NS2 – LAB 2
Eng. Ibrahim Amreya & Dr. Amjad Hawash
Network & Information Security Program.
An-Najah National University.

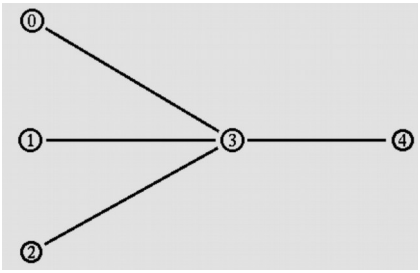
Creating Output files for Xgraph

Objectives:
Analyzing and plotting received traffic from 3 nodes with respect to:
-data rate
-delay
-speed of link
-size of data

xgraph is a plotting program which can be used to create graphic representations of simulation results. We will learn how to create output files in Tcl scripts which can be used as data sets for xgraph. Traffic generators will be illustrated as well.

Steps:

1- Topology and Traffic Sources:
First of all, we create the following topology:




```
set n0 [$ns node]
set n1 [$ns node]
set n2 [$ns node]
set n3 [$ns node]
set n4 [$ns node]
$ns duplex-link $n0 $n3 1Mb 100ms DropTail
$ns duplex-link $n1 $n3 1Mb 100ms DropTail
$ns duplex-link $n2 $n3 1Mb 100ms DropTail
$ns duplex-link $n3 $n4 1Mb 100ms DropTail
```

We are going to attach traffic sources to the nodes n0, n1 and n2, but first we write a procedure that will make it easier for us to add the traffic sources and generators to the nodes:

```
proc attach-expoo-traffic { node sink size burst idle rate } {
        #Get an instance of the simulator
        set ns [Simulator instance]
        #Create a UDP agent and attach it to the node
        set source [new Agent/UDP]
        $ns attach-agent $node $source
        #Create an Expoo traffic agent and set its configuration parameters
        set traffic [new Application/Traffic/Exponential]
        $traffic set packetSize_ $size
        $traffic set burst_time_ $burst
        $traffic set idle_time_ $idle
        $traffic set rate_ $rate
        # Attach traffic source to the traffic generator
```

```
        $traffic attach-agent $source
        #Connect the source and the sink
        $ns connect $source $sink
        return $traffic
}
```

This procedure takes six arguments: A node, a previously created traffic sink, the packet size for the traffic source, the burst and idle times (for the exponential distribution) and the peak rate.

First, the procedure creates a traffic source and attaches it to the node, then it creates a Traffic/Expoo object, sets its configuration parameters and attaches it to the traffic source, before eventually the source and the sink are connected. Finally, the procedure returns a handle for the traffic source. This procedure is a good example how reoccuring tasks like attaching a traffic source to several nodes can be handled. Now we use the procedure to attach traffic sources with different peak rates to n0, n1 and n2 and to connect them to three traffic sinks on n4 which have to be created first:

```
set sink0 [new Agent/LossMonitor]
set sink1 [new Agent/LossMonitor]
set sink2 [new Agent/LossMonitor]
$ns attach-agent $n4 $sink0
$ns attach-agent $n4 $sink1
$ns attach-agent $n4 $sink2
set source0 [attach-expoo-traffic $n0 $sink0 200 2s 1s 100k]
set source1 [attach-expoo-traffic $n1 $sink1 200 2s 1s 200k]
set source2 [attach-expoo-traffic $n2 $sink2 200 2s 1s 300k]
```

2- Recording Data in Output Files:
Now we have to open three output files. The following lines have to appear 'early' in the Tcl script.

```
set f0 [open out0.tr w]
set f1 [open out1.tr w]
set f2 [open out2.tr w]
```

These files have to be closed at some point. We use a modified 'finish' procedure to do that.

```
proc finish {} {
        global f0 f1 f2
        #Close the output files
        close $f0
        close $f1
        close $f2
        #Call xgraph to display the results
        exec xgraph out0.tr out1.tr out2.tr -geometry 800x400 &
        exit 0
}
```

