

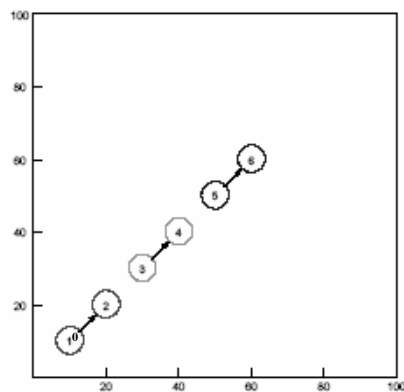
EEC 687/787 Mobile Computing (Spring, 2007)

Ns-2 Laboratory #4 (February 5)

Chansu Yu

Cleveland State University

Recap: Mobile Network Simulation with ns-2



- 6 nodes
- Located (10,10), (20,20), ...
- CBR (Constant bit rate) traffic based on UDP 1→2, 3→4, 5→6



```
Ns run script: ed6sta.tcl
Summary: filter (/) and grep
Summary script: fil*.awk,
                delay.awk
Xgraph
```

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c.yu91@csuohio.edu

Mobile Node Modules

```
$ns_node-config
-adhocRouting      DumbAgent \
-llType            LL \
-macType           Mac/802_11 \
-ifqType           Queue/DropTail/PriQueue \
-ifqLen            50 \
-antType           Antenna/OmniAntenna \
-propType          Propagation/FreeSpace \
-phyType           Phy/WirelessPhy \
-channelType       Channel/WirelessChannel \
-topoInstance     $topo \

set WT1 [$ns_node $1]
...
set WT6 [$ns_node $6]
```

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c.yu91@csuohio.edu

Mobile Node Modules (Continued)

- ❑ Agent
 - Responsible for packet generations and receptions
 - Can think of it as an Application layer
 - CBR(Constant Bit Rate), TCP, Sink, FTP, etc.
- ❑ RTagent(DSDV, TORA, AODV) or DSR
 - Ad-hoc network routing protocols
 - Configure multi hop routes for packets
- ❑ LL (Link Layer)
 - Runs data link protocols
 - Fragmentation and reassembly of packet
 - Runs Address Resolution Protocol(ARP) to resolve IP address to MAC address conversions

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c.yu91@csuohio.edu

Mobile Node Modules (Continued)

❑ IFq (Interface Queue)

- PriQueue is implemented to give priority to routing protocol packets
- Supports filter to remove packets destined to specific address

❑ Mac Layer

- IEEE 802.11 protocol is implemented
- Uses RTS/CTS/DATA/ACK pattern for all unicast pkts and DATA for broadcast pkts

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c.yu91@csuohio.edu

Mobile Node Modules (Continued)

❑ NetIF (Network Interfaces)

- Hardware interface used by mobilenode to access the channel
- Simulates signal integrity, collision, tx error
- Mark each transmitted packet with transmission power, wavelength etc.

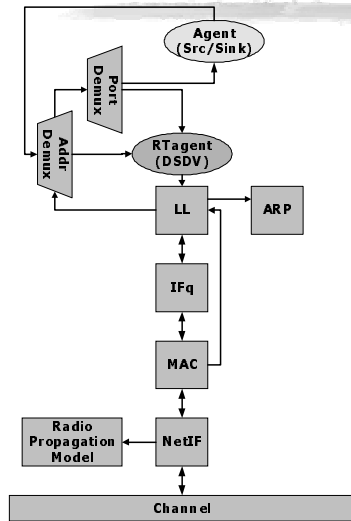
❑ Radio Propagation Model

- Uses Friss-space attenuation($1/r^2$) at near distance and Two ray ground ($1/r^4$) at far distance
- Decides whether the packet can be received by the mobilenode with given distance, transmit power and wavelength
- Implements Omni Directional Antenna module which has unity gain for all direction

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c.yu91@csuohio.edu

Wireless Simulation in ns-2 (Mobile Node Diagram – DSDV or AODV)



As in “\$WT1 set X_10”

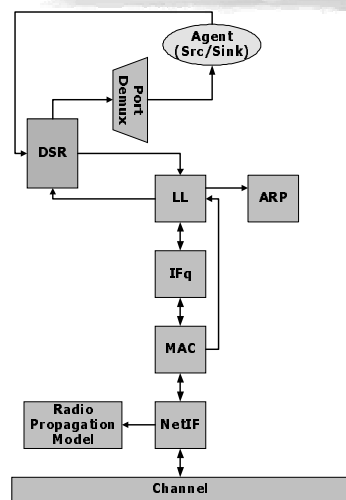
```
set my_mac [$WT1 set mac_(0)]
set my_ifq [$WT1 set ifq_(0)]
```

to access mac/ifq objects of node WT1

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c.yu91@csuohio.edu

Wireless Simulation in ns-2 (Mobile Node Diagram – DSR)



* See ns-2 manual

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c.yu91@csuohio.edu

Mobile Network Simulation

- Number of nodes
- Moving range
- Initial positions
- Moving pattern
 - Direction
 - Velocity
 - Acceleration

- Node WT1 moves towards (90, 50) with speed 20m/s at time 15
`$ns_ at 15.0 "WT1 setdest 90.0 50.0 20.0"`

