Multicast Video Performance Evaluation for Emergency Response Communications

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Background

- Wireless communications
- Optical communications
- Information theory
- Human factors in telecoms

WIRELESS VIDEO MULTICAST

In TKK the wireless video multicast for public safety is studied using:

- Test bed experiments within small scale scenarios
- Simulations utilizing QualNet 4.0 Software for large scale scenarios
- Flat ad hoc topology is used in all cases

The test bed :

- Comprises of 4-5 laptops – PCs
- The Video conference program (VIC) with H.261 codec is used
- The average data rate of the video application is around 300 kbps
- NRL implementation : Simplified Multicast Forwarding in conjuction with OLSR

The Simulator :

- QualNet models large scale networks in reasonable simulation times
- Provides ODMRP library for wireless multicast

- Team coordination
- Distant evaluation
- Secure safety of firefighters

Qualnet 4.0

QualNet's 4.0 Advanced Wireless Library can support include:

- Network planning
- Frequency planning
- Capacity planning
- Service quality planning

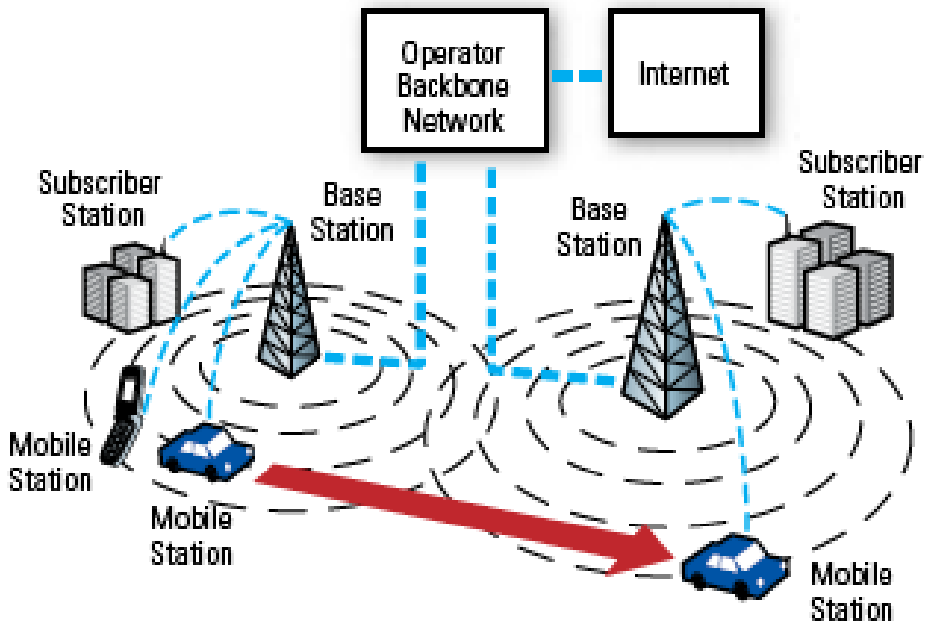
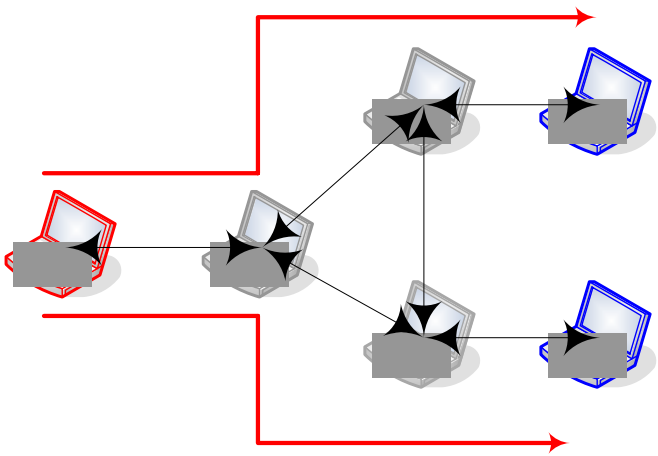
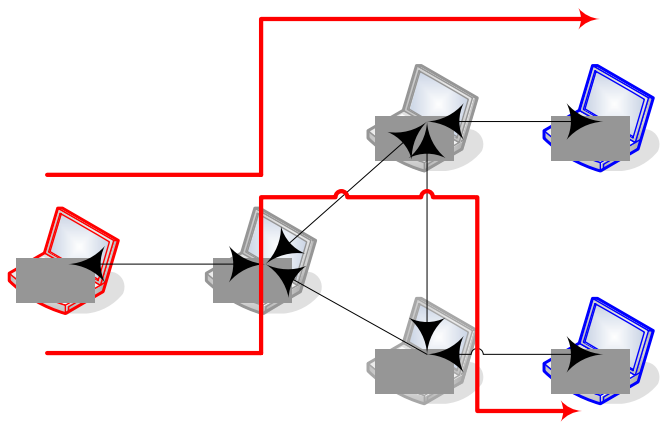


