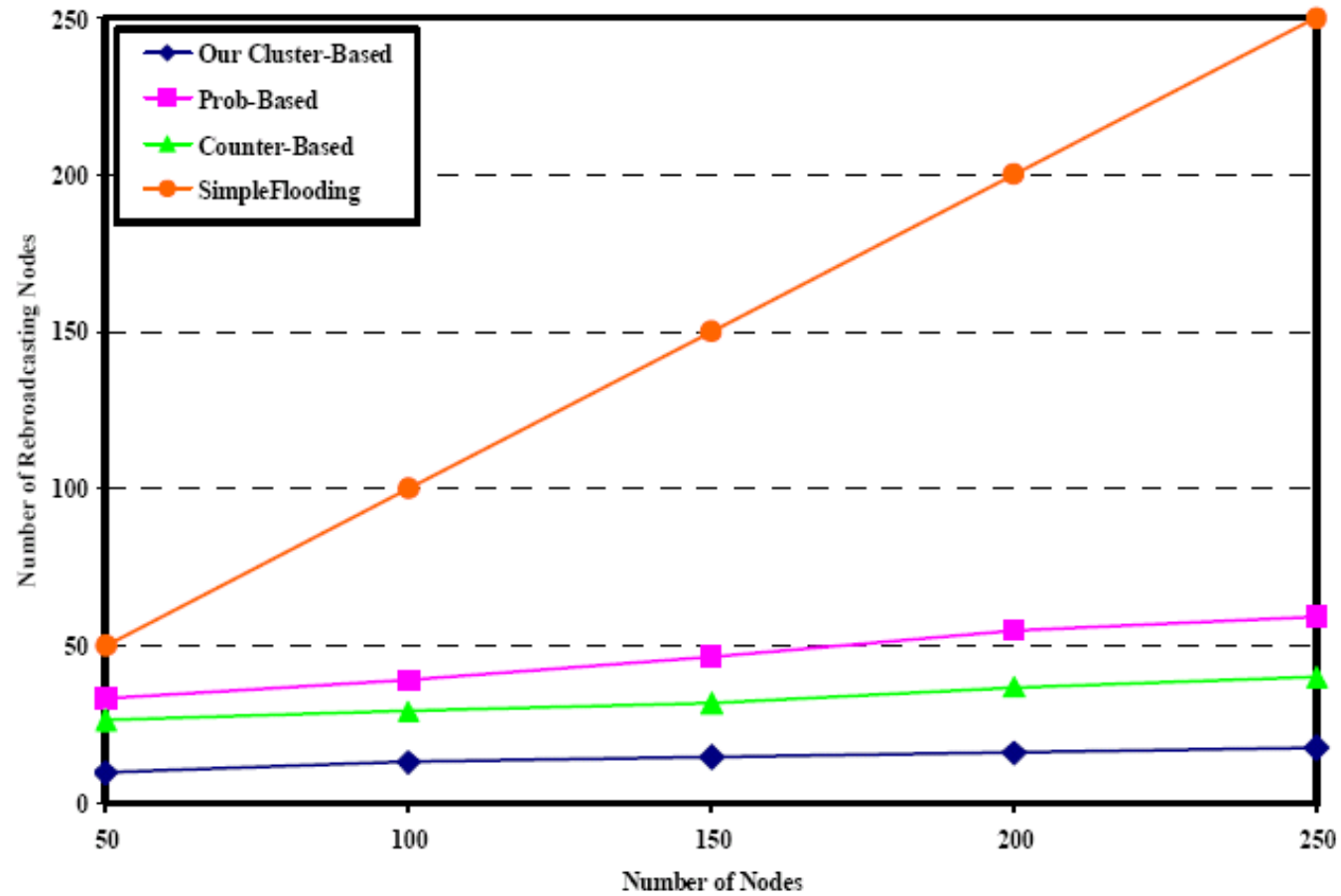
# Simulation results

- Four schemes to compare
  - Proposed Cluster-based algorithm
  - Flooding
  - Probability-based with 0.3
  - Counter-based with 4

