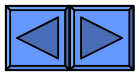
Improving Scalability of Heterogeneous Wireless Networks with Hierarchical OLSR

Communications Research Centre Canada
August, 2004

Communications Research Centre (CRC)
Defence R&D Canada - Ottawa

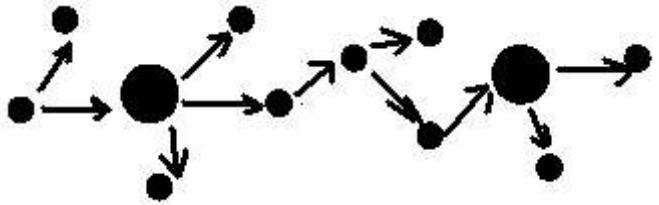
Heterogeneous Wireless Network

- Nodes outfitted with equipments having distinct communication capabilities (e.g., data rate, radio range, frequency band, battery life, etc.)
- A military communication network is a heterogeneous wireless network
- Different network components (soldiers, tanks, command posts, etc.) are equipped with different wireless interface cards

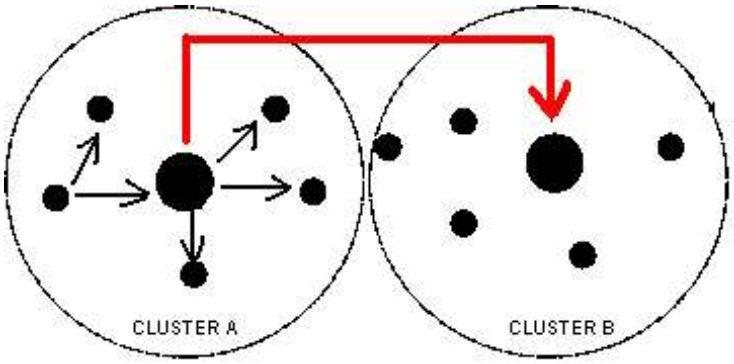


Optimizing Routing in Heterogeneous Network

- Heterogeneous networks faces scalability problem.
- Control overhead increases with the size of network increases.
- A hierarchical structure is introduced to reduce the amount of control traffic and optimize the use of links.
- The hierarchical mechanism is fully integrated with the OLSR