Diagram of Base Stations and Mobile Stations in the Advanced Wireless (WiMAX) Library of QualNet.

ON DEMAND MULTICAST ROUTING PROTOCOL

- Mesh based instead of tree based brings route redundancy
- Mesh initiated by the multicast source
- Trade off between data and control messages overhead
- A subset of network nodes is responsible for flooding the data packets





✓ The alternate path could be discovered

PERFORMANCE METRICS – QoS CONSTRAINTS

- Average data packet delivery ratio

The ratio of data packets delivered to the multicast receivers versus the number of data packets expected to be delivered

- Average data latency

Average delay of data packets from application layer of multicast source to application layer of multicast receiving nodes

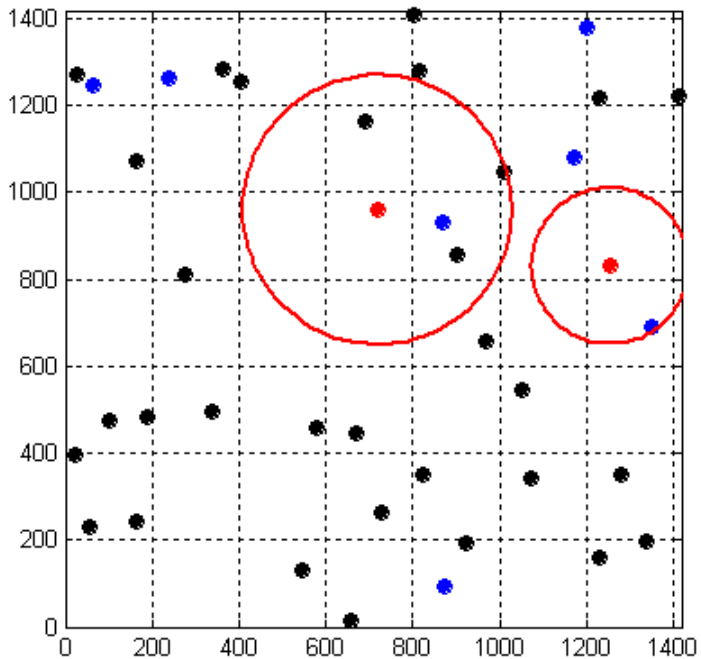
- MESA project states that:

Video communication frame loss up to 25% and average end-to-end delay less than 500ms are demanded

