

Performance Evaluation Of Mobile Ad Hoc Networks

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Committee

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Outline

- ◆ Introduction
- ◆ Background on MANET Routing Protocols
- ◆ AODV
- ◆ Motivation
- ◆ Issues addressed in this Thesis
- ◆ Experimental Evaluation
- ◆ Simulation
- ◆ Conclusion

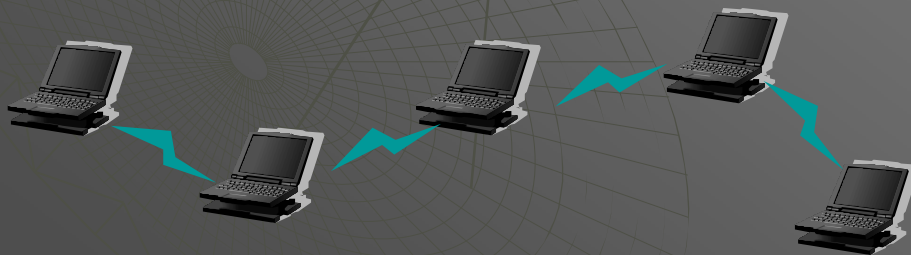
Introduction

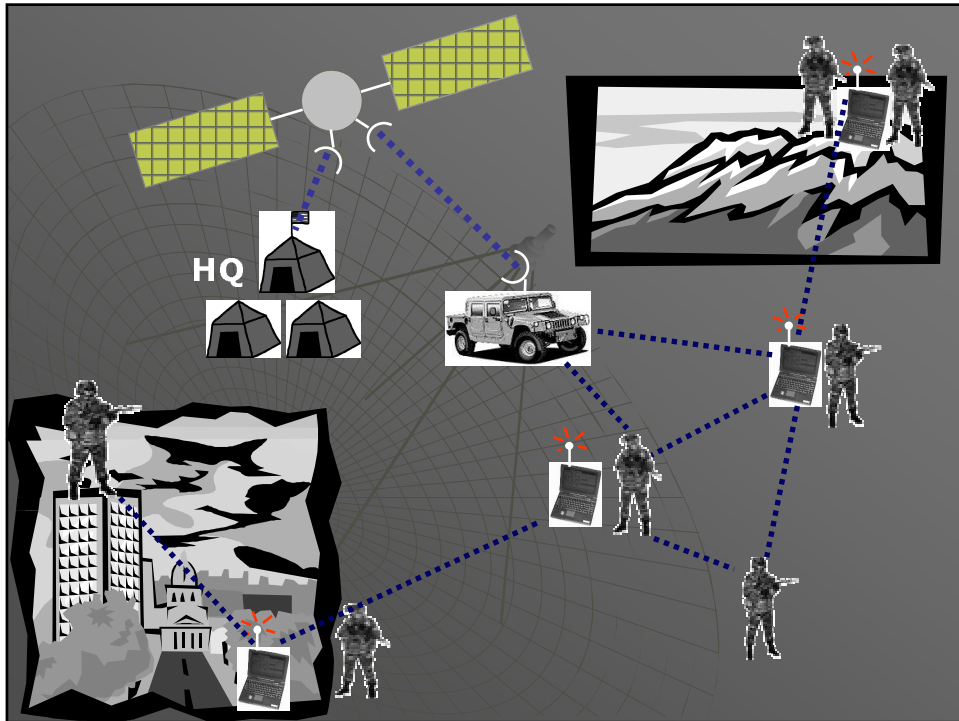
Ad Hoc Networking



MANET

- ◆ What is a *MANET* ?
 - Mobile nodes, Wireless links
 - Infrastructure less: by the nodes...
 - Multi-hop routing: ...for the nodes
 - Minimal administration: no hassles





Background on MANET Routing Protocols

- ◆ Routing protocols for MANETs is divided into two types
 - Proactive routing protocol – Table driven
 - DSDV
 - Reactive routing protocol – On demand
 - DSR, AODV (DSR+DSDV)

Ad hoc On-Demand Distance Vector (AODV)

- ◆ Initial design of AODV was undertaken to improve upon the deficiencies in DSDV
- ◆ AODV reduces the need for system-wide broadcasts to counter the problems due to the characteristics of wireless medium
- ◆ AODV found it necessary to incorporate the on-demand route discovery and route maintenance mechanisms from DSR