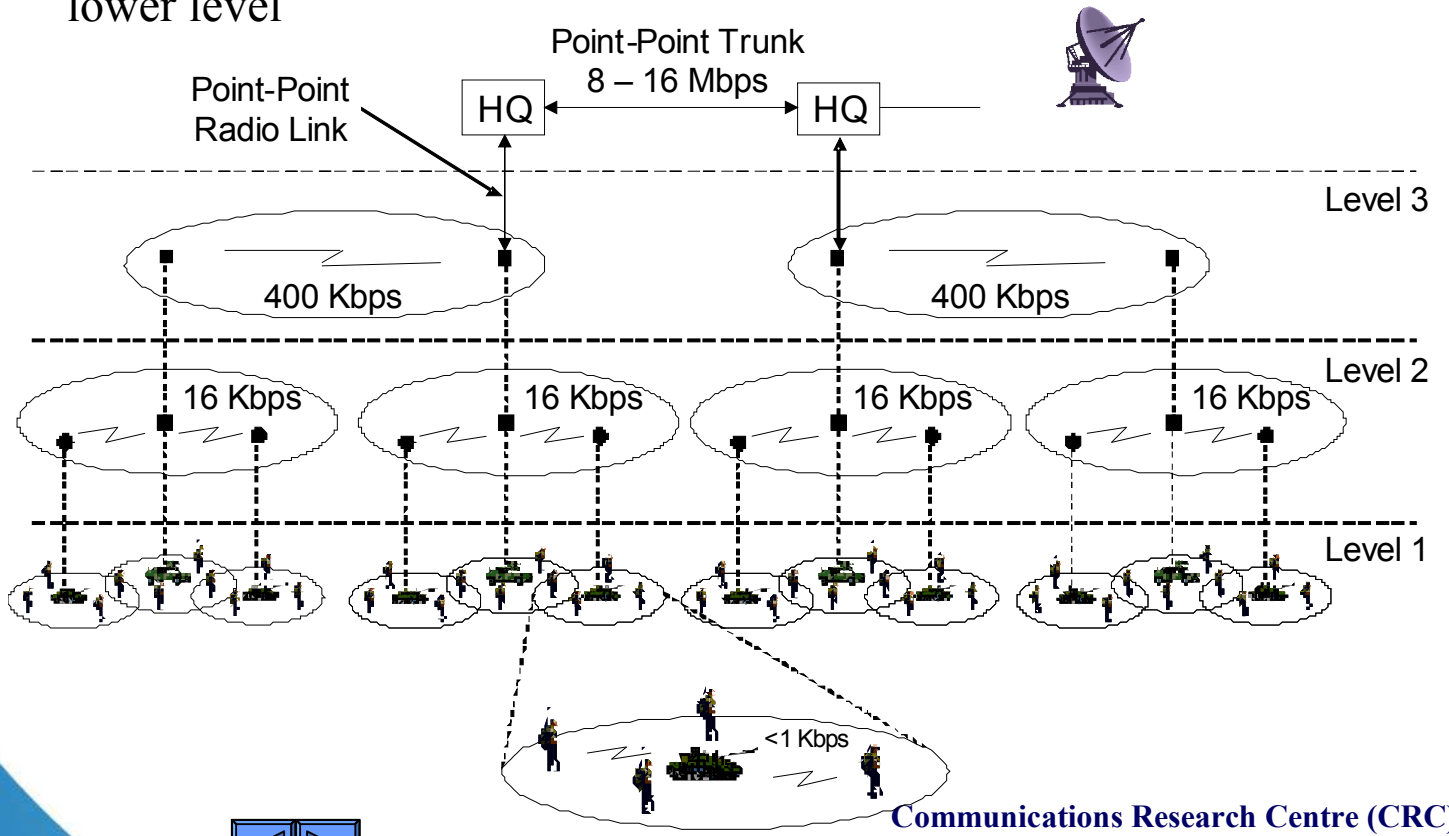
Flat routing approach



Hierarchical routing approach

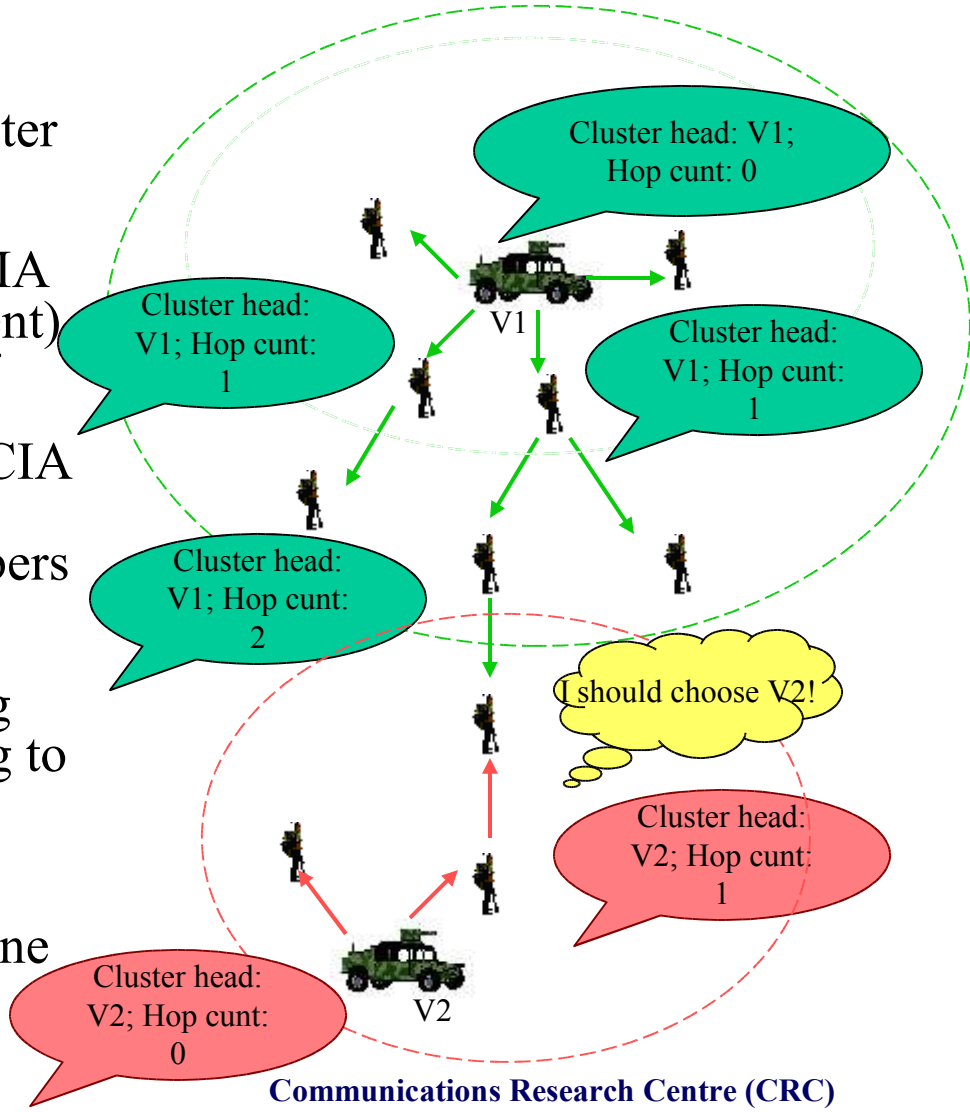
Hierarchical OLSR Overview

- The military communication network is selected as target study
- The network components (soldiers, mobile units, command posts, headquarters) are organized into different topology level
- Nodes at same topology level are grouped into clusters; the one participated in a higher topology level become the cluster header of the lower level