SIMULATION SET UP – PERFORMANCE PARAMETERS

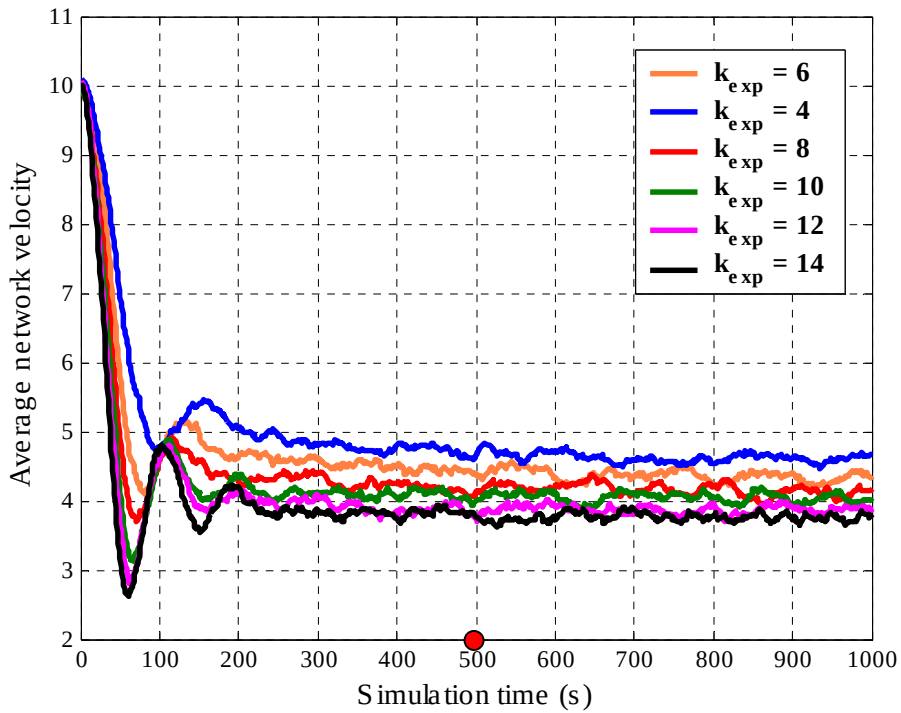
- N = 40 Nodes
- IEEE PHY 802.11b @ 11Mbps
- Two-power model
- Mobility
- 802.11 without VCS at the MAC
- ODMRP with typical soft state timers
- UDP - RTP
- Video modelled as CBR traffic
- Datarate : 355 kbps
- Performance parameters
  - Multicast group size
  - Number of video feeders
  - Node density

$$k_{exp} = \frac{p R^2}{S} N$$



MOBILITY MODEL

- Random waypoint mobility model was used in the simulations
- Requirement : the minimum velocity should be non zero
- The performance metrics are collected after the “warm-up “ phase
- The denser is the topology, the lower becomes the average speed