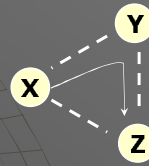
Destination Sequenced Distance Vector (DSDV)

- ◆ DSDV is derived from *Distributed Bellman-Ford* (DBF) algorithm
 - DBF was designed for wired networks, so when used in wireless networks routing loops are formed
 - Enhancements are made in DSDV to counter looping problem

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Formation of Loops when DBF is used

- X-Y-Z are connected in a triangle
- X-Z link is highly unstable
- If Y-Z link fails for a short period, it causes a routing loop Y-X-Y-Z



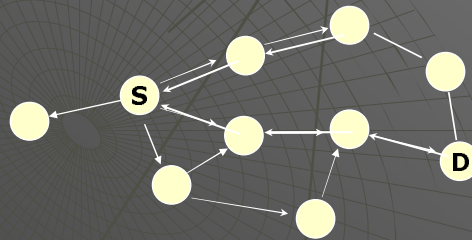
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DSDV uses the sequence numbers to remove stale routes from the routing table of each node

- $S(X)$ and $S(Y)$ are the destination sequence numbers stored at node X and node Y respectively
- If $S(X) < S(Y)$, node X does not update routes
- If $S(X) = S(Y)$, node X checks for lower metric
- If $S(X) > S(Y)$, node X updates accordingly

Dynamic Source Routing (DSR)

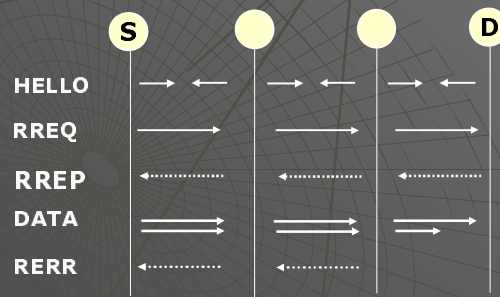
- ◆ On-demand Route Discovery mechanism



AODV

- ◆ Uses two mechanisms for routing
 - **Route Discovery** – This mechanism is invoked when a source node has data to send
 - ◆ Route request (RREQ) – Broadcasts in search for a destination
 - ◆ Route reply (RREP) – Unicast packet by the destination/intermediate node
 - **Route Maintenance** – This mechanism responds to link failures
 - ◆ Route error (RERR) – Broadcast packet when a link fails

Contd...



Motivation

- ◆ In a *Mobile Ad Hoc Network (MANET)*, the surrounding physical environment is an important element to be considered for its deployment
- ◆ It is necessary to evaluate MANET in real world scenarios before actually using it in the commercial world

Issues Addressed in this Thesis

- ◆ Comparing two MANET implementations
- ◆ Comparing the performance of MANET in an indoor/outdoor environment
- ◆ Key parameters in determining MANET performance
- ◆ Differences between simulations and the real world
- ◆ Analyzing the effects of interference in a small MANET using simulation

Experimental Evaluation

- ◆ Survey of Existing AODV Implementations
- ◆ Experimental Environment
- ◆ Evaluation Tool
- ◆ Results & Discussion

Survey of Existing AODV Implementations

- ◆ User space implementation
 - Mad-hoc, AODV-UIUC, AODV-UU, AODV-UCSB
- ◆ Kernel space implementation
 - Kernel-AODV

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- ◆ Kernel space implementations
 - Less portable
 - Weakens memory management
- ◆ AODV-UU and AODV-UCSB were chosen