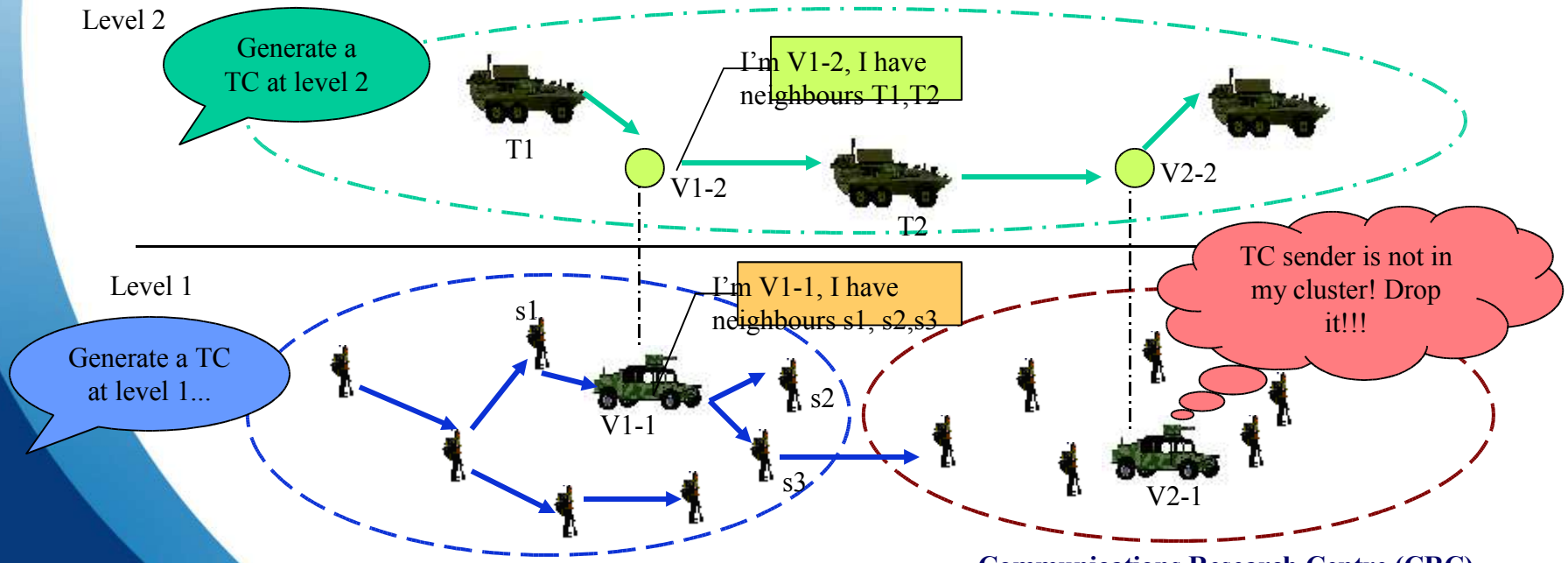
HOLSR - Cluster Configuration

- Nodes with multiple interfaces acts as the cluster head
- Cluster head generates CIA (Cluster ID Announcement) message to identify itself
- Other nodes receive the CIA and join the cluster and become the cluster members
