Planning Wireless LAN Network Deployments

LAB 1: Mixed 11g/11n WLAN Performance

Overview

The network administrator at a campus plans to upgrade all access points in the buildings from 802.11g access points (APs) to 802.11n access points (APs) to improve network performance. Clearly, the users of the network are not forced to buy new 802.11n cards as the technology is legacy compatible i.e. 802.11n APs can service 802.11g devices.

The network administrator wants to investigate the impact of 11g legacy devices in 11n BSS. He wants to find out if 11n users will see any degradation in the network performance and the extent of degradation if any.

Objective

Determine impact of legacy 11g nodes on an 11n WLAN network.

Methodology

1. Create an 802.11n-based wireless LAN network using the Wireless Deployment Wizard.

2. Configure traffic on the stations.

3. Introduce legacy nodes in the network and determine if there is degradation in throughput.

Instructions

Open Project

1. Start **Riverbed Modeler Academic Edition 17.5,** if it is not already open.

2. Select **File/Open.**

3. Select **1504_Lab1** and click Open.

    a. The project will open with the scenario named **all_11n**.

4. Maximize the project by clicking on the **Maximize** button on the top right corner of the project editor.

Important Note: Because Riverbed Modeler Academic Edition has a limited set of tools compared to the full version of Modeler, some sections of this tutorial have been configured for you. An example of a feature that is missing in the Modeler Academic Edition is the Wireless Deployment Wizard which can be used to interactively deploy a wireless network. You can still accomplish the same functionality by selecting nodes from the object palette and configuring all the attributes manually; however this can be laborious for a large wireless deployment. For purposes of this tutorial, we have already configured the topology

for <u>steps 5-27</u> below. Please read through the steps so as to understand the attribute configurations that are in place.

**Use the Wireless Deployment Wizard to create a WLAN network**

5. Select **Topology/Deploy Wireless Network…**
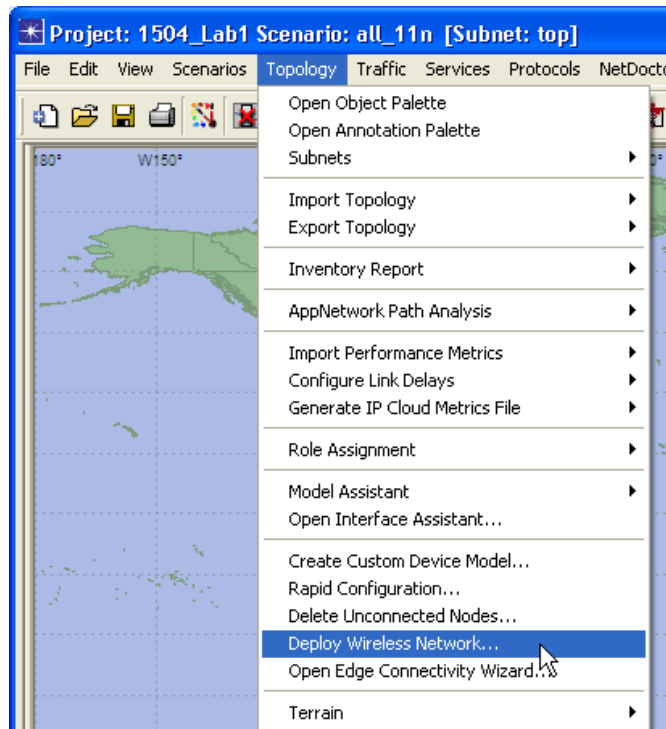
6. Click on **Continue** on the Welcome screen.

7. The **Network Creation** stage opens up. In this stage, the user chooses if they will use the wizard to specify the network deployment parameters, or use a previously saved network specification file. Make sure that the "**Use wizard to provide network specifications**" option is selected.
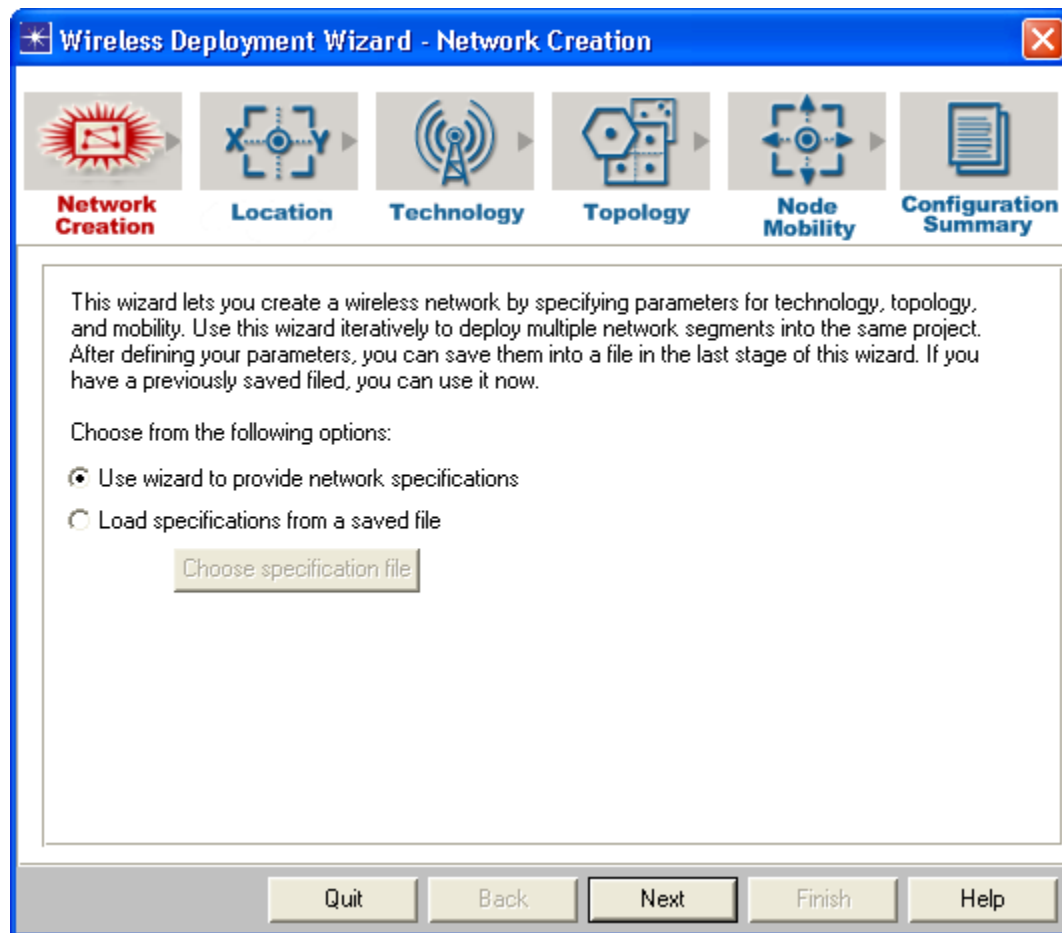
- Click **Next** to go to the next stage of the wizard.