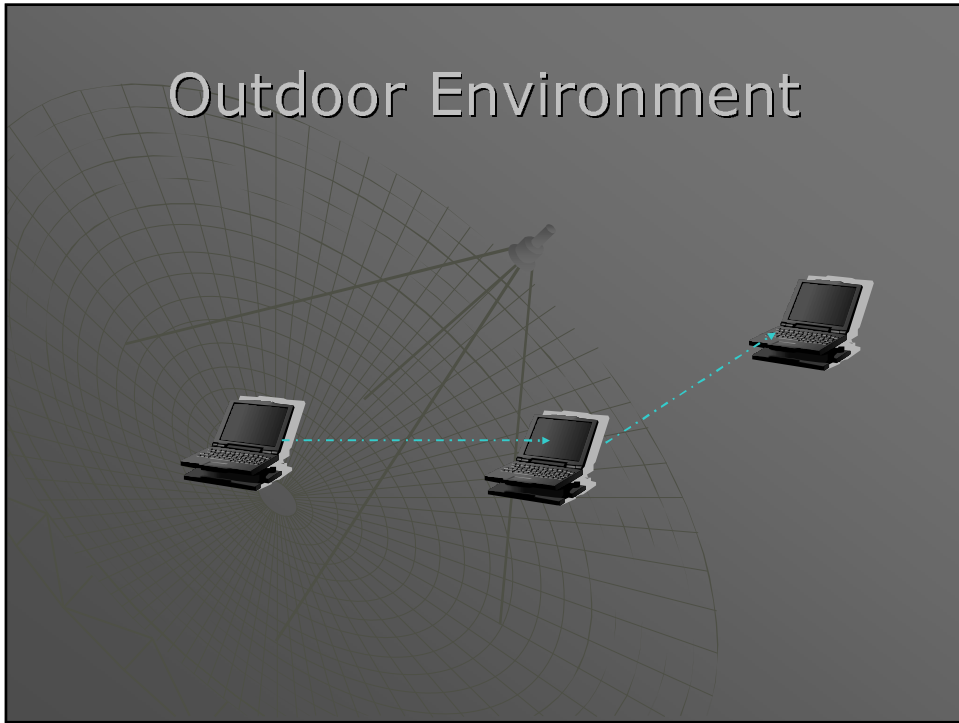
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- ◆ AODV-UU and AODV-UCSB are written in Linux and C
- ◆ Logical structure of both is the same
- ◆ AODV-UU supports *unidirectional-link avoidance*

Experimental Environment

- ◆ Experiments were conducted for static and mobile scenarios in indoor and outdoor environment
 - Static scenario - varying packet sizes
 - Mobile scenario - walking speed, fixed packet size

Outdoor Environment



Indoor Environment



Performance Metrics

- ◆ Throughput – It is defined as the amount of data successfully delivered from the source to the destination in a given period of time.
- ◆ Response Time – This is defined as the time required for a packet to travel from source to destination.
- ◆ Block Size – It is defined as the ratio of total size of each data packet transmitted

Evaluation Tool

- ◆ The following four graphs helps in analyzing the MANET properties
 - Throughput Graph
 - Network Signature Graph
 - Saturation Graph
 - Mobility Graph

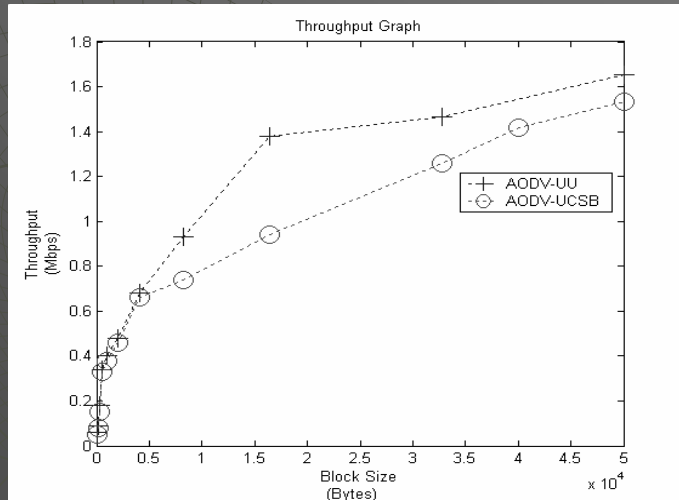
Network Connectivity Test

- ◆ **Hello**
 - Correct reception of neighboring HELLO messages
 - Correct installation of route to neighboring node
 - Deletion of route when nodes are disconnected
- ◆ **2-hop RREQ/RREP**
 - Node 1 issues a RREQ for node 3
 - Node 2 receives the RREQ, and replies with a RREP
 - Node 1 receives the RREP, install the route, and pings are correctly received
- ◆ **RERR**
 - Node 2 issues a RERR for node 3 and removes its route to node 3
 - Node 1 receives this RERR, and removes its route to node 2 also

