Wireless Networking

ECE 477
Spring 2016

Project #1 – Due Thursday, March 10

The objective of this project is to use the Riverbed Modeler Academic Edition simulator to investigate the performance of 802.11 with changing parameters and numbers of users.

Riverbed Modeler is a simulation tool that is widely used in industry to simulate protocols and networks to assess performance and resource needs. Riverbed Modeler is quite expensive, so it is not available in the UMKC computer labs. It is, however, available free as its academic edition from the Riverbed web site. The program is only a Windows-based program, so it can only be run on a Mac with a Windows emulator such as Crossover.

You may work in teams of up to 3 people. It is recommended that one person on the team have access to a Windows machine to run the native version of the simulator.

One report is required per team. Your project report should be submitted to the link provided on the Blackboard site.

Only provide the exact information requested.

Task 1: Riverbed Modeler Tutorials
Under the Riverbed Modeler Modeler "Help" menu, select the tutorials, which will direct you to a webs site. Choose and go through the "Introduction to Riverbed Modeler Academic Edition". The actual path for the example network is "Riverbed EDU/17.5.A/models/std/example_networks". Right-click and choose "Go to Parent Subnet" to go back to a previous view.

Plot 1.1
Show the results window that you obtain in Section 5, part 5 for running a simulation and viewing results. This should look like the image in the tutorial document.

There are several methods for printing Riverbed Modeler graphs. Two of these are (1) Alt-Printscreen to copy the image of the window that can be pasted into a word processor, or (2) right click on the plot the "Export Graph Data to Spreadsheet". Then use the spreadsheet analyze that data and produce a figure. If Riverbed Modeler does not automatically connect to your spreadsheet program, you may need to follow the path to the file that it gives in the error message.

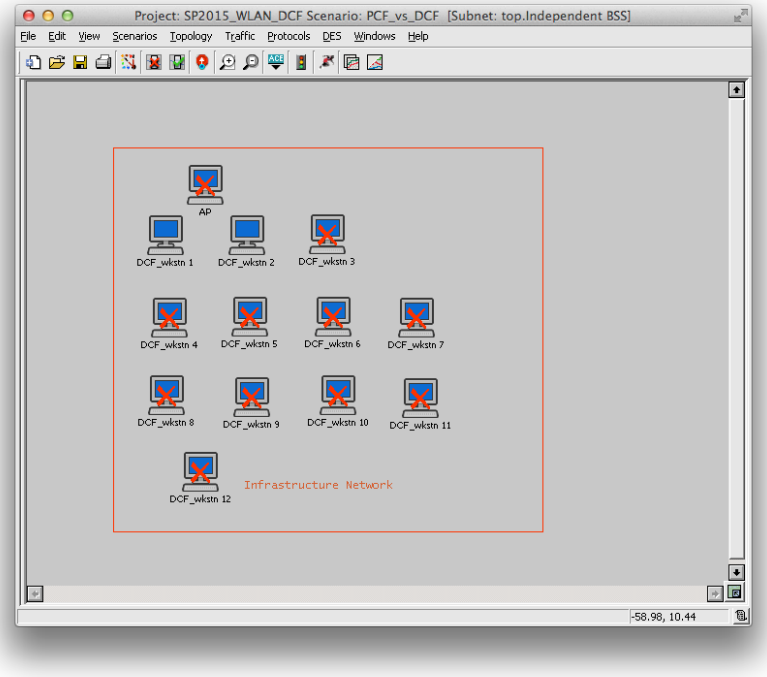
Question 1.1
What are the first five data points from the simulation from the spreadsheet data that comes from Plot 1.1 (Section 5, part 5)?

Plot 1.2
From the simulation you used to produce Plot 1.1, show a plot of the Global RIP traffic received and traffic sent. Show these as overlaid statistics. Use the "Show" button and only show the plot in your report.

Task 2: Maximum 802.11 Performance

Download the Riverbed Modeler Model of an IEEE 802.11 WLAN is provided for you on the course Blackboard site. Once you have unzipped the file into a directory, Then open the project that has the name "SP2015_WLAN_DCF.prj" (you may get an error, but choose "Ignore Files") and then save with your own initials at the beginning of the file name to replace "SP2015".