It not only closes the output files, but also calls xgraph to display the results.
Now we can write the procedure which actually writes the data to the output files.

```
proc record {} {
        global sink0 sink1 sink2 f0 f1 f2
        #Get an instance of the simulator
        set ns [Simulator instance]
        #Set the time after which the procedure should be called again
        set time 0.5
        #How many bytes have been received by the traffic sinks?
        set bw0 [$sink0 set bytes_]
        set bw1 [$sink1 set bytes_]
        set bw2 [$sink2 set bytes_]
        #Get the current time
        set now [$ns now]
        #Calculate the bandwidth (in MBit/s) and write it to the files
        puts $f0 "$now [expr $bw0/$time*8/1000000]"
        puts $f1 "$now [expr $bw1/$time*8/1000000]"
        puts $f2 "$now [expr $bw2/$time*8/1000000]"
        #Reset the bytes_ values on the traffic sinks
        $sink0 set bytes_ 0
        $sink1 set bytes_ 0
        $sink2 set bytes_ 0
        #Re-schedule the procedure
        $ns at [expr $now+$time] "record"
}
```

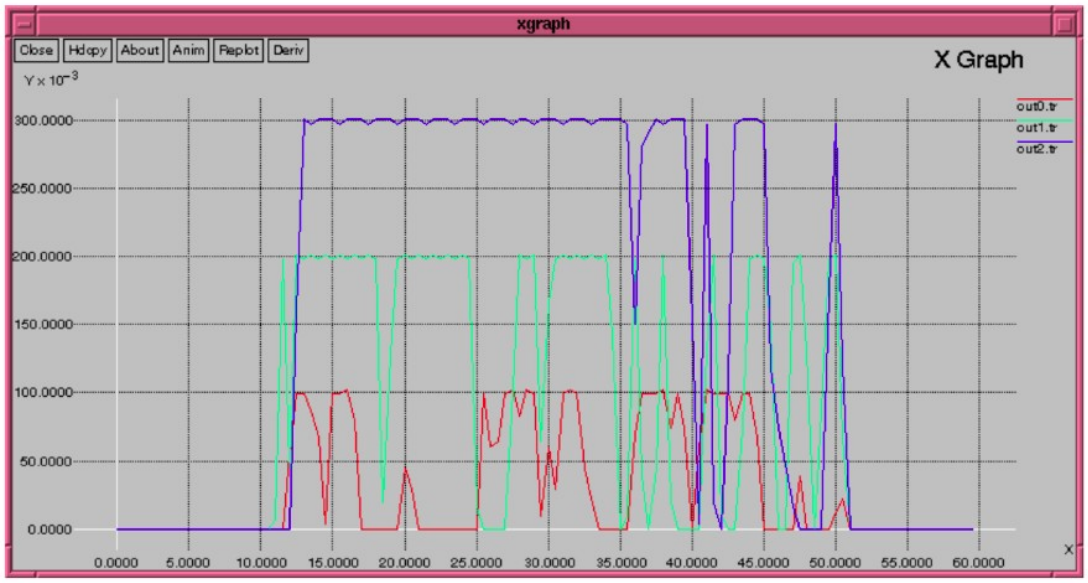
This procedure reads the number of bytes received from the three traffic sinks. Then it calculates the bandwidth (in MBit/s) and writes it to the three output files together with the current time before it resets the bytes_ values on the traffic sinks. Then it re-schedules itself.

3- Running the Simulation:
We can now schedule the following events:

```
$ns at 0.0 "record"
$ns at 10.0 "$source0 start"
$ns at 10.0 "$source1 start"
$ns at 10.0 "$source2 start"
$ns at 50.0 "$source0 stop"
$ns at 50.0 "$source1 stop"
$ns at 50.0 "$source2 stop"
$ns at 60.0 "finish"
$ns run
```

First, the 'record' procedure is called, and afterwards it will re-schedule itself periodically every 0.5 seconds. Then the three traffic sources are started at 10 seconds and stopped at 50 seconds. At 60 seconds, the 'finish' procedure is called.

When you run the simulation, an xgraph window should open after some time which should look similar to this one:



As you can see, the bursts of the first flow peak at 0.1Mbit/s, the second at 0.2Mbit/s and the third at 0.3Mbit/s.

Now, repeat the simulation:

1- Add two extra nodes n5 and n6, set their sources and sinks as in point 1 above.
2- Run the simulation, snapshot the generated graph (to be put in your report).
3- Compare the generated graph with the previous one (in terms of delay).
4- Modify the 'time' value in the 'record' procedure. Set it to '0.1' and see what happens, and then try '1.0' (Take a snapshot for each case).
5- Describe the changes in the generated graphs with respect to previous point.

