NS-2 Tutorial

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Motivation for Simulations

- Cheap -- does not require costly equipment
- Complex scenarios can be easily tested
- Results can be quickly obtained – more ideas can be tested in a smaller timeframe
- The real thing isn't yet available
- Controlled experimental conditions
  - Repeatability helps aid debugging
- Disadvantages: Real systems too complex to model

Features of NS-2

- Protocols: TCP, UDP, HTTP, Routing algorithms etc
- Traffic Models: CBR, VBR, Web etc
- Error Models: Uniform, bursty etc
- Radio propagation, Mobility models
- Energy Models
- Topology Generation tools
- Visualization tools
- Extensibility

NS Structure

- NS is an object oriented simulator
- Back end is C++ event scheduler
  - Protocols mostly
- Front end is oTCL
  - Creating scenarios, extensions to C++ protocols
  - Objects created in oTCL have a corresponding object in C++

TCL tutorial

- Variables:
```
set x 1
set y $x
```
- Arrays:
```
set a(0) 1
```
- Printing:
```
puts "$a(0) \n"
```
- Arithmetic Expression:
```
set z = [expr $y + 5]
```
- Control Structures:
```
if {$z == 6} then { puts "Correct!"}
for {set i =0} {$i < 5} {incr i }{
    puts "$i * $i equals [expr $i * $i]"
}
```
- Procedures:
```
proc sum {a b} {
    return [expr $a + $b]
}
```

How to Start?

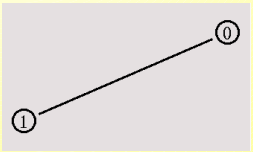
- Create simulator object: set ns [new simulator]
- Open a file for writing data for input to nam (network animator)
```
set nf [open out.nam w]
$ns namtrace-all $nf
```
- Finish procedure:
```
proc finish {} {
    global ns nf
    close $nf
    exec nam out.nam &
    exit 0
}
```

How to Start?

- Tell simulator object when to finish
```
$ns at 5.0 "finish"
```
- Start the simulation
```
$ns run
```

Creating topology

- Two nodes connected by a link
- Creating nodes
```
set n0 [$ns node]
set n1 [$ns node]
```
- Creating link between nodes
```
$ns duplex-link $n0 $n1 1Mb 10ms DropTail
```



Sending data

- Create UDP agent

```
set udp0 [new Agent/UDP]
$ns attach-agent $n0 $udp0
```

- Create CBR traffic source for feeding into UDP agent

```
set cbr0 [new Application/Traffic/CBR]
$cbr0 set packetSize_ 500
$cbr0 set interval_ 0.005
$cbr0 attach-agent $udp0
```

- Create traffic sink

```
set null0 [new Agent/Null]
$ns attach-agent $n1 $null0
```

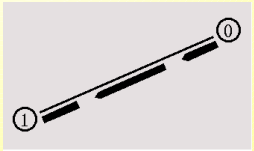
Sending data

- Connect two agents

```
$ns connect $udp0 $null0
```

- Start and stop of data

```
$ns at 0.5 “$cbr0 start”
$ns at 4.5 “$cbr0 stop”
```



Creating TCP Connections

- Create TCP agent and attach it to the node

```
set tcp0 [new Agent/TCP]
$ns attach-agent $n0 $tcp0
```

- Create a Null Agent and attach it to the node

```
set null0 [new Agent/TCPSink]
$ns attach-agent $n1 $null0
```

- Connect the agents

```
$ns connect $tcp0 $null0
```

Traffic on top of TCP

- FTP

```
set ftp [new Application/FTP]
$ftp attach-agent $tcp0
```

- Telnet

```
set telnet [new Application/Telnet]
$telnet attach-agent $tcp0
```

Introducing Errors

- Creating Error Module

```
set err [new ErrorModel]
$err unit pkt_
$err set rate_ 0.01
$err ranvar [new RandomVariable/Uniform]
$err drop-target [new Agent/Null]
```

- Inserting Error Module

```
$ns lossmodel $err $n0 $n1
```

Tracing

- All packet trace

```
$ns trace-all [open out.tr w]
<event> <time> <from> <to> <pkt> <size>
------
<flowid> <src> <dst> <seqno> <aseqno>

+ 0.51    0 1 cbr 500 ------- 0 0.0 1.0 0 2
-  0.51    0 1 cbr 500 ------- 0 0.0 1.0 0 2
r  0.514  0 1 cbr 500 ------- 0 0.0 1.0 0 0
```

- Variable trace

```
set par [open output/param.tr w]
$tcp attach $par
$tcp trace cwnd_
$tcp trace maxseq_
$tcp trace rtt_
```

Summary

- Simulators help in easy verification of protocols in less time, money
- NS offers support for simulating a variety of protocol suites and scenarios
- Front end is oTCL, back end is C++
- NS is an on-going effort of research and development