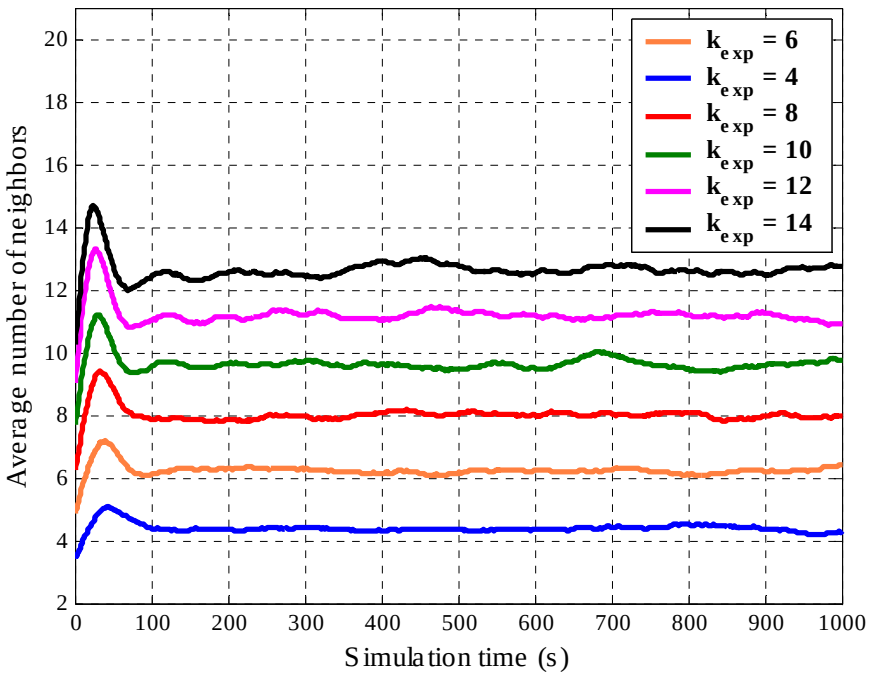


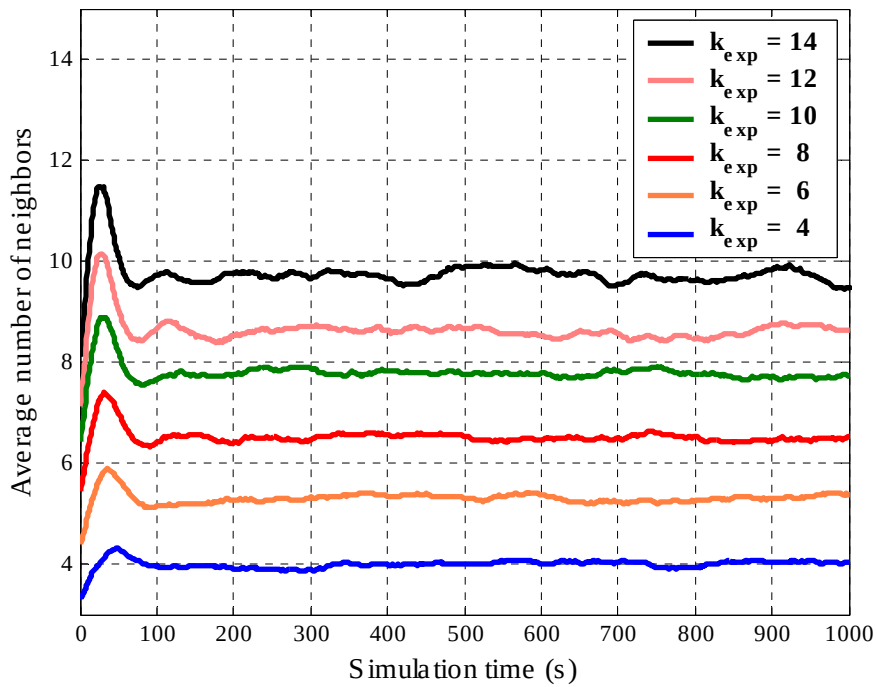
$$V_{\min} = 1 m/s \quad V_{\max} = 19 m/s \quad t_{\text{pause}} = 50 s$$

EDGE EFFECTS

Nodes placed near the boundaries of the area would not increase their average number of neighbors proportionally to the square of the transmission radius

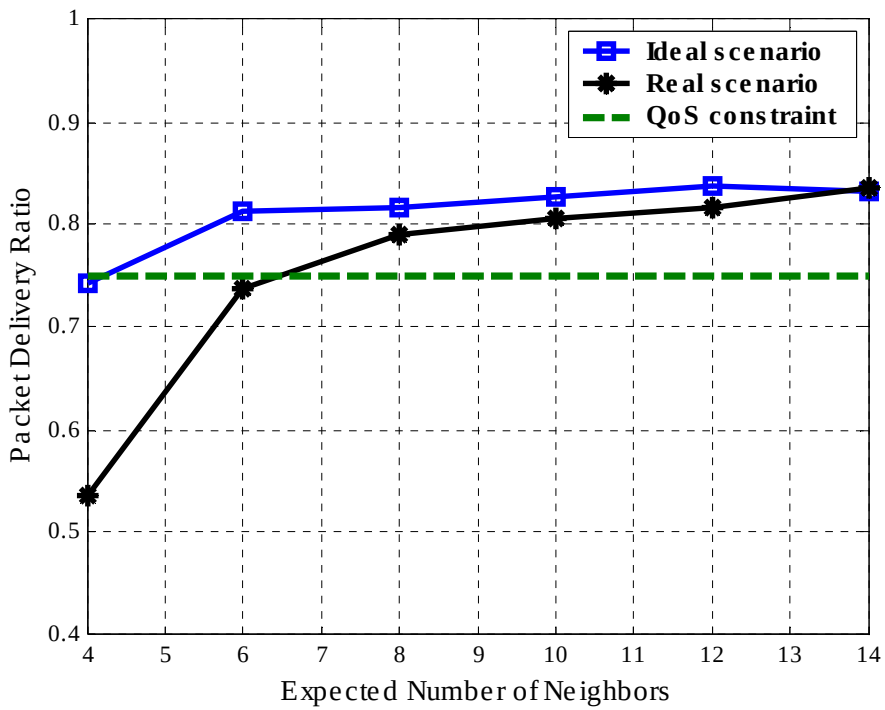
- The actual number of neighbors converges to the expected number for homogeneous power assignment
- Edge effect is more persistent for dense node distributions