The model will look similar to the following.



The figure shows 12 mobile nodes and one access point. DCF_wkstn 1 and 2 are active and the rest are "failed". Nodes can be failed or recovered by options provided by right-clicking on particular nodes.

All of the nodes have been pre-configured to generate packets at a constant rate of 10,000 packets per second, each of size 12500 bytes (total bit rate of 1 Gbps). The wireless medium is set at a rate of 600 Mbps, so even one node will generate

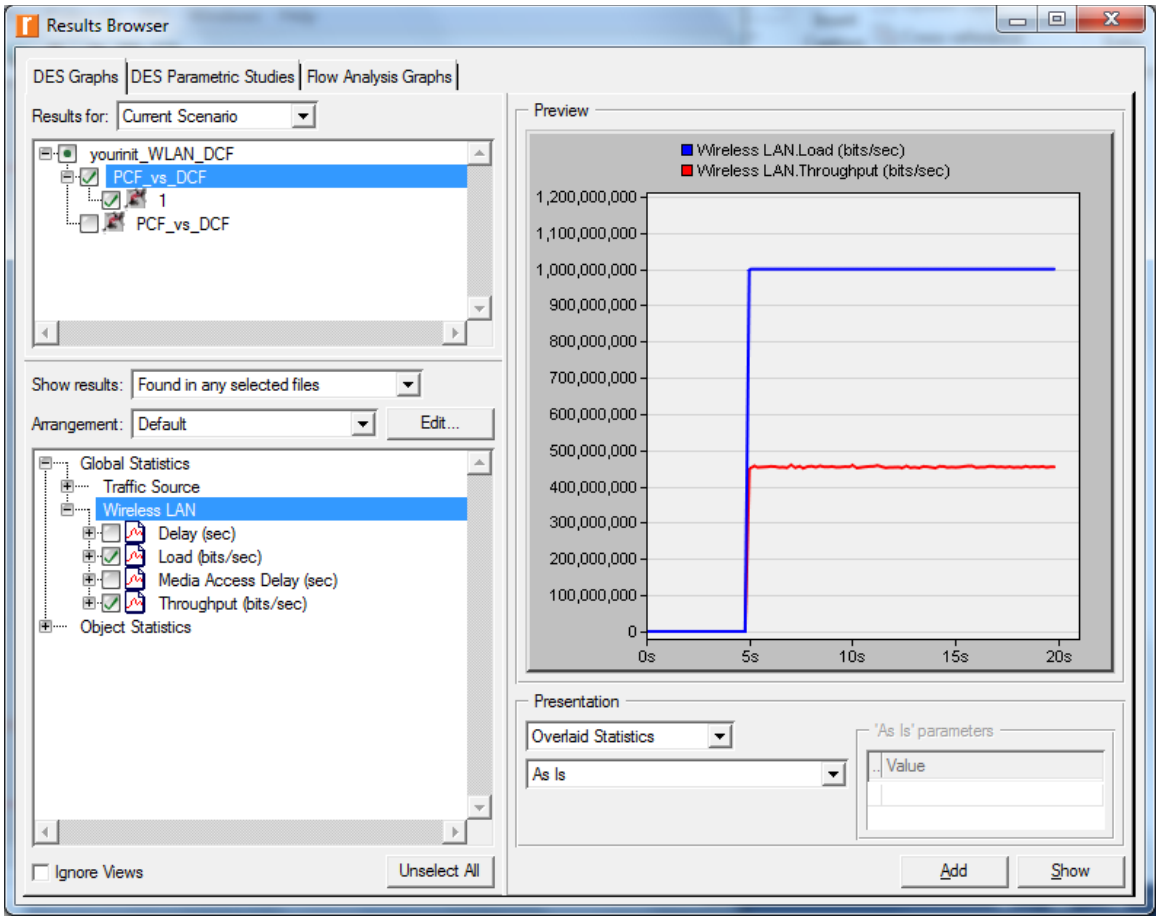
more traffic than the network can handle and will produce significant dropped traffic.