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c.yu91@csuohio.edu

Mobility Model in ns-2

- RWP (Random Waypoint) mobility model
 - The most popular in simulation studies

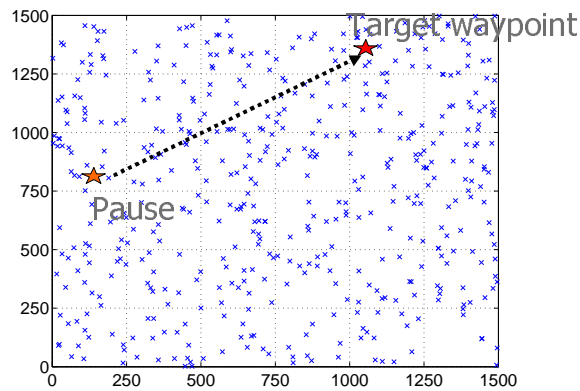
 - Two parameters: Pause time and speed $[0, v_{\max}]$

 - Pause ▶
 - Select a waypoint randomly ▶
 - Move toward it with a randomly chosen speed between $[0, v_{\max}]$ ▶
 - Repeat

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c.yu91@csuohio.edu

RWP Mobility Model



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c.yu91@csuohio.edu

setdest

A Node-Movement Generator

- Generating idea**
Node moves randomly. (distribution of nodes: uniform)
- Location**
~ns/indep-utils/cmu-scen-gen/setdest/setdest{.cc; .h}
- Command format (version 1)**
setdest -v 1 [-n ##] [-p ##] [-M ##] [-t ##] [-x ##] [-y ##]
- Option explanation**
n: number of nodes; p: pause time; M: maximum speed;
t: simulation time; x: maximum x; y: maximum y
- setdest -v 1 -n 50 -p 20 -M 5 -t 150 -x 300 -y 1500 > mob

In run script

```
set opt(sc) "./mob"  
source $opt(sc)
```

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c.yu91@csuohio.edu

Quiz

- Include mobility:
 - Increase the network size 300x1500
 - Increase the number of nodes 50
 - Use AODV as routing agent
 - Nodes move randomly (pause time 20 sec., speed 5m/s)

- Try with filter() and “grep” to get PDR
- Try with fil2.awk, fil4.awk and fil6.awk to get xput graph
- Try with delay.awk to get delay

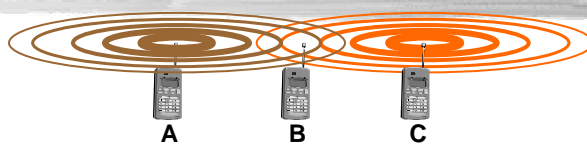
Modify ex6sta.tcl

```
* WT1~WT6 => node_(0)~node_(59)
* create-god $opt(nn) =>
  set god_ [create-god $opt(nn)]
* Leave 3 CBR traffic
* Add mobility file
* Propagation/FreeSpace =>
  Propagation/TwoRayGround
```

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c.yu91@csuohio.edu

Homework #1: Hidden Terminal (due Monday, February 12)



- Simulate scenario with 3 nodes (A, B, and C), where A is hidden to C (or vice versa). Nodes A and C send high rate CBR/UDP packets to node B. Nodes A and C do not use RTS/CTS (note RTSThreshold in ex6sta.tcl). Show the throughput diagram for two traffic streams.

- Repeat the same scenario with using RTS/CTS.

- Simulate a multihop scenario using AODV as a routing protocol and show the throughput versus number of hops. (See the scenario detail in the next slide.)

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c.yu91@csuohio.edu

Scenario Files

- Standard scenario
 - 50 nodes, 300x1500m network area, simulation time of 900 seconds
 - TwoRayGround, 802.11, AODV
 - 30 CBR sources, four 256-byte packets/second
 - Maximum node speed 5m/s, pause time of 20 seconds

- Mobility generator: setdest

- Traffic generator: cbrgen

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c.yu91@csuohio.edu

cbrgen.tcl A CBR Traffic Generator

- What is CBR?
 - Constant Bit Rate.
- Generating idea
 - Randomly pick up node pairs as sources and destinations.

- Traffic generator
 - ~ns/indep-utils/cmu-scen-gen/cbrgen.tcl
- Command format
 - ns cbrgen.tcl [-type ##] [-nn ##] [-seed ##] [-mc ##][-rate ##]

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c.yu91@csuohio.edu

cbrgen.tcl (cont.)

Option explanation

type: traffic/connection type. Must be tcp or cbr.

nn: number of nodes.

seed: seed for generating random number. It is used to generate the random starting time of the traffic.

mc: maximum number of connections.

rate: packet rate = 1 / packet interval

Generate real random traffic

cbrgen.tcl does not generate the real random traffic.

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c.yu91@csuohio.edu

cbrgen.tcl

A CBR Traffic Generator

For 50 nodes, 30 connections and packet rate of 4.0

```
ns cbrgen.tcl -type cbr -nn 50 -seed 1 -mc 30 -rate 2.0 > tfc
```

Read "tfc" file

Read "cbrgen.tcl"

- Is packet size 512 bytes?
- Does it have the exactly 30 connections?
- When does each source start transmitting?
- Who are the destinations?

In run script

```
set opt(tf) ".tfc"  
source $opt(tf)
```

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c.yu91@csuohio.edu

Simulation Study

- ❑ Simulation study usually based on random numbers (seed)
 - Results vary depending on the selection of seed number
 - One single simulation run does not tell us the true performance metrics

- ❑ Methodology
 - Run multiple simulation runs with different seed numbers
 - Take the average

- ❑ Is it enough?
 - Observed packet delays are 2.9, 3.0 and 4.1 seconds
 - Observed packet delays are 0.0, 3.0 and 6.0 seconds
 - Averages are 3.0 seconds in both cases but we are more “confident” about this value in the first case.