SIMULATION SCENARIOS & RESULTS I

- Two multicast senders and ten multicast receiving nodes belonging to the same multicast session
- Same expected density but different actual density of nodes for the two scenarios
- The performance degradation is severe for sparse network topology
- The mesh based ODMRP eliminates the unidirectional effect in dense networks



SIMULATION SCENARIOS & RESULTS I

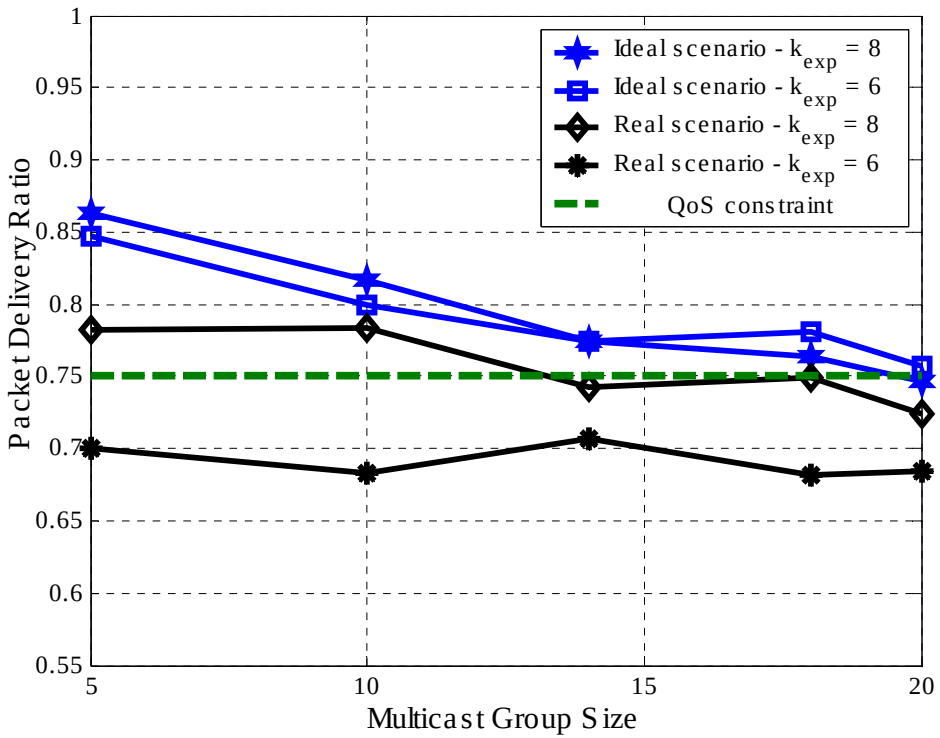
- The average latency is increased as the topology becomes denser
  - More nodes become members of the Forwarding Group broadcasting data and control packets
  - The channel contention becomes more persistent when the number of neighbors increases
- The average latency is significantly smaller when unidirectional links are accounted
  - Control and data packets are dropped
  - Less actual number of neighbors
  - Smaller Forwarding Group