For this task, Workstation 1 should be generating 1.0 Gbps, Workstation 2 should not be generating any traffic (Start Time = Never, Edit Attributes/Traffic Generation Parameters/Start Time), and all other nodes (including the AP) should be failed.

For this task, produce two plots, with one node and two nodes transmitting as follows.

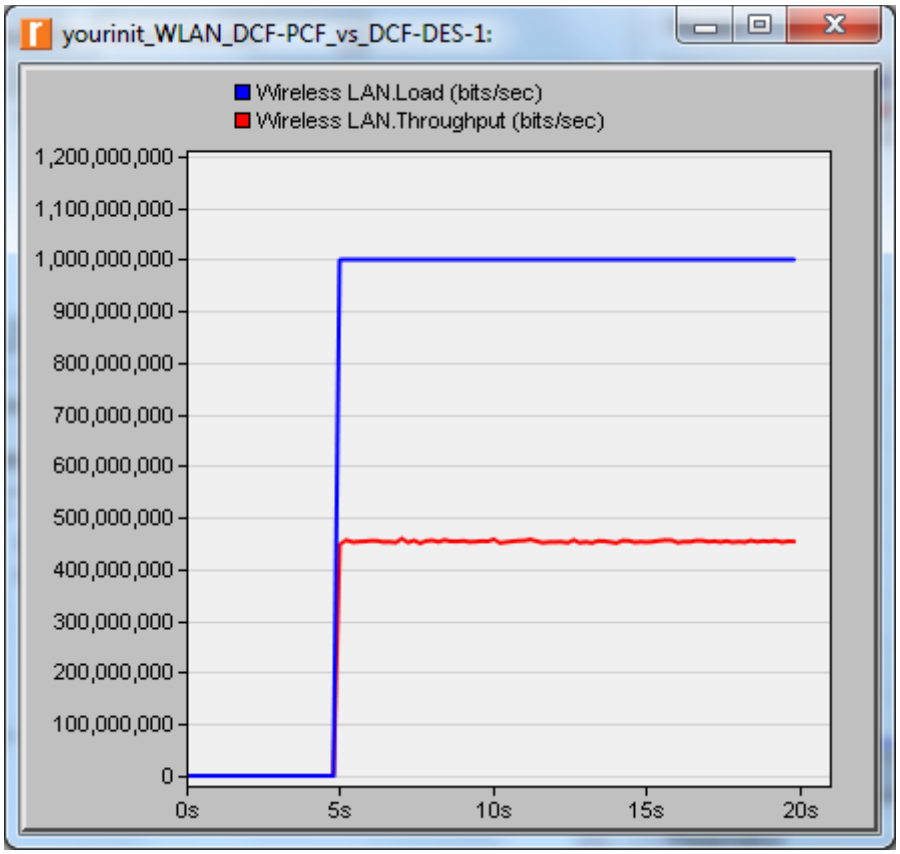
Note: When running a simulation and storing results to a network drive, there may be a delay of a few seconds before the results are available to plot.

Plot 2.1 – Enable node 1 to Send to node 2. Make sure access point functionality is disabled on the AP, even if the graphical display already looks like the node is failed. After running the simulation, right-click on the background and select "View Results". Create a plot of Global Statistics (see below) that has curves overlaid for Load and Throughput. Make sure to unclick the lower "PCF_vs_DCF"; this is not needed. Choose "Overlaid Statistics" under that plot to have the two curves shown on the same plot.



To show just the plot, click on “Show”. Show a plot that looks like the following.

Plot 2.1



Question 2.1 – Now find the average *stabilized* throughput by dumping that data into an Excel spreadsheet. That is, compute the throughput that the system can achieve in this configuration. Right-click on the figure and choose "Export Graph Data to Spreadsheet". Then use Excel to find the average value for the column for relevant values for the Throughput. What is that value?

Plot 2.2 – Now see how the throughput of the network changes when the number of sources increases from 1 to 2. Recover workstation 3. Now workstations 1 and 3 will send traffic to random destinations (for example, 1 will send randomly to 1, 2, or 3). Show the plot similar to Plot 2.1 for this result, but this time used *stacked statistics*.