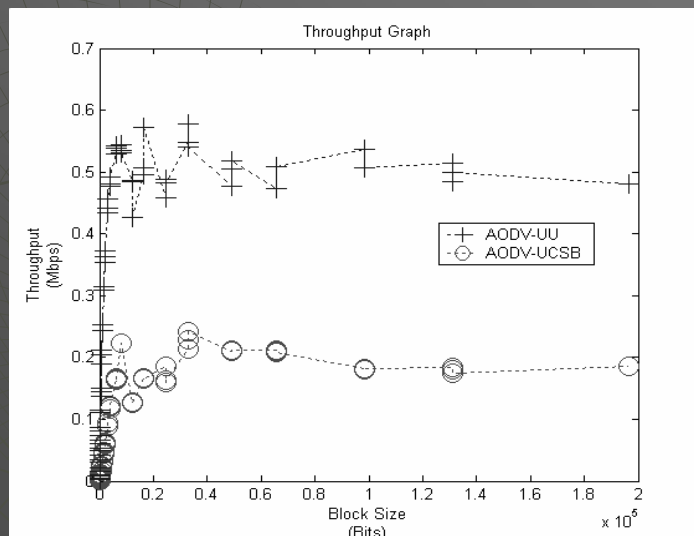
Results & Discussion

- ◆ **Comparison of AODV-UU and AODV-UCSB**
 - Implemented a static scenario in Indoor and Outdoor environment to study the effect of unidirectional links
 - Implemented mobile scenario to compare route discovery time

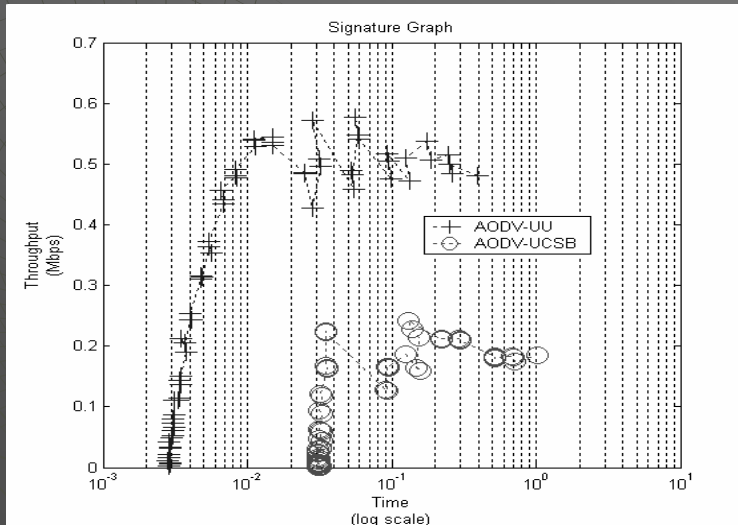
Throughput Graph (Outdoor)



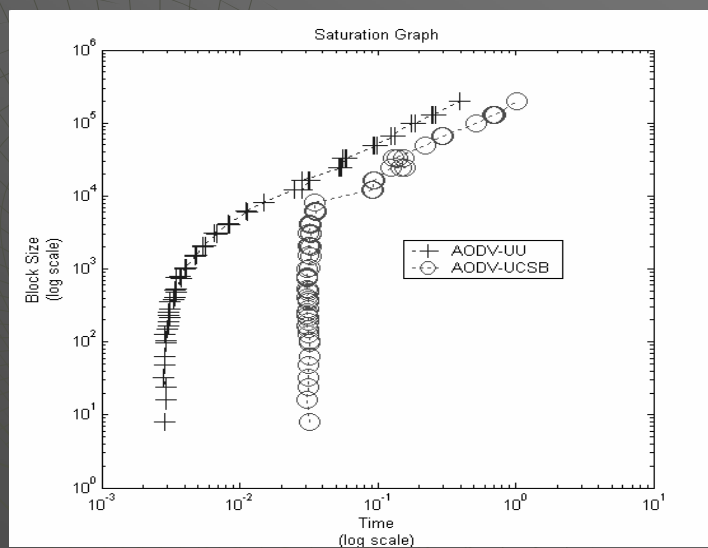
Throughput Graph (Indoor)