	Average Number of neighbors per node					
	4	6	8	10	12	14
Delay (ms) real scenario	23	34	44	75	93	90
Delay (ms) ideal scenario	109	306	292	361	370	334

Table 1: Average end to end delay of two video applications for various densities of nodes

SIMULATION SCENARIOS & RESULTS II

- Two multicast senders and variable multicast receiving nodes
- Two critical expected density of nodes are simulated
- The protocol scales well with the multicast group size



SIMULATION SCENARIOS & RESULTS II

- The average latency is increased as more nodes join the multicast session
  - The number of Join Replies grows proportionally to the number of multicast receiving nodes
  - The size of the FG group is also increased

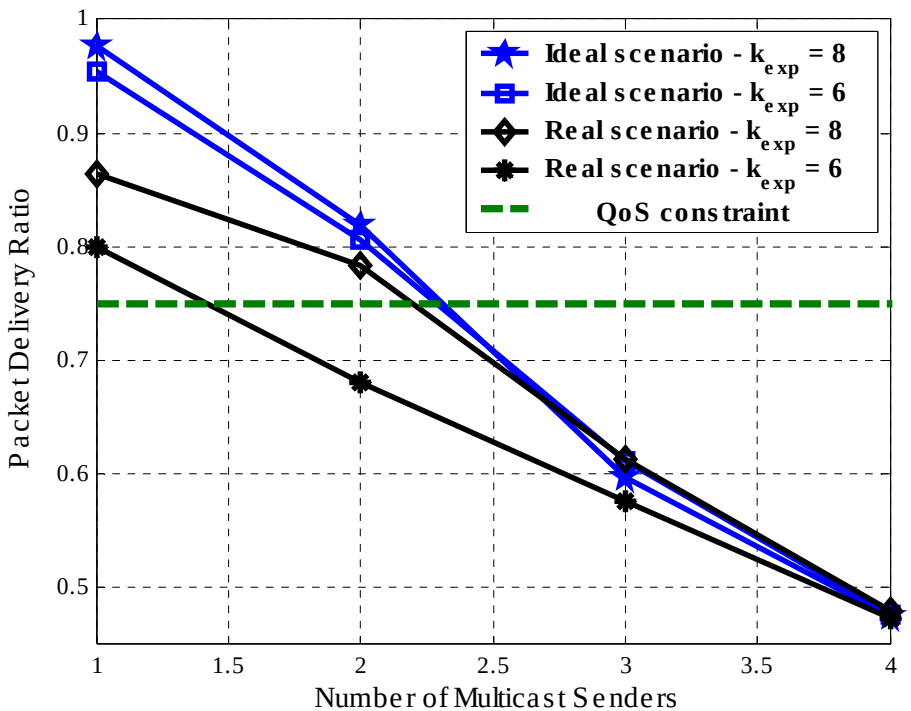
- The average latency is smaller within unidirectional networks

	Size of Multicast Group				
	5	10	14	18	20
Delay (ms) ideal scenario 8 neighbors	102	319	460	552	553
Delay (ms) ideal scenario 6 neighbors	103	250	374	453	433
Delay (ms) real scenario 8 neighbors	24	56	96	109	151
Delay (ms) real scenario 6 neighbors	23	32	45	64	59

Table 2: Average end-to-end delay of two video applications for different size of the multicast group.

SIMULATION SCENARIOS & RESULTS III

- The needs for devices multicasting video communication is high
- Ten multicast receiving nodes and variable number of video feeders
- The performance degradation is severe for all scenarios and node densities in case the number of video feeders becomes larger than two
- ODMRP builds per-source meshes



CONCLUSIONS

- The model used to describe mobility affects significantly the simulation results
- The performance with respect to the node density should consider the edge effect phenomena
- The effect of extensive unidirectional links is eliminated as the density of the network is increased
- The control and data forwarding overhead is smaller for networks with high degree of unidirectionality
- As the number of multicast sender increases the flat ad-hoc network topology fails to meet the QoS constraints

Chorist project

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