Question 2.2 – What is the change in total (i.e., global) throughput between the two cases?

Question 2.3 – What is the change in throughput per node between the two cases?

Task 3: Performance With and Without the AP

For this task, the AP will be enabled so it will serve as an intermediate point for all traffic. This is accomplished by right-clicking on the AP and choosing "Recover this Node", and then also editing the attributes of the AP so that AP

functionality is enabled. Make sure also that the AP is not generating its own traffic (i.e., start time is never).

Plot 3.1 – Show the plot of Load and Throughput (same as 2.1) for only Node 1 generating traffic.

Plot 3.2 – Now show the results with Nodes 1 and 3 generating traffic. This time *show stacked statistics*.

Note: Riverbed Modeler Academic Edition is limited to 50 Million events per simulation run.

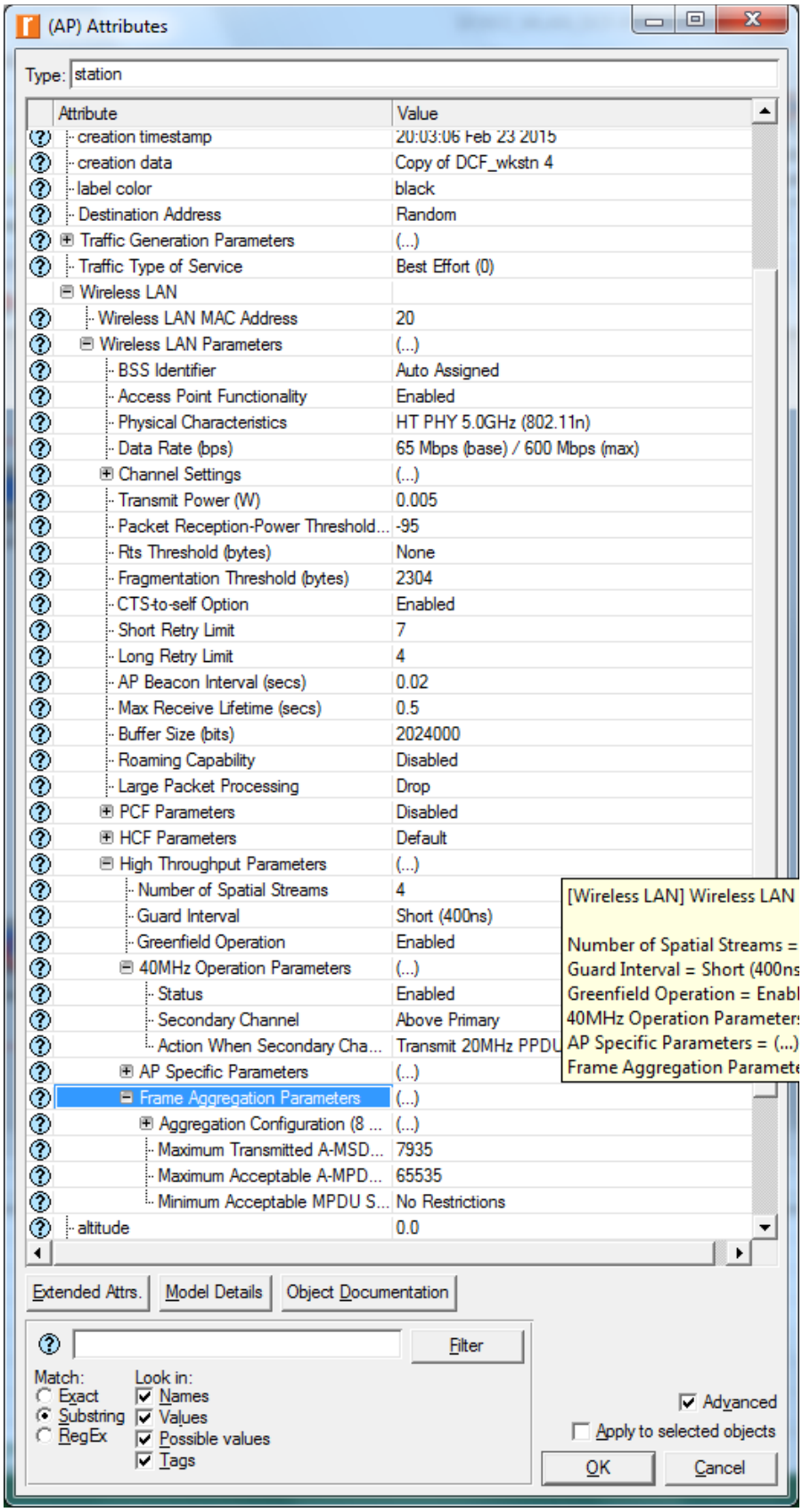
> For this project for Plot 3.1 for one source and AP functionality:
> Packets generated from 5 to 20 seconds
> Packets generated every 0.00001 seconds
> Total of 150,000 packets
> A total of 6 Million 802.11 events are processed to Modeler to process, send, and receive these packets.
> Modeler may not allow 2 sources with 15 seconds of simulation. You will need to shorten the simulation time (see in the window that comes up to start a simulation) or Modeler may not allow the simulation to start. It must estimate the number of events before it even starts.