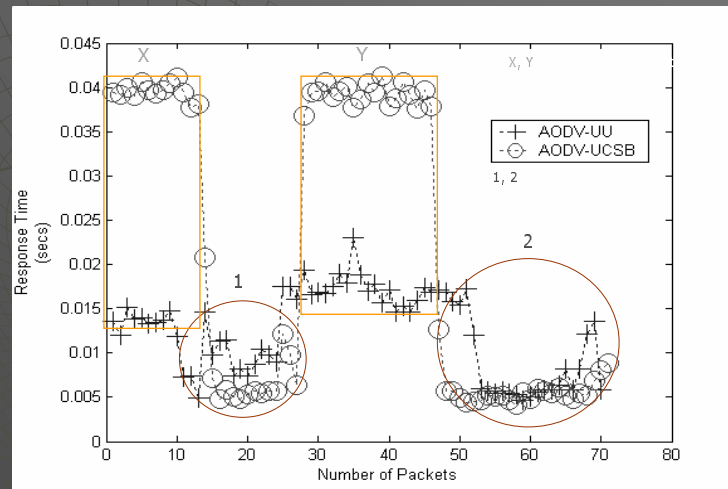
Network Signature Graph (Indoor)



Saturation Graph (Indoor)



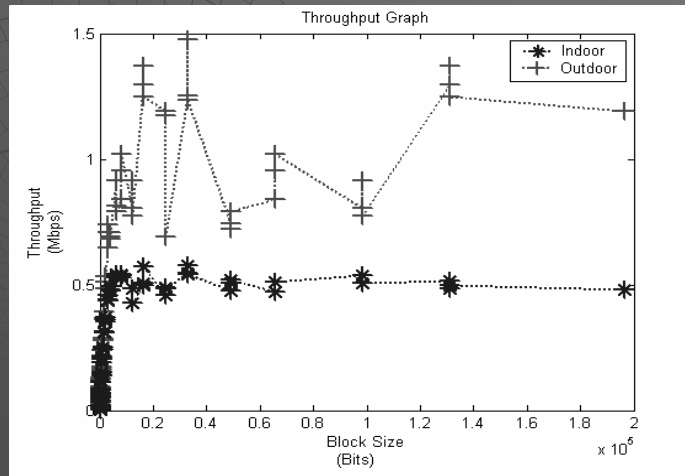
Mobility Graph (Indoor)



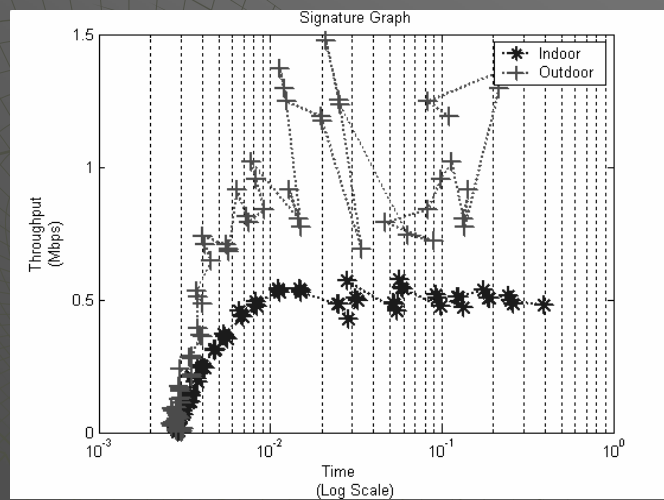
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- ◆ Comparison of Indoor and Outdoor environment using AODV-UU
 - Study the effect of external environment on the performance of AODV-UU
 - AODV-UU was tested for static scenario in indoor and outdoor environment