# Reachability

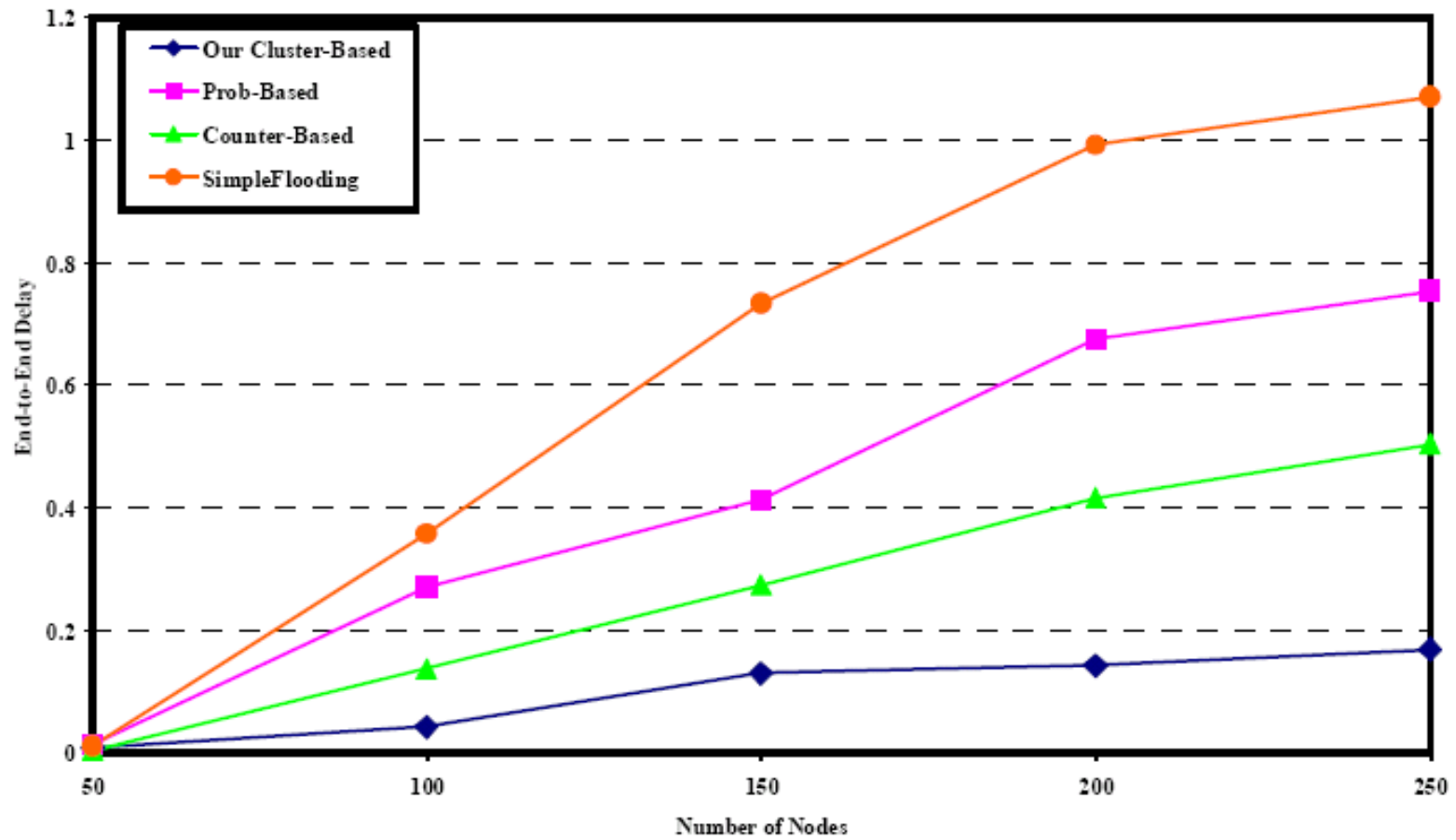


# Number of Rebroadcasting

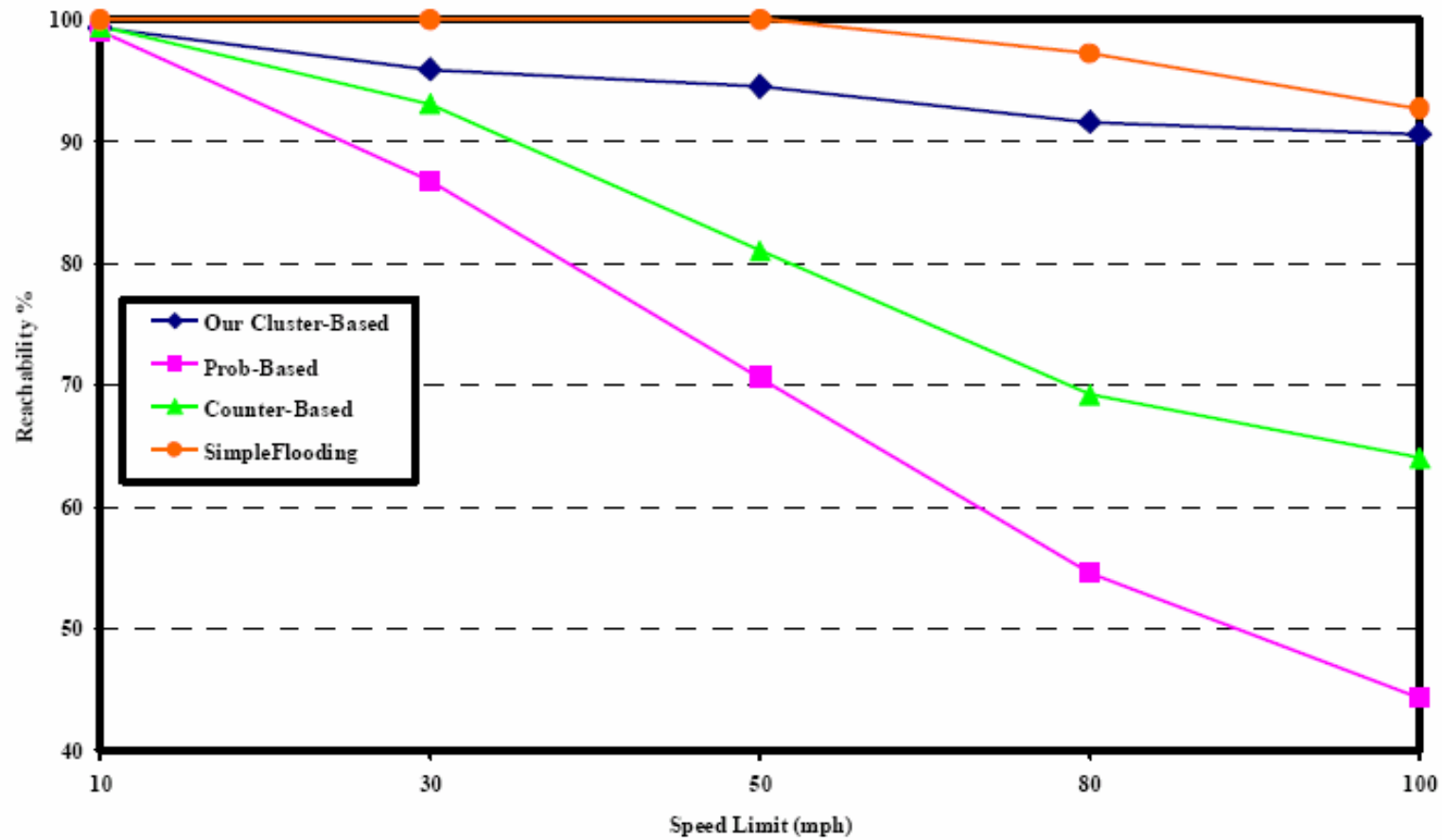




# End-to-End Delay



# Reachability vs. Speed Limit



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# Conclusions

- The directional data and leader duration help improve the stability of clustering scheme under VANET environments.
  - Decreases the overhead required to maintain network topology due to high mobility.
- The broadcasting scheme selects subset of gateways to rebroadcast a package.
  - Significantly improves broadcast reachability with a very low number of rebroadcasts.