- Cluster members also generate CIA announcing which cluster they belong to
- Nodes located in the overlapping regions of clusters join the closest one



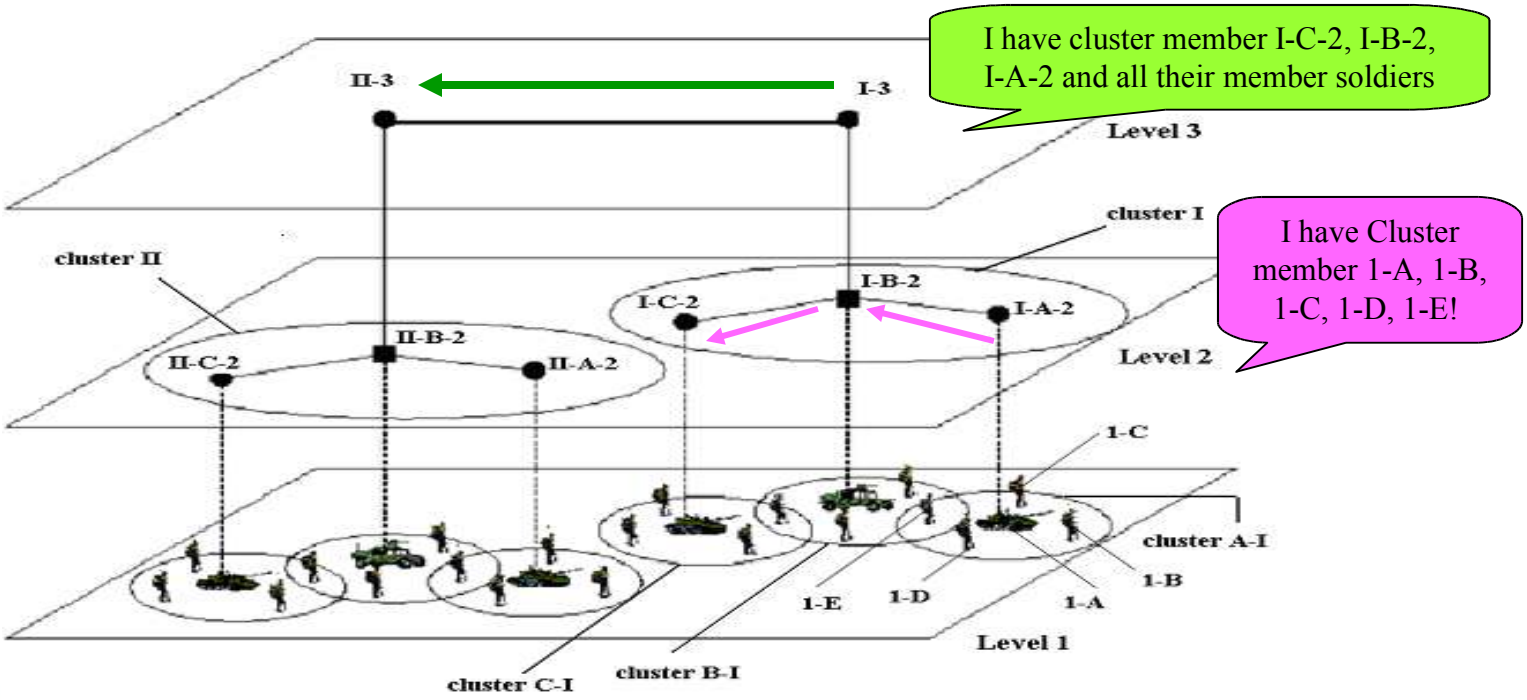
HOLSR - Neighbour Sensing, MPR Selection and TC re-transmission