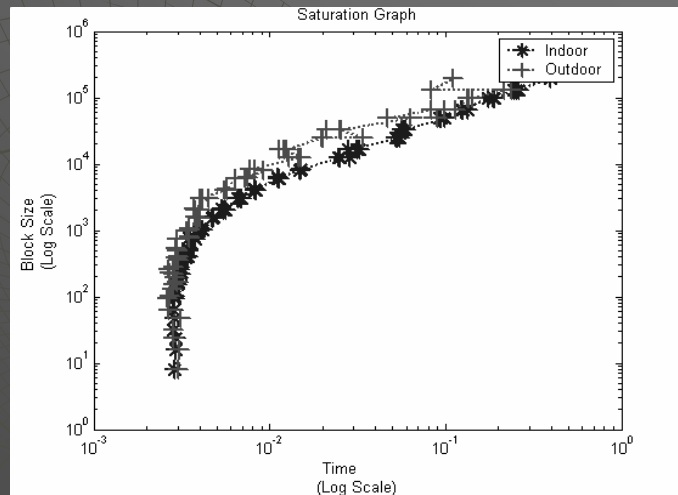
Throughput Graph (AODV-UU)



Signature Graph (AODV-UU)



Saturation Graph (AODV-UU)



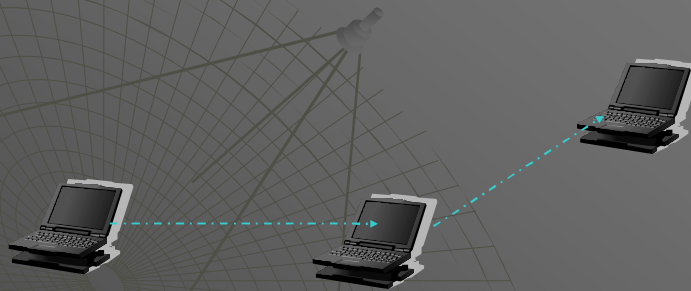
Simulation

- ◆ Simulation Tool used is *ns-2*
- ◆ Assess the credibility of the simulator by comparing simulation results with experimental results for mobile scenario
- ◆ Study the effect of interference in small MANETs

Simulation Parameters

	Parameters	Values
Radio Characteristics	Transmission range	250 meters
	Wireless bandwidth	1 Mbps
Communication Model	Traffic type	Constant bit rate
	Packet size	Varying
Mobility Pattern	Node speed	0 m/s – 5 m/s (walking speed)
Simulation Parameters	Simulation time	300 seconds
	Number of nodes and network area	5 nodes in an area 1000 x 1000m
Routing and MAC Protocols	Routing protocol	AODV
	MAC protocol	IEEE 802.11