Question 3.1 – Analysis – Provide a table that compares <u>total</u> WLAN throughput for 1 and 2 sources, with and without the AP.

Question 3.2 – Discussion – Why are the results as they are in Question 3.1?

Task 4: Your Own Study of 802.11n

The default configuration for this project is to use the maximum possible throughput values for 802.11n. Now edit the attributes of the 802.11n High Throughput parameters. Produce your own study of the throughput (<u>*still for a single node sending*</u>) when some of those parameters have changed. These are located in Wireless LAN/Wireless LAN Parameters/High Throughput Parameters. Produce at least two sets of plots and compute the stabilized throughput for each.


(AP) Attributes
Type: station
Attribute
Value
creation timestamp
20:03:06 Feb 23 2015
creation data
Copy of DCF_wkstn 4
label color
black
Destination Address
Random
Traffic Generation Parameters
(...)
Traffic Type of Service
Best Effort (0)
Wireless LAN
Wireless LAN MAC Address
20
Wireless LAN Parameters
(...)
BSS Identifier
Auto Assigned
Access Point Functionality
Enabled
Physical Characteristics
HT PHY 5.0GHz (802.11n)
Data Rate (bps)
65 Mbps (base) / 600 Mbps (max)
Channel Settings
(...)
Transmit Power (W)
0.005
Packet Reception-Power Threshold...
-95
Rts Threshold (bytes)
None
Fragmentation Threshold (bytes)
2304
CTS-to-self Option
Enabled
Short Retry Limit
7
Long Retry Limit
4
AP Beacon Interval (secs)
0.02
Max Receive Lifetime (secs)
0.5
Buffer Size (bits)
2024000
Roaming Capability
Disabled
Large Packet Processing
Drop
PCF Parameters
Disabled
HCF Parameters
Default
High Throughput Parameters
(...)
Number of Spatial Streams
4
Guard Interval
Short (400ns)
Greenfield Operation
Enabled
40MHz Operation Parameters
(...)
Status
Enabled
Secondary Channel
Above Primary
Action When Secondary Cha...
Transmit 20MHz PPDU
AP Specific Parameters
(...)
Frame Aggregation Parameters
(...)
Aggregation Configuration (8 ...
(...)
Maximum Transmitted A-MSD...
7935
Maximum Acceptable A-MPD...
65535
Minimum Acceptable MPDU S...
No Restrictions
altitude
0.0
[Wireless LAN] Wireless LAN
Number of Spatial Streams =
Guard Interval = Short (400ns
Greenfield Operation = Enabl
40MHz Operation Parameters
AP Specific Parameters = (...)
Frame Aggregation Paramete
Extended Attrs.
Model Details
Object Documentation
Filter
Match:
Exact
Substring
RegEx
Look in:
Names
Values
Possible values
Tags
Advanced
Apply to selected objects
OK
Cancel