- Nodes with multiple interfaces participate in multiple topology level
- Each interface performs neighbour sensing and MPR selection independently at each topology level, within its own cluster
- TC re-transmission is restricted within local cluster

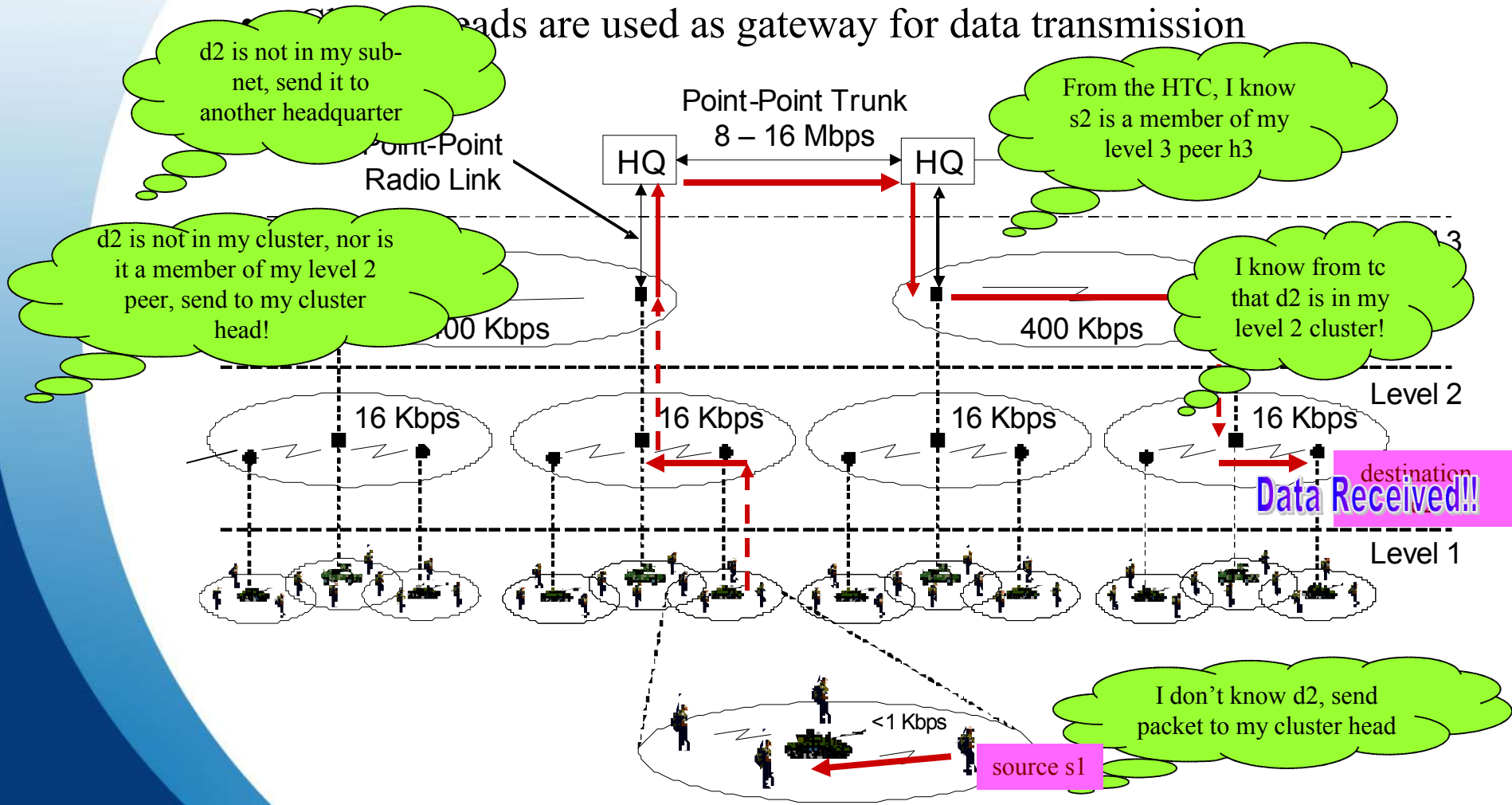


HOLSR - Transmit Cluster Membership Information

- Cluster head uses HTC (Hierarchical TC) to transmit cluster membership information
- HTC is relayed by peer cluster heads at same topology level
- Same as TC, HTC re-transmission is restricted within the cluster