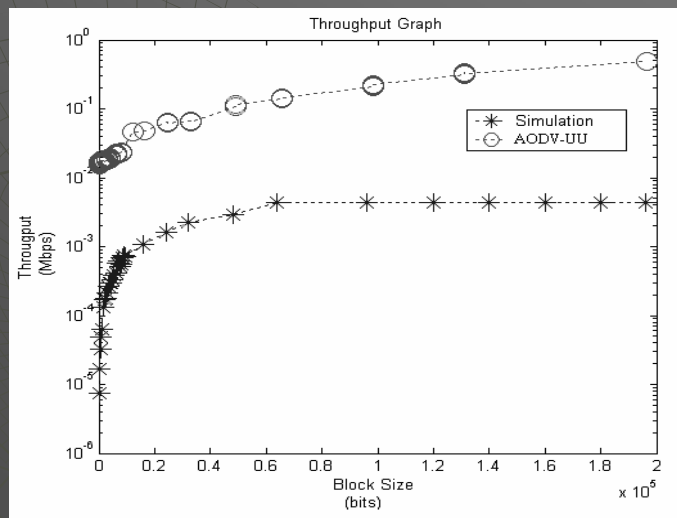
Assess the credibility of the simulator



Experimental Scenario

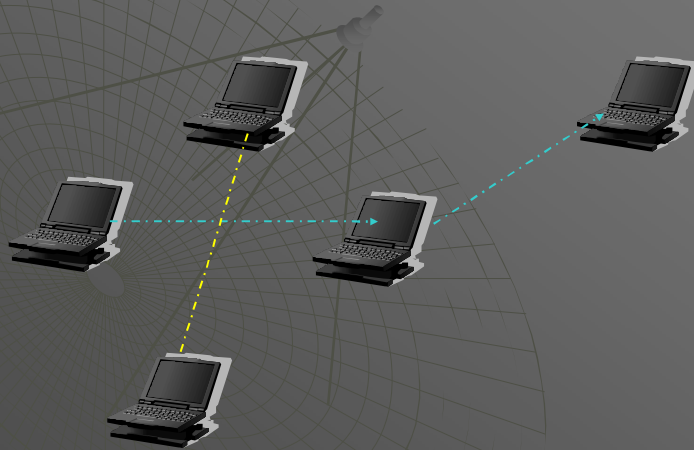


Throughput Graph



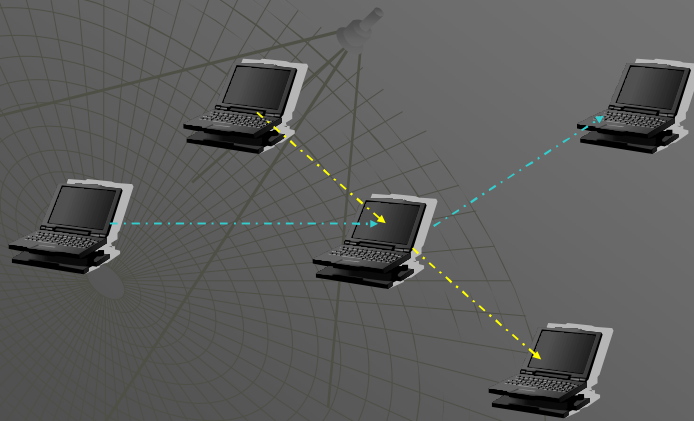
Study the effects of Interference on MANET

- ◆ Mobility Scenario with Interference Traffic Pattern 1

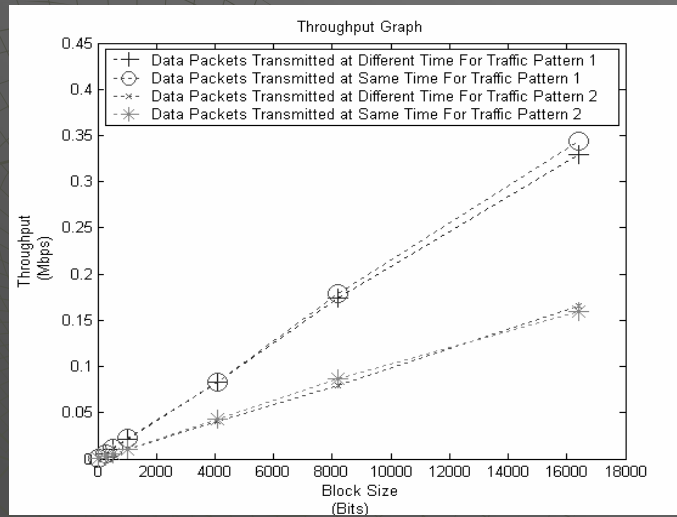


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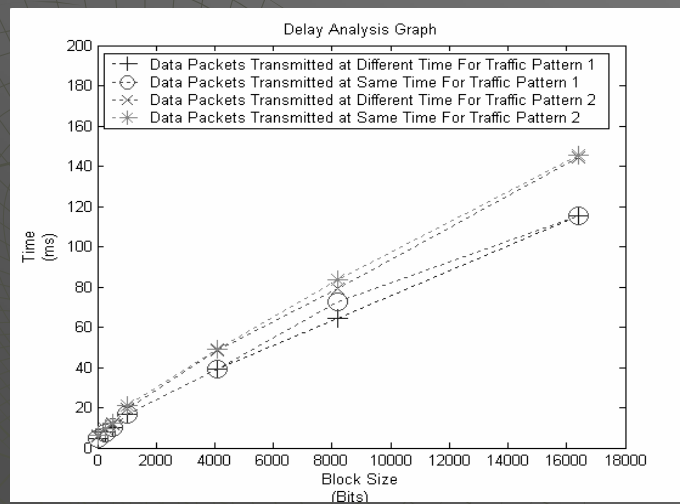
- ◆ Mobility Scenario with Interference Traffic Pattern 2



Throughput Graph



Delay Analysis Graph



Conclusions

- ◆ The effect of unidirectional links on MANETs performance is quite considerable and cannot be ignored.
- ◆ The performance of MANET can be improved in indoor/outdoor environment, by finding the critical zones
- ◆ Strong correlation between the parametric values obtained by simulation and experimental results
- ◆ As the Interference traffic increases the performance of the protocol degrades proportionally (linearly)