

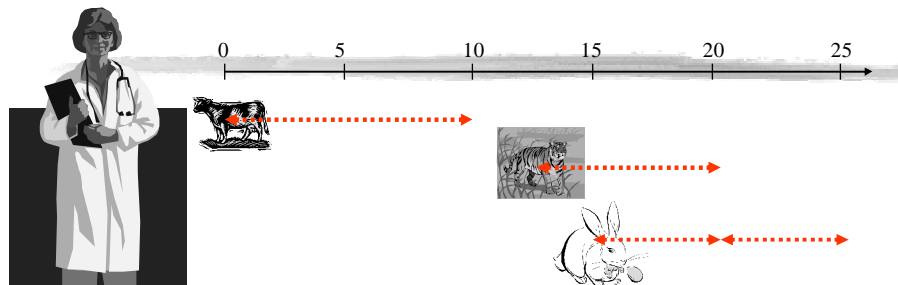
EEC 687/787 Mobile Computing (Spring, 2008)

Ns-2 Laboratory #3

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Quiz



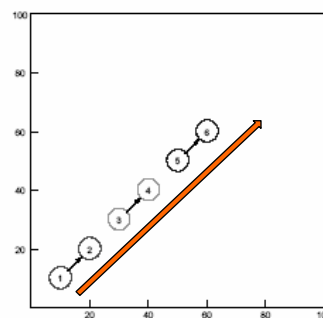
- (1) Throughput =
- (2) Delay =
- (3) Service time =
- (4) Queueing delay =
- (5) Utilization =

Mobile Network Simulation

- Large number of mobile nodes (e.g. 50)
- Node mobility
- Traffic

Mobile Network Simulation

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



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

Lab Exercise #3 (in class)

- ❑ Introduce mobility and draw a throughput chart using xgraph (WT1-> WT2)
 - \$ns_ at 15.0 "WT1 setdest 90.0 90.0 20.0"
 - Does the mobility change the performance?

- ❑ Increase the network size to (1000x1000) and repeat the same experiment
 - \$ns_ at 15.0 "WT1 setdest 900.0 900.0 20.0"
 - Does the mobility change the performance?
 - If different than the above, why is that?

5

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Mobility Model in ns-2

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

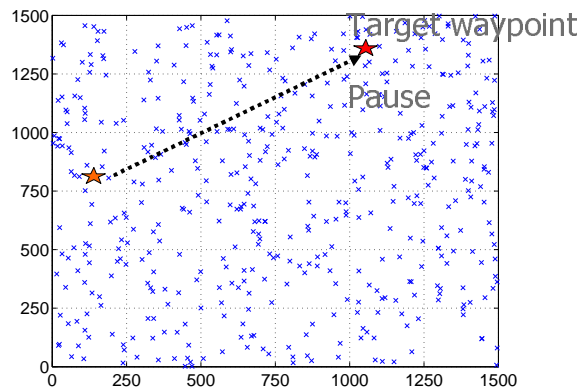
 - Two parameters: Pause time and speed $[0, v_{\max}]$

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

6

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RWP Mobility Model



7

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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 25 -p 20 -M 5 -t 300 -x 850 -y 300 > mob

In run script

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

8

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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 ##]

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.

cbrgen.tcl

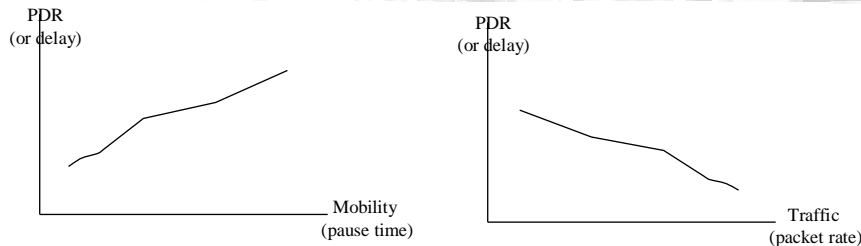
A CBR Traffic Generator

- For 25 nodes, 10 connections and packet rate of 2.0 ns
cbrgen.tcl -type cbr -nn 25 -seed 1 -mc 10 -rate 2.0 > traffic
- Read “traffic” file
- Read “cbrgen.tcl”
 - How to determine packet size?
 - How to correctly make 10 connections?
 - When does each source start transmitting?
 - Who are the destinations?

Lab Exercise #3 (Lab report)

- Download mobility.tcl
- Create mobility file “mob”
- Create traffic file “traffic”
- Run ns-2 to get the trace file and to get average delay and pdr
 - ns mobility.tcl -scen mob -tfc traffic

Lab Exercise #3 (Lab report)



- Change pause time (0, 10, 50, and 100) when generating “mob” and draw a chart that shows “pause time” versus “pdr/delay”
- Change packet rate (0.5, 1, 2, 3) when generating “traffic” and draw a chart that shows “pause time” versus “pdr/delay”

13

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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.

14

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Confidence Interval & Level

- ❑ How much are we confident that the TRUE value lies within a certain value interval?
 - Confidence level
 - Confidence interval

- ❑ Example: Average packet delay is within [2.9, 3.1] seconds with probability 95%.
 - Confidence level: 95%
 - Confidence interval: [2.9, 3.1] seconds or $\pm 3.3\%$ error (=0.1/3.0)

15

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95% Confidence Intervals

- ❑ Write as:

$$\mu = \bar{x} \pm 1.96\sigma_{\bar{x}}$$

- ❑ Method
 - Get the measurements
 - Calculate the mean and standard deviation

- ❑ If all the observed measurements are within the CI, we can say that "We are 95% confident that the true population mean is between..."

16

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99% Confidence Intervals

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- Calculate the mean and standard deviation

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Using the Sample Std.Dev.

- ❑ Since we do not know our true population standard deviation to calculate the standard error, we must substitute the sample standard deviation in the standard error formula
- ❑ The provides us with an estimate of our standard error; thus, our confidence intervals can only be approximate
- ❑ Can be substituted because of the Central Limit Theorem, that a n greater than 30 will give us a nearly normal distribution

At Least ...

- ❑ When confidence interval/level is not doable,
 - You should run multiple runs of the same simulation scenarios with different seeds to obtain an average performance

- ❑ Different seeds???

 - Same traffic (#connections), but different pairs
 - Same traffic between the same pairs, but different mobility pattern

ns Tutorials

- ❑ NS website <http://www.isi.edu/nsnam/ns/>
- ❑ NS Manual http://www.isi.edu/nsnam/ns/doc/ns_doc.pdf
- ❑ Marc Greis's Tutorial <http://www.isi.edu/nsnam/ns/tutorial>
- ❑ <http://www.cs.virginia.edu/~cs757/slidespdf/cs757-ns2-tutorial-exercise1.pdf>
- ❑ <http://nile.wpi.edu/NS/>
- ❑ http://nesl.ee.ucla.edu/courses/ee206a/2002s/guest_presentations/GP02_Park_ns2.ppt
- ❑ http://www.ece.ubc.ca/~elec565/ns2_tutorial.ppt