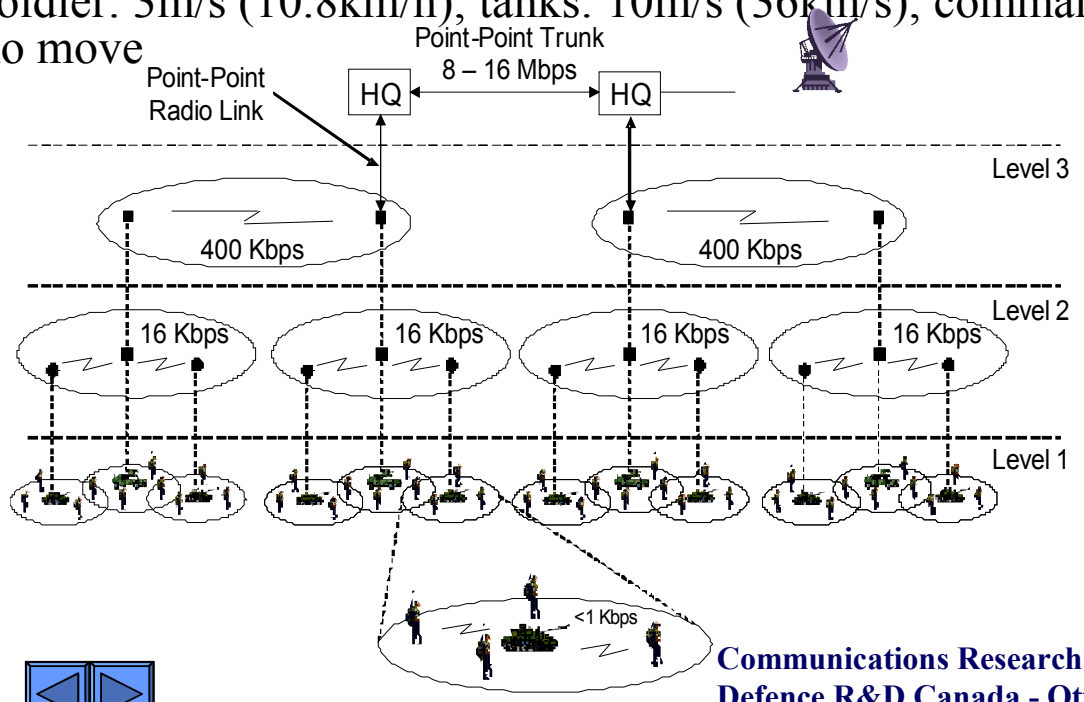


HOLSR - Data Transmission

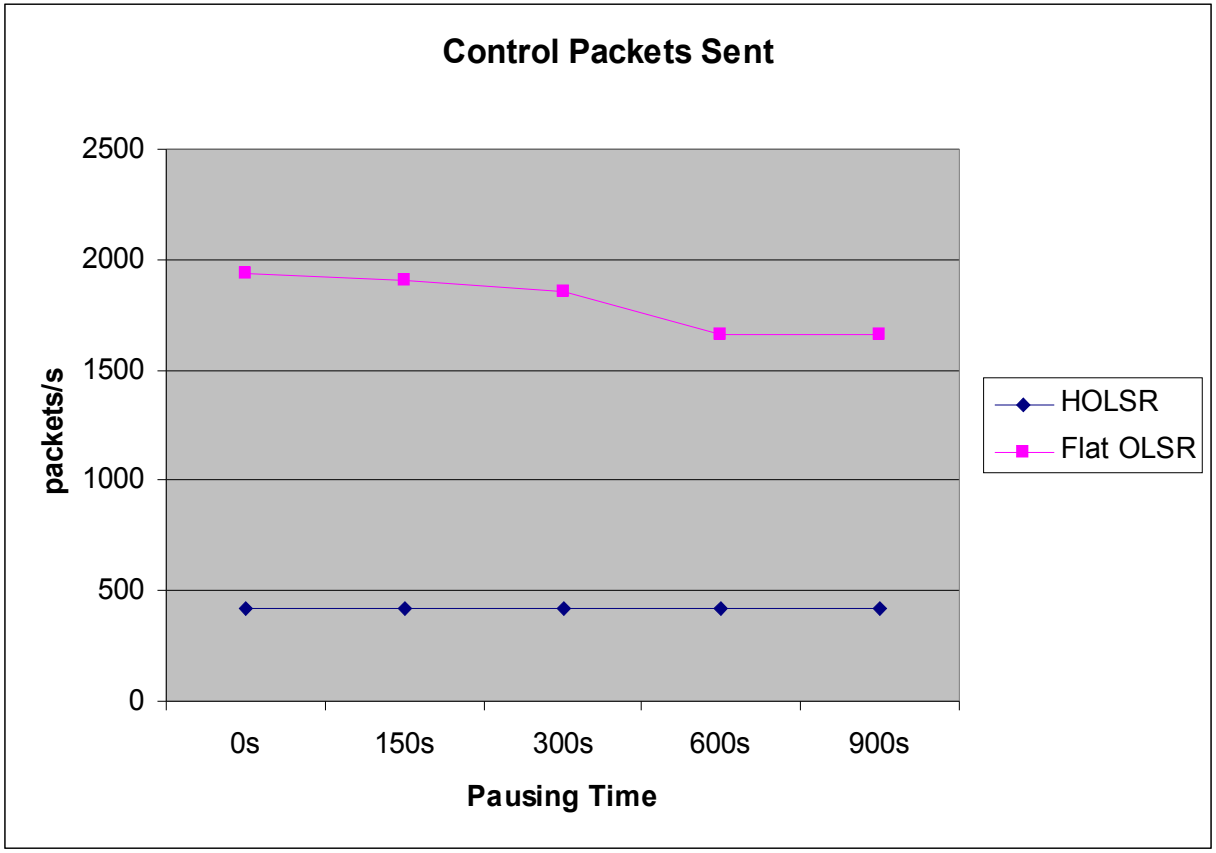


Simulation in OPNET

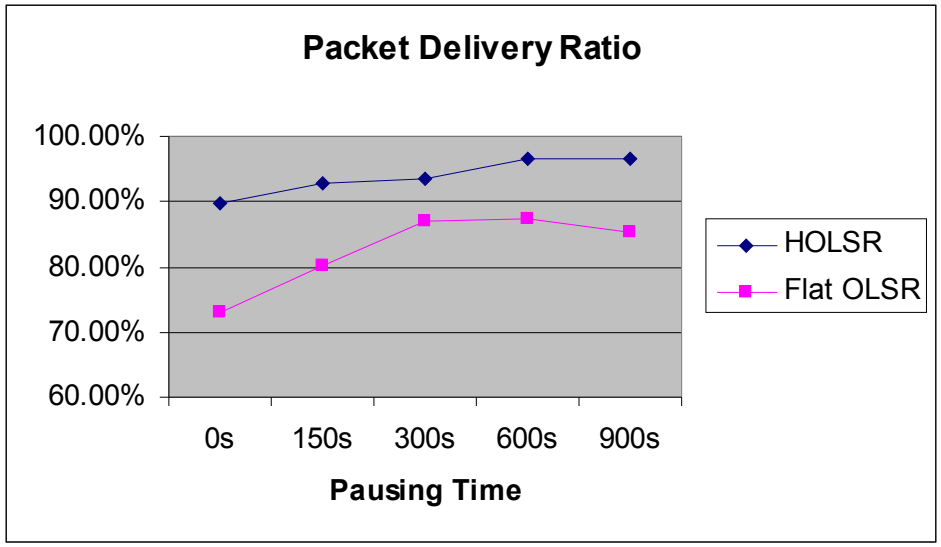
- In each of the two sub-net:
  - 45 soldiers: 1 interface, 1Mbps, 250m range
  - 15 tanks: 2 interfaces, 5.5Mbps, 750m range
  - 5 command posts: 3 interfaces, 11Mbps, 500m range
- Movement scenario: random waypoint
  - soldier: 3m/s (10.8km/h); tanks: 10m/s (36km/s); command post: no move