The complete source code that you need to work on:

```
#Create a simulator object
set ns [new Simulator]

#Open the output files
set f0 [open out0.tr w]
set f1 [open out1.tr w]
set f2 [open out2.tr w]

#Create 5 nodes
set n0 [$ns node]
set n1 [$ns node]
set n2 [$ns node]
set n3 [$ns node]
set n4 [$ns node]
```

```
#Connect the nodes
$ns duplex-link $n0 $n3 1Mb 100ms DropTail
$ns duplex-link $n1 $n3 1Mb 100ms DropTail
$ns duplex-link $n2 $n3 1Mb 100ms DropTail
$ns duplex-link $n3 $n4 1Mb 100ms DropTail

#Define a 'finish' procedure
proc finish {} {
        global f0 f1 f2
        #Close the output files
        close $f0
        close $f1
        close $f2
        #Call xgraph to display the results
        exec xgraph out0.tr out1.tr out2.tr -geometry 800x400 &
    exit 0
}


#Define a procedure that attaches a UDP agent to a previously created node
#'node' and attaches an Expoo traffic generator to the agent with the
#characteristic values 'size' for packet size 'burst' for burst time,
#'idle' for idle time and 'rate' for burst peak rate. The procedure connects
#the source with the previously defined traffic sink 'sink' and returns the
#source object.
proc attach-expoo-traffic { node sink size burst idle rate } {
        #Get an instance of the simulator
        set ns [Simulator instance]

        #Create a UDP agent and attach it to the node
        set source [new Agent/UDP]
        $ns attach-agent $node $source

        #Create an Expoo traffic agent and set its configuration parameters
        set traffic [new Application/Traffic/Exponential]
        $traffic set packetSize_ $size
        $traffic set burst_time_ $burst
        $traffic set idle_time_ $idle
        $traffic set rate_ $rate

    # Attach traffic source to the traffic generator
    $traffic attach-agent $source
        #Connect the source and the sink
        $ns connect $source $sink
        return $traffic
}


#Define a procedure which periodically records the bandwidth received by the
```

```
#three traffic sinks sink0/1/2 and writes it to the three files f0/1/2.
proc record {} {
        global sink0 sink1 sink2 f0 f1 f2
           #Get an instance of the simulator
           set ns [Simulator instance]
           #Set the time after which the procedure should be called again
        set time 0.5
           #How many bytes have been received by the traffic sinks?
        set bw0 [$sink0 set bytes_]
        set bw1 [$sink1 set bytes_]
        set bw2 [$sink2 set bytes_]
           #Get the current time
        set now [$ns now]
           #Calculate the bandwidth (in MBit/s) and write it to the files
        puts $f0 "$now [expr $bw0/$time*8/1000000]"
        puts $f1 "$now [expr $bw1/$time*8/1000000]"
        puts $f2 "$now [expr $bw2/$time*8/1000000]"
           #Reset the bytes_ values on the traffic sinks
        $sink0 set bytes_ 0
        $sink1 set bytes_ 0
        $sink2 set bytes_ 0
           #Re-schedule the procedure
        $ns at [expr $now+$time] "record"
}


#Create three traffic sinks and attach them to the node n4
set sink0 [new Agent/LossMonitor]
set sink1 [new Agent/LossMonitor]
set sink2 [new Agent/LossMonitor]
$ns attach-agent $n4 $sink0
$ns attach-agent $n4 $sink1
$ns attach-agent $n4 $sink2

#Create three traffic sources
set source0 [attach-expoo-traffic $n0 $sink0 200 2s 1s 100k]
set source1 [attach-expoo-traffic $n1 $sink1 200 2s 1s 200k]
set source2 [attach-expoo-traffic $n2 $sink2 200 2s 1s 300k]

#Start logging the received bandwidth
$ns at 0.0 "record"
#Start the traffic sources
$ns at 10.0 "$source0 start"
$ns at 10.0 "$source1 start"
$ns at 10.0 "$source2 start"
#Stop the traffic sources
$ns at 50.0 "$source0 stop"
$ns at 50.0 "$source1 stop"
$ns at 50.0 "$source2 stop"
```

```
#Call the finish procedure after 60 seconds simulation time
$ns at 60.0 "finish"

#Run the simulation
$ns run
```