8. The **Location** stage can be used to specify the location of the network.

- Select the option **Create network in current subnet**

- Set **X** and **Y** to **0** and **0** respectively

- Make sure that the settings look as shown below:
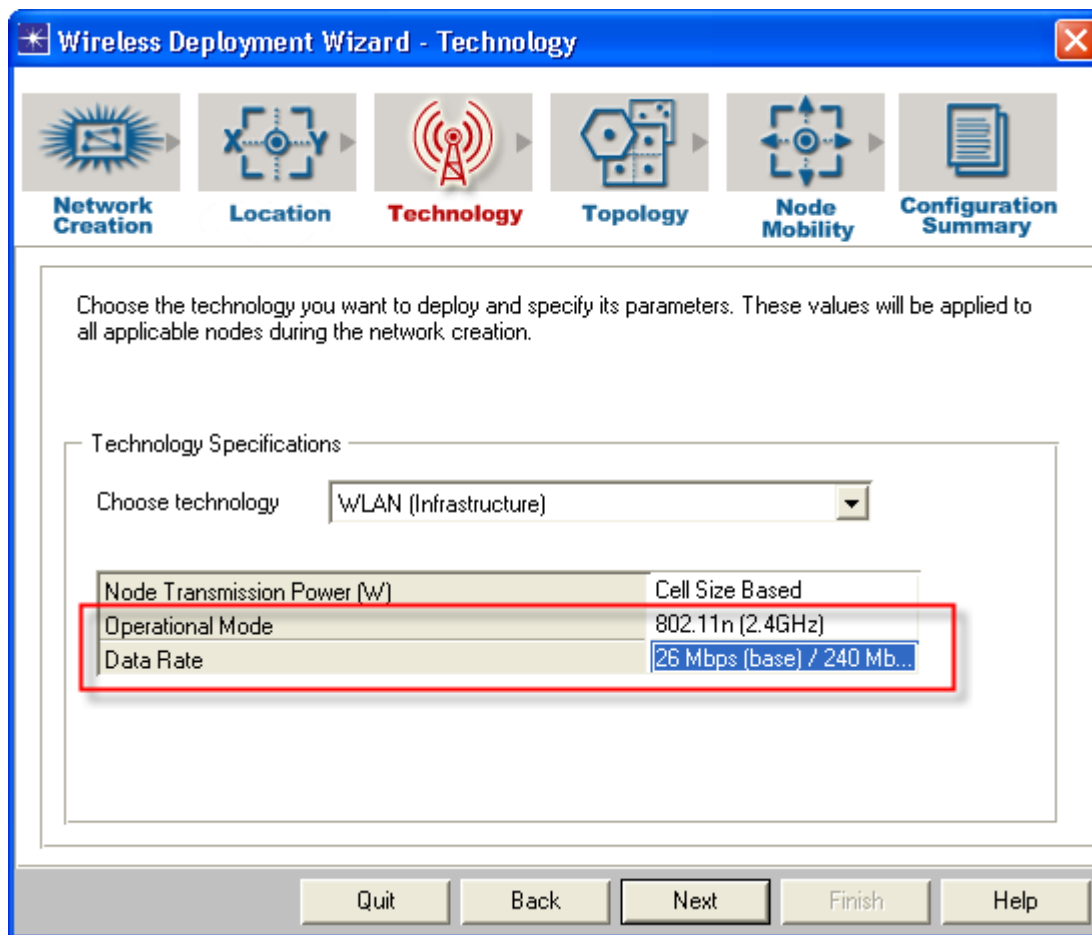

- Click **Next** to continue

9. The **Technology** stage is used to select a particular deployment technology and to specify technology specific parameters. Make sure that the **Choose Technology** option is set to **WLAN (Infrastructure).**

10. Since the desired operational mode for the network is 802.11n, set the **Operational Mode** to **802.11n (2.4GHz).** Note that this implies that all nodes will be operating in 802.11n mode.

11. Set the Data Rate to **26 Mbps (base) / 240 Mbps (max)**. Note that this implies that the data rate on all nodes will be set to **26 Mbps (base) / 240 Mbps (max)**.

Make sure that the **Technology** stage looks as below:

12. Click **Next** to open the **Topology** stage of the wizard. In this stage a **Geographical Overlay** and **Node Placement Algorithm** is specified for the deployment.

13. Make sure that **Cell (Hexagon)** is selected as the geographical overlay.

14. Set the **Number of Cells** is set to **1**.

15. Set the **Cell Radius (km)** to **0.25**.

16. Make sure that the **Mobile Node Placement Specifications,** is set to **Random**

17. Make sure that the stage looks as below:
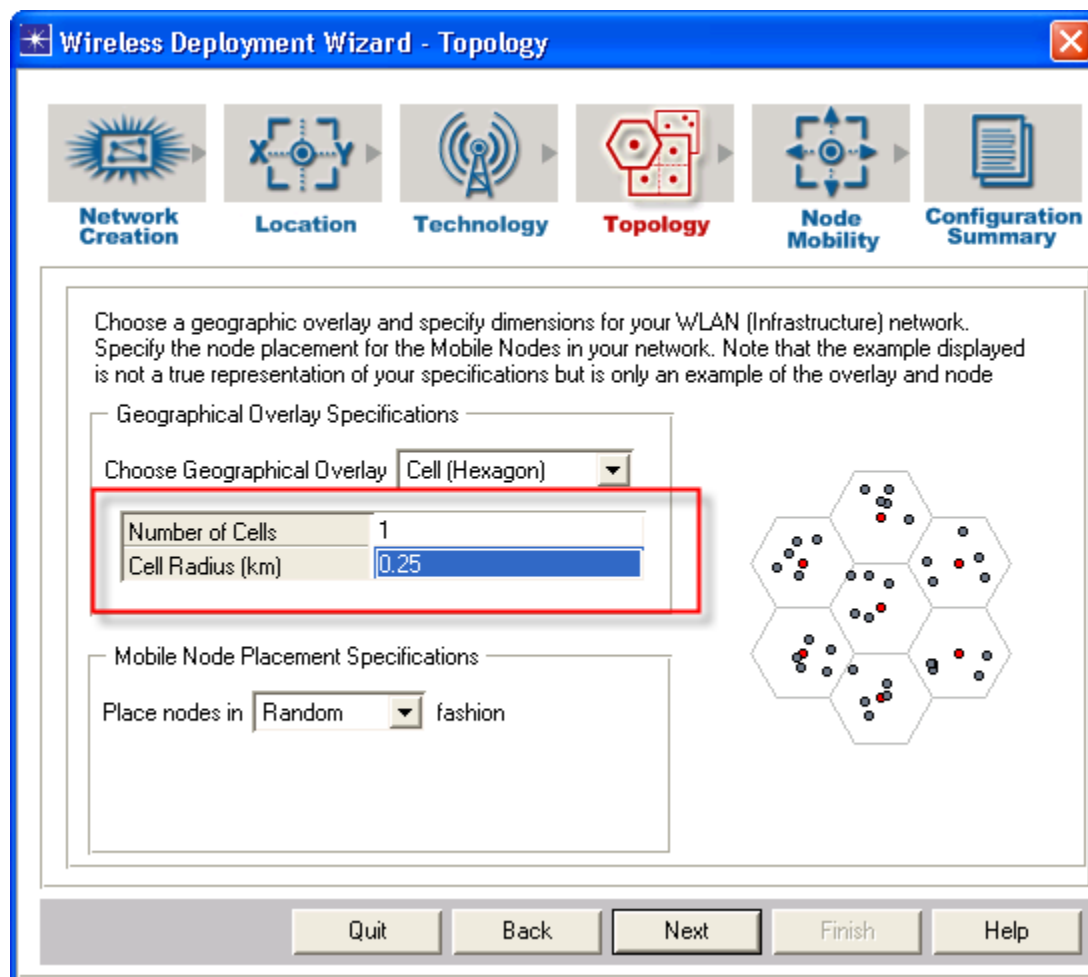
18. Click **Next** to provide node specifications as part of the **Topology** stage.

19. Users are given the option of choosing a particular node model for the Access Points and the Mobile Nodes. For the purposes of our lab, we will leave the "**Mobile Node**" node model to the default value.

20. Select wlan_eth_bridge_adv node model for the access point

    - Click on drop down menu beside Node Model under Access Point and click on Edit.

    - The object palette of wireless_lan_adv opens up.

    - Select **wlan_eth_bridge_adv** from the object palette and click **OK**.

21. Users are given the option of choosing the number of the mobile nodes per cell. Set the Mobile Node **Count (per-cell)** to **8.**

22. The wireless wizard provides the ability to connect the access points using a backbone network. For this lab, we do not require this functionality, so **uncheck** the **Connect all Access Points (via serial interfaces) using a backbone network** checkbox

23. Make sure that the stage looks as below:

24. Click **Next** to open the Mobility Specification dialog. For simplicity, we will not have any mobility in the network.

25. In the Node Mobility screen, click on the first row and hit **Delete Row** button.

Make sure that the stage looks as below:
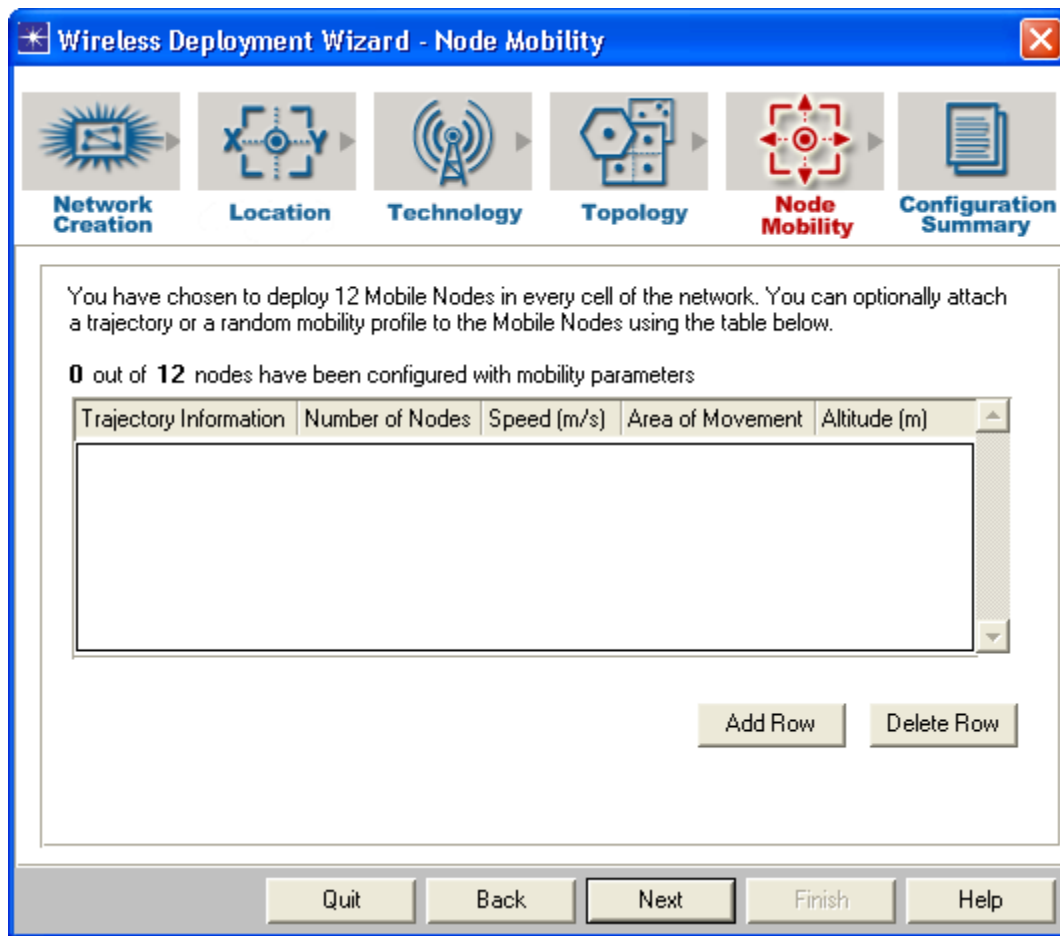
26. Click **Next** to open the **Configuration Summary** stage.

Review the Configuration Summary.
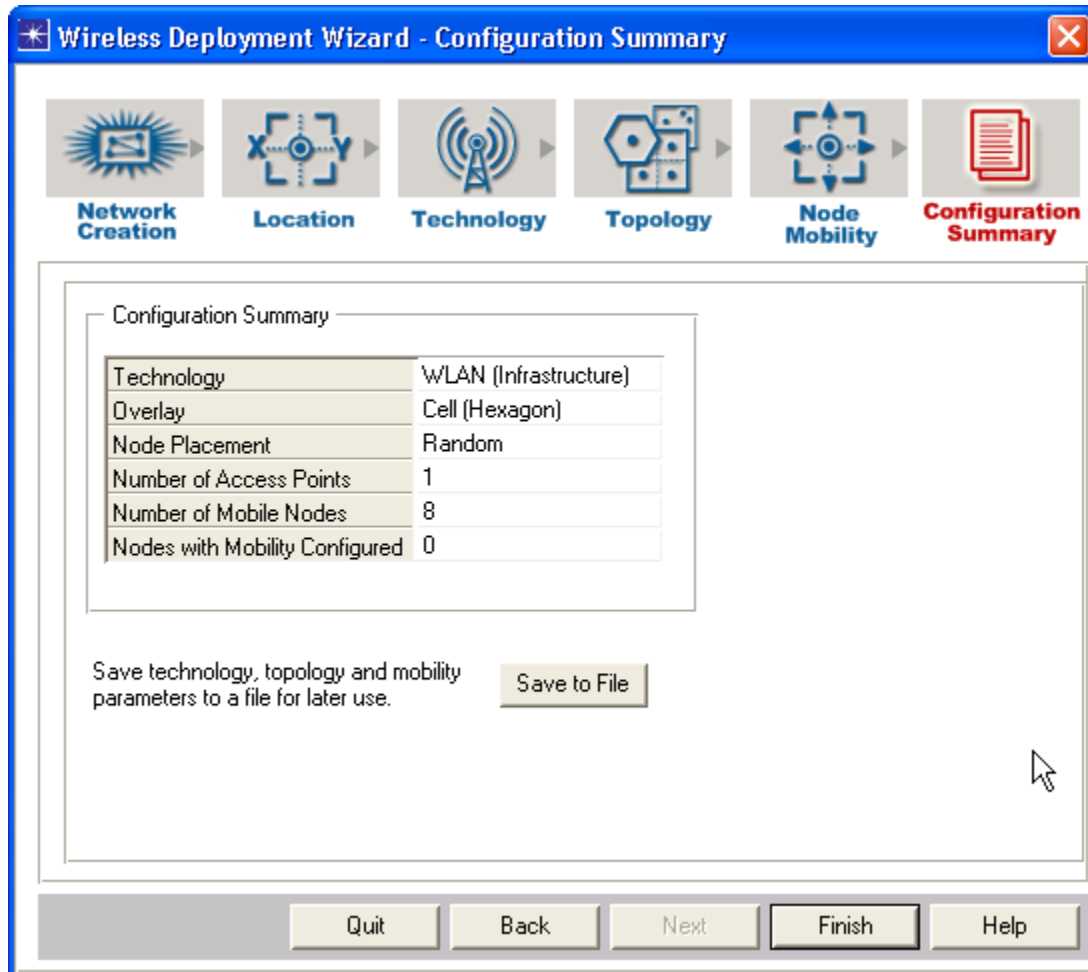
27. Click **Finish** to deploy the network.

A WLAN Infrastructure network with 1 hexagonal cell will be created. Note that the WLAN stations are placed in a random fashion and the access point is at the center of the cell.
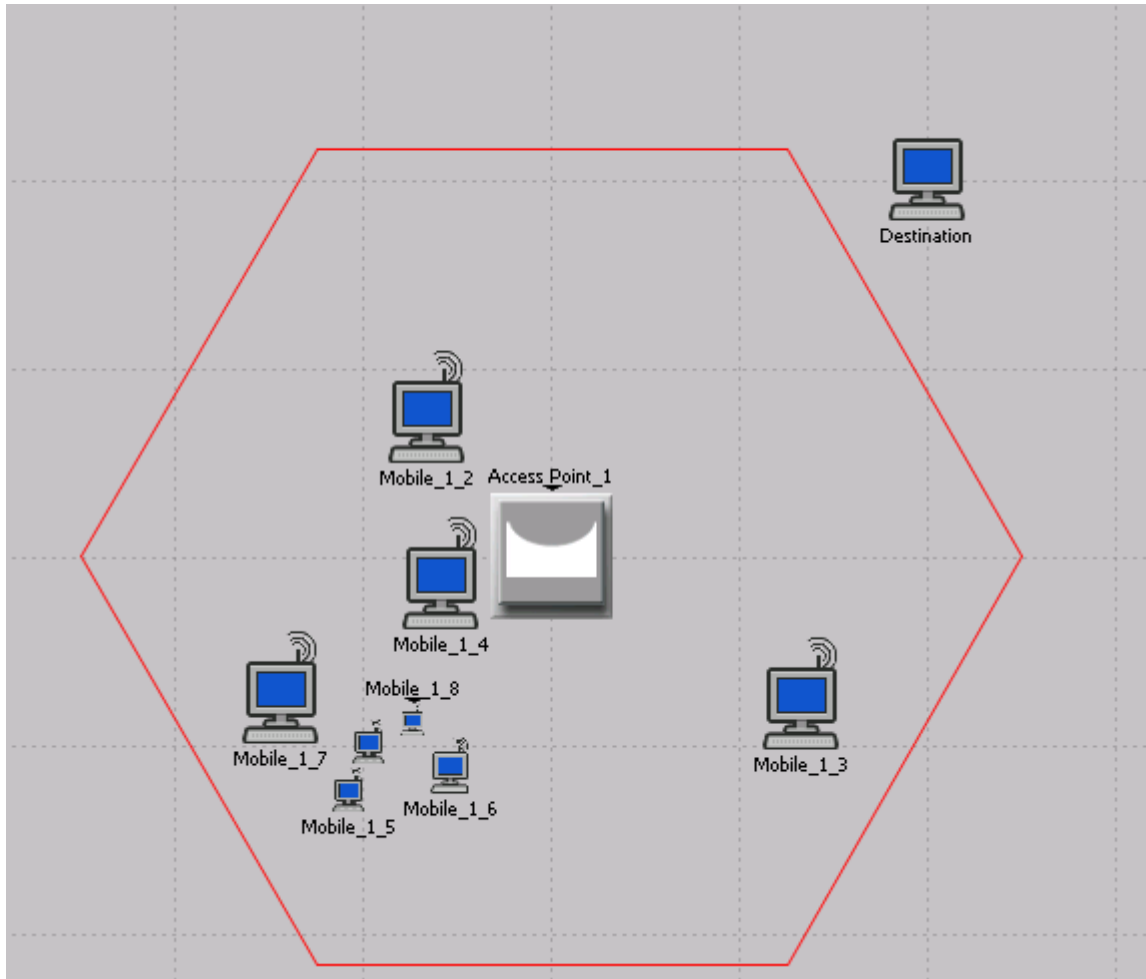
28. The wireless wizard has automatically configured certain attributes on the Access point and Mobiles as per the specification in the wizard. Right click on **Access Point_1** and click on **Edit Attributes**. Right click on any mobile station between **Mobile_1_1** to **Mobile 1_8** (say **Mobile_1_3** for example) and click on **Edit Attributes** and place the two attribute dialog boxes side by side.

• Expand the **Wireless LAN/Wireless LAN Parameters** attribute. We will look at the highlighted attributes below in the next few bullet points
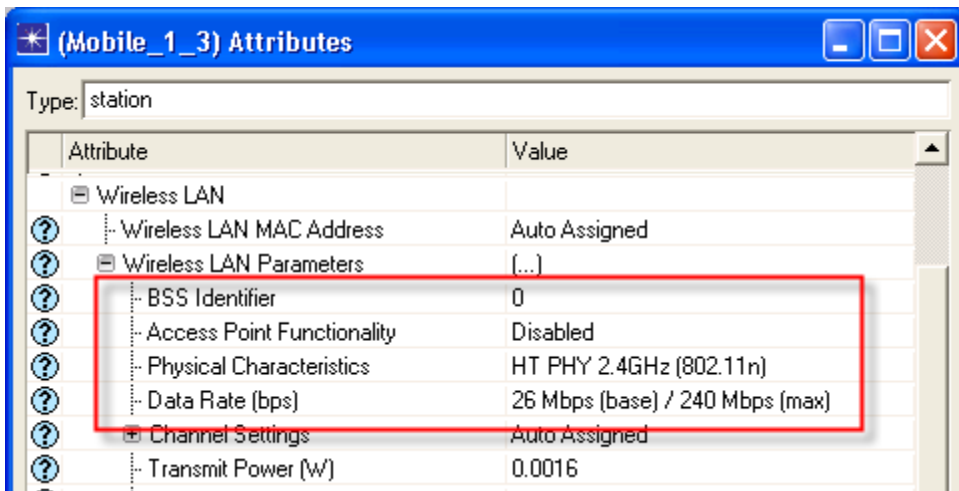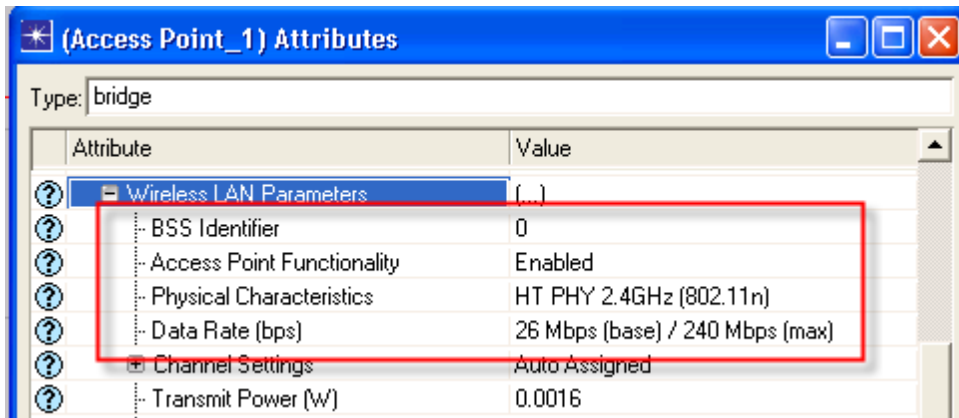
- On **Access Point_1**: Note that the BSS Identifier has been configured to **0**. Note that the **Mobile_1_3** has the BSS Identifier configured to **0** as well.

- On **Access Point _1**: Note that the attribute **Access Point Functionality** it set to **Enabled**.

- On **Access Point_1** and **Mobile_1_3**: Note that the attribute **Physical Characteristics** is set to **HT PHY 2.4GHz (802.11n)** as per our specification in the wireless wizard. This attribute has been set to the same value on all nodes in the network

- On **Access Point_1** and **Mobile_1_3**: Note that the attribute **Data Rate** is set to **26 Mbps (base) / 240 Mbps (max)** as per our specification in the wireless wizard. This attribute has been set to the same value on all nodes in the network

29. Click **Cancel** to close the two attribute dialog boxes.
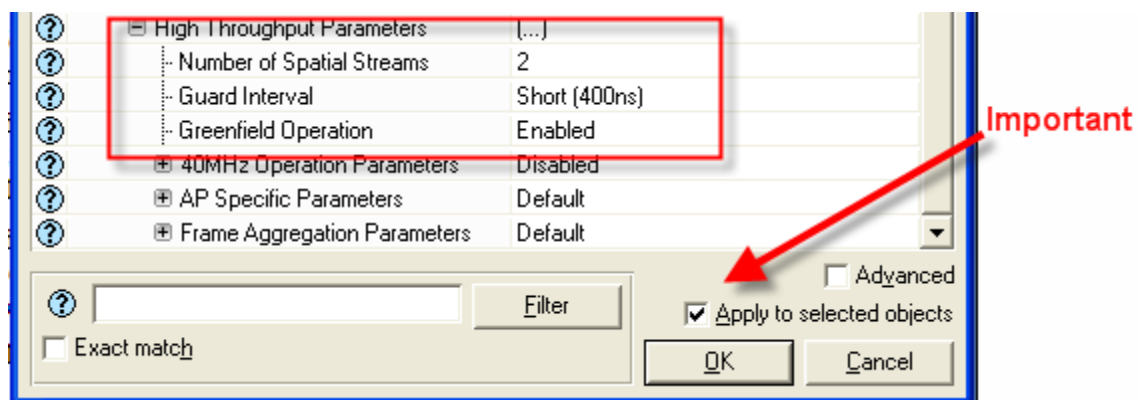
Configuring High Throughput Parameters (802.11n configuration):

The actual physical data rate used for data frame transmissions of the STAs using 802.11n physical layer depends on the configurations of **Wireless LAN/Wireless LAN Parameters/ High Throughput Parameters** attribute.

30. Set the number of spatial streams to 2 and enable greenfield operation on the mobile nodes

- Right click on any of the Mobile nodes and select **Select Similar Nodes**

- Right click on any one of the selected nodes and select **Edit Attributes** making sure that all the 8 nodes are still selected.

- Select the check box "**Apply to selected objects**".

- Expand the **Wireless LAN/Wireless LAN Parameters/ High Throughput Parameters** attribute.

- Set the attribute **Number of Spatial Streams** to **2**

    i. Configuring spatial streams greater than 1 results in a higher physical data rate

- Observe that the attribute **Guard Interval** is set to **Short (400ns)**

    i. Configuring short guard interval results in a higher physical data rate

- The above two configurations sets the actual physical data rate at **57.8 Mbps** as per Table 20-30 in IEEE 802.11n-2009

- Also set the attribute **Greenfield Operation** to **Enabled**, thereby the wireless nodes will be able to use a shorter physical layer header HT –Greenfield format which will increase the wireless LAN throughput.

- Click on **OK**.

31. Configure High Throughput Parameters on the **Access_Point_1** such that the number of spatial streams is 2 and Greenfield operation is enabled.

- Right click on **Access_Point_1** and click on **Edit Attributes.**

- Expand the **Wireless LAN/Wireless LAN Parameters/ High Throughput Parameters** attribute.

- Set the attribute **Number of Spatial Streams** to **2**

- Observe that the attribute **Guard Interval** is set to **Short (400ns)**

- Set the attribute Greenfield Operation to **Enabled**.

- Click on **OK** and accept the changes

Connect Access Point_1 to the Destination by a 1000BaseX link

32. Open the object palette by clicking on .

33. Search for **1000BaseX** link model.

34. Click on the **1000BaseX** as marked in the figure given below:
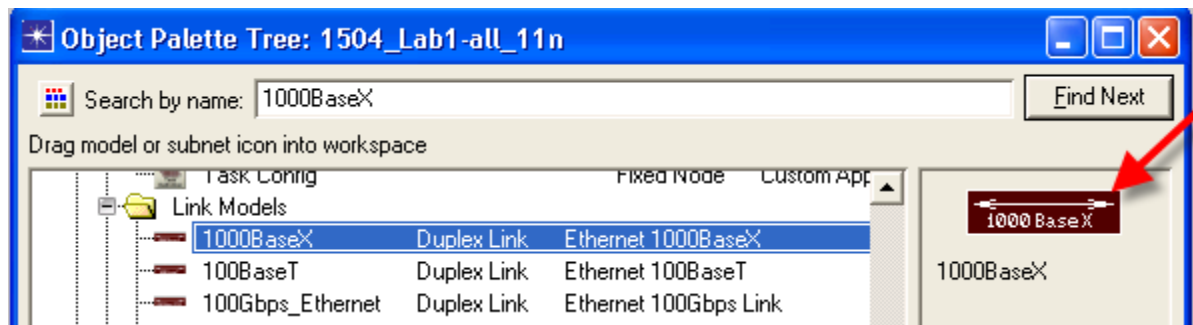
35. Then draw a link between **Access Point_1** and **Destination**.
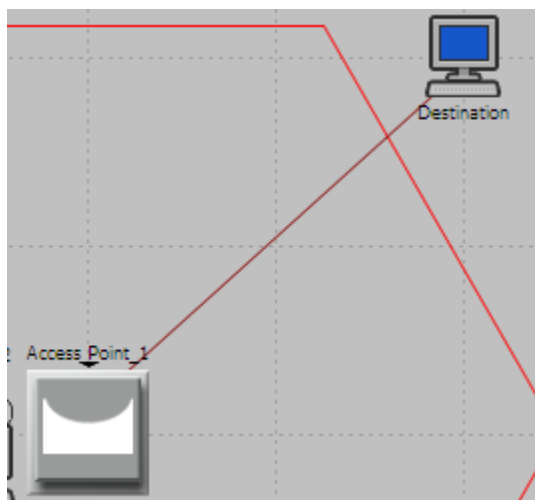
36. Right click on empty space in project editor to bring cursor back to normal.

37. Close the object palette.

Configure Traffic in the network

The station nodes (**Mobile_1_1** to **Mobile_1_8**) shall send traffic to the **Destination.** In order to direct the traffic to the Destination, you have to set the destination address on the nodes generating traffic to the MAC address of the Destination. The MAC address of the destination is configured as 1 under **Ethernet\ Ethernet Parameters\ Address** attribute.
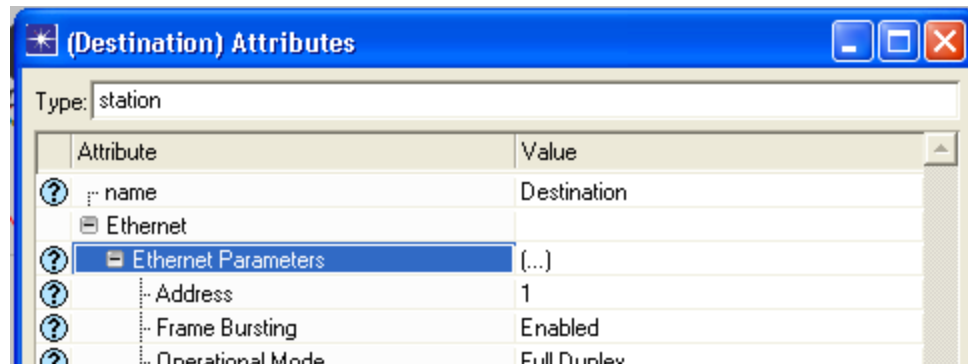
We shall configure the traffic generation attributes on the nodes using by editing the **Traffic Generation Parameters** attribute.

38. Right click on any of the mobile nodes and select **Edit Attributes.**

- Observe that the **Destination Address** attribute is set to **1.**

- Set the **Traffic Generation Parameters > Traffic Type of Service** to **Interactive Voice (6)** as shown below:
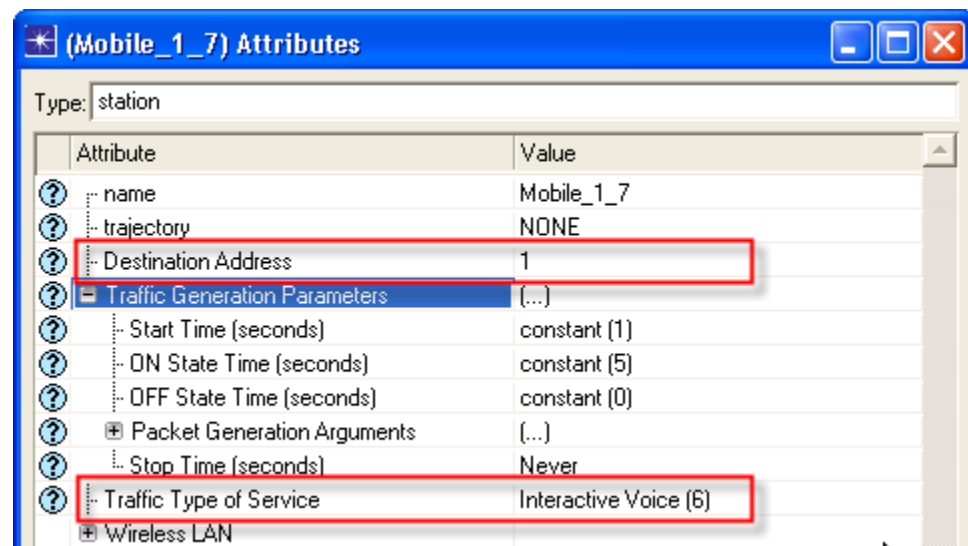
39. Double click on the **Value** of attribute **Traffic Generation Parameters** and set the attributes as shown in the figure below**.**
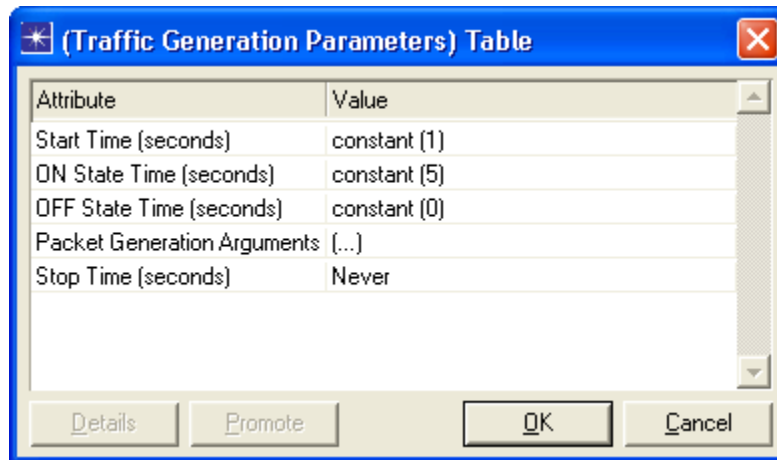
- The traffic generator is basically an ON-OFF traffic generator. The **Traffic Generation Parameters** were set using the Model Assistant file. The time at which the node will start sending traffic **(Start Time)** is set at 1 second. The **ON State Time** is configured to be 5 seconds and the **OFF State Time** is set to 0 seconds.

40. Click on the **Value** of **Packet Generation Arguments.**
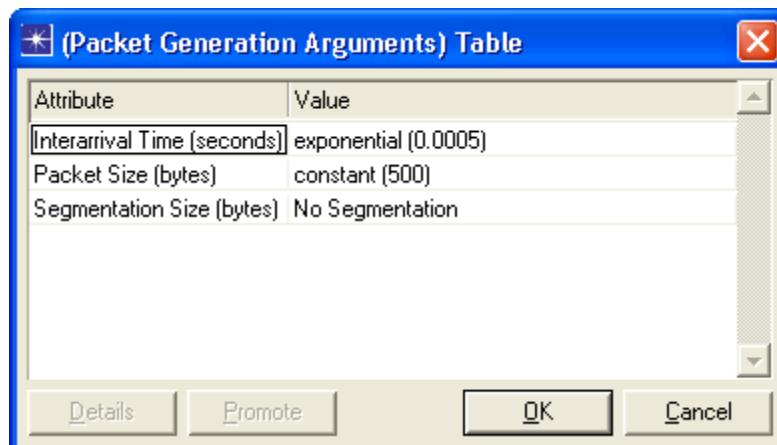
- Set the **Interarrival Time** during the ON state is set to exponential with a mean of 0.0005 and the packet size is set at **500 bytes.**

- Note that the total expected Load on the Wireless LAN network can be computed as follows:

  Load = ((Mean ON Time) / (Mean ON Time + Mean OFF Time)) * (Packet size in bits) * (Number of nodes Generating traffic) / (Mean Inter-arrival Time)

  This implies that the Load = (5/5) * (500 * 8) * 8 / (0.0005) =64.0 Mbps

  The load is configured in such a way that the WLAN queues are never empty.

- Make these traffic changes to nodes **Mobile_1_1** to **Mobile_1_8**. A simple way to configure this may be right-clicking on one of the mobile nodes then choosing **Select Similar Nodes**. Once the attribute changes are done as described in steps 38-40 above, make sure that the **Apply to**

Selected Objects option is checked, then click on OK so that the changes are applied to all mobile nodes at once.

Collect Statistics

41. Select **DES/Choose Individual Statistics.**

- Expand **Global Statistics**, and subsequently expand **Wireless LAN** and observe that **Throughput (bits/sec)**, **Data Dropped (Buffer Overflow) (bits/sec)**, **Data Dropped (Retry Threshold Exceeded) (bits/sec)** and **Media Access Delay (sec)** are selected.
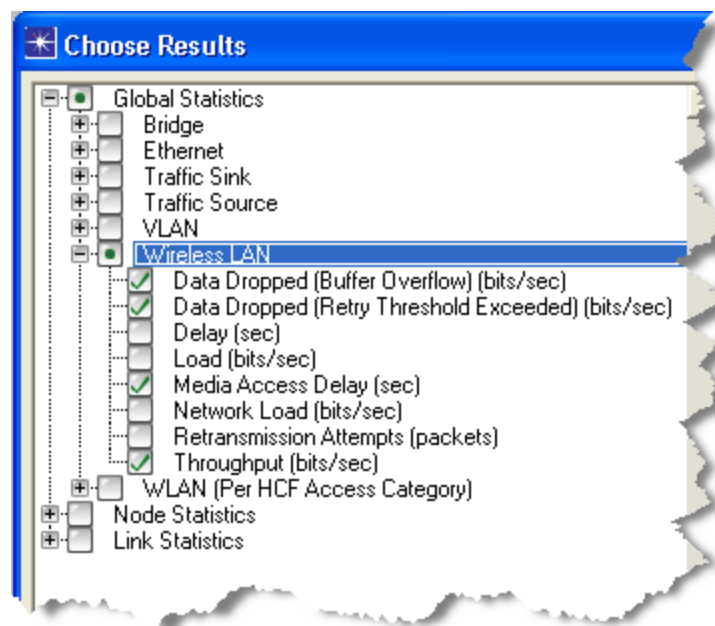
42. Click **Cancel** to close the statistics selection window.

Run Simulation

43. Click on the **Configure/Run Discrete Event Simulation (DES)** button .

44. Verify that the **Simulation Duration** is set to **30 seconds** and then click the **Run** button

45. When the simulation completes click on the **Close** button.

Measuring the impact of the legacy nodes

46. Switch to scenario **mixed_11g_no_traffic** by selecting the menu option **Scenario \ Switch to Scenario**.

47. This is the exactly the same scenario as before but a **legacy_11g** is introduced into the BSS. The legacy node is configured with **Extended Rate PHY (802.11g)** physical characteristics and data rate set to **18 Mbps.**

- Note that the **11g_legacy** node does not send any traffic
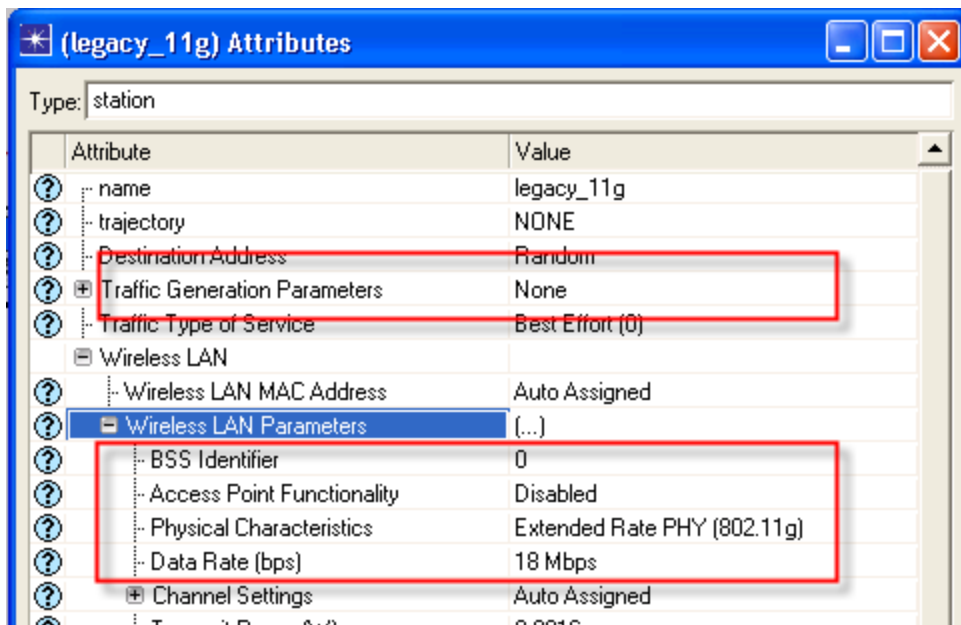
Run simulation

48. Click on the **Configure/Run Discrete Event Simulation (DES)** button [icon].

49. Verify that the **Simulation Duration** is set to **30 seconds** and then click the **Run** button.

50. When the simulation completes click on the **Close** button.

View Results

51. Click on the **Hide/Show Graph Panels** icon to open up Saved Template.
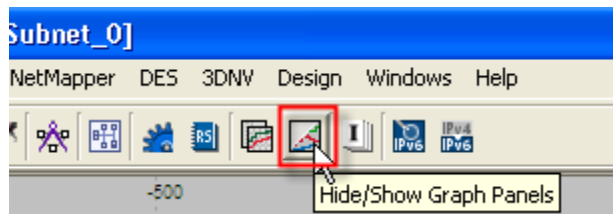
52. Click on **DES / Panel Operations / Panel Templates / Load With Latest Results.**
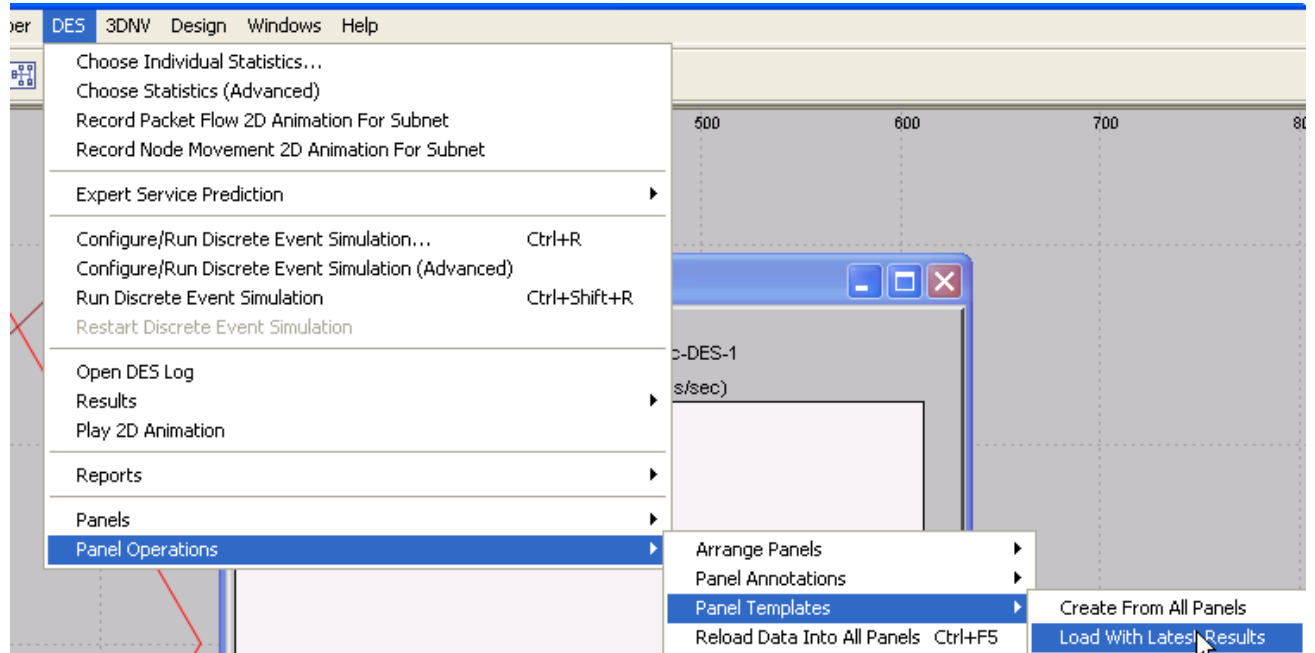
The graph compares the throughput achieved in the scenario where all nodes were 802.11n and the scenario where we had a 802.11g legacy nodes.

Wireless LAN.Data Dropped (Retry Threshold Exceeded) (bits/sec) and Wireless LAN.Data Dropped (Buffer Overflow) (bits/sec)

Results Analysis

- The network administrator expected to see performance degradation in the presence of legacy 802.11g but to his astonishment he finds the opposite in WLAN Throughput statistics.

- Since the **Data Dropped (Retry Threshold Exceeded) (bits/sec)** is almost the same in both scenarios the loss of packets due contention conditions is the same across both scenarios.

- With eight contenders and non-empty buffers, WLAN transmissions experience a large number of collisions.

- However in mixed_11g_no_traffic scenario, the higher layer packets are sent at a much faster rate which is inferred from lesser **Data Dropped (Buffer Overflow) (bits/sec)** and lesser **Media Access Delay (sec)**.
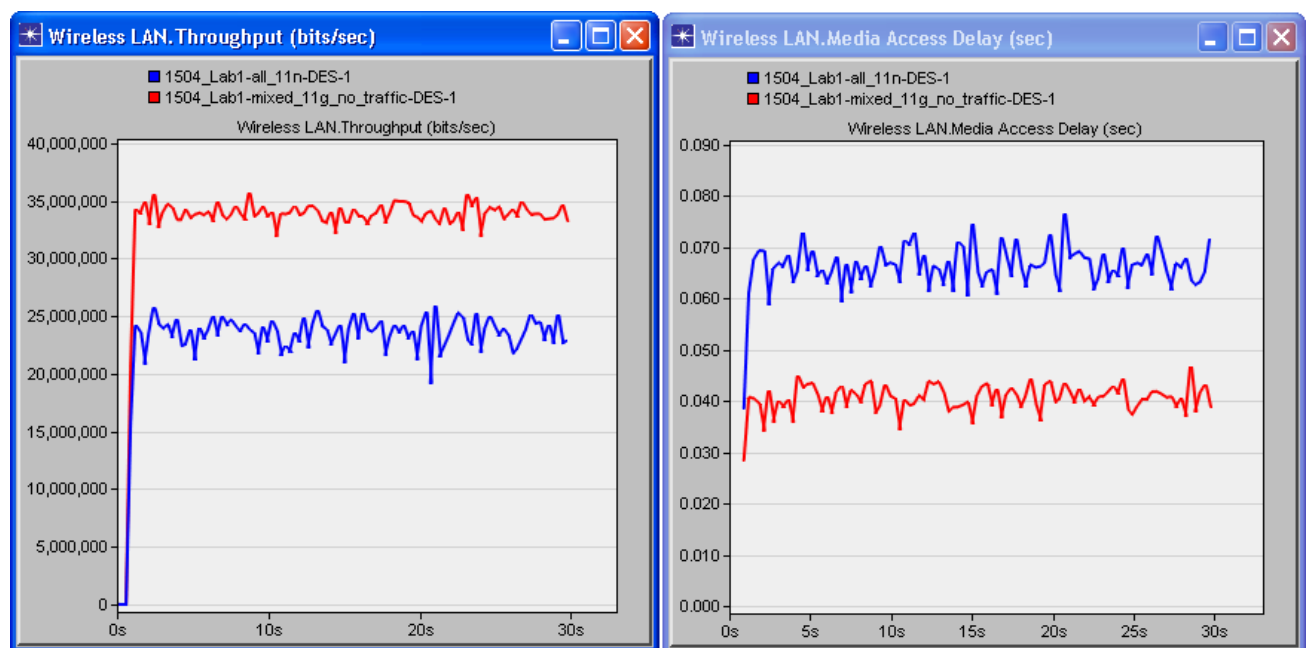