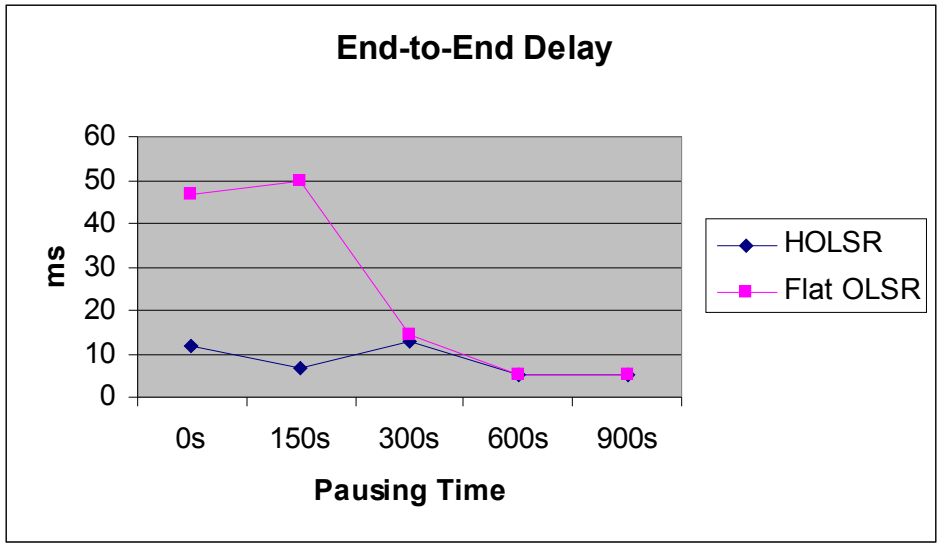


Performance Evaluation in OPNET



Performance Evaluation in OPNET Cont..





Conclusion

- Reduce protocol overhead
  - limit topology control information within the cluster
  - handle local movement at local area
- Improve protocol performance
  - make efficient use of high capacity links
  - higher data packet delivery ratio and shorter end-to-end delay
  - avoid frequent routing updates
- Scalability of OLSR is improved in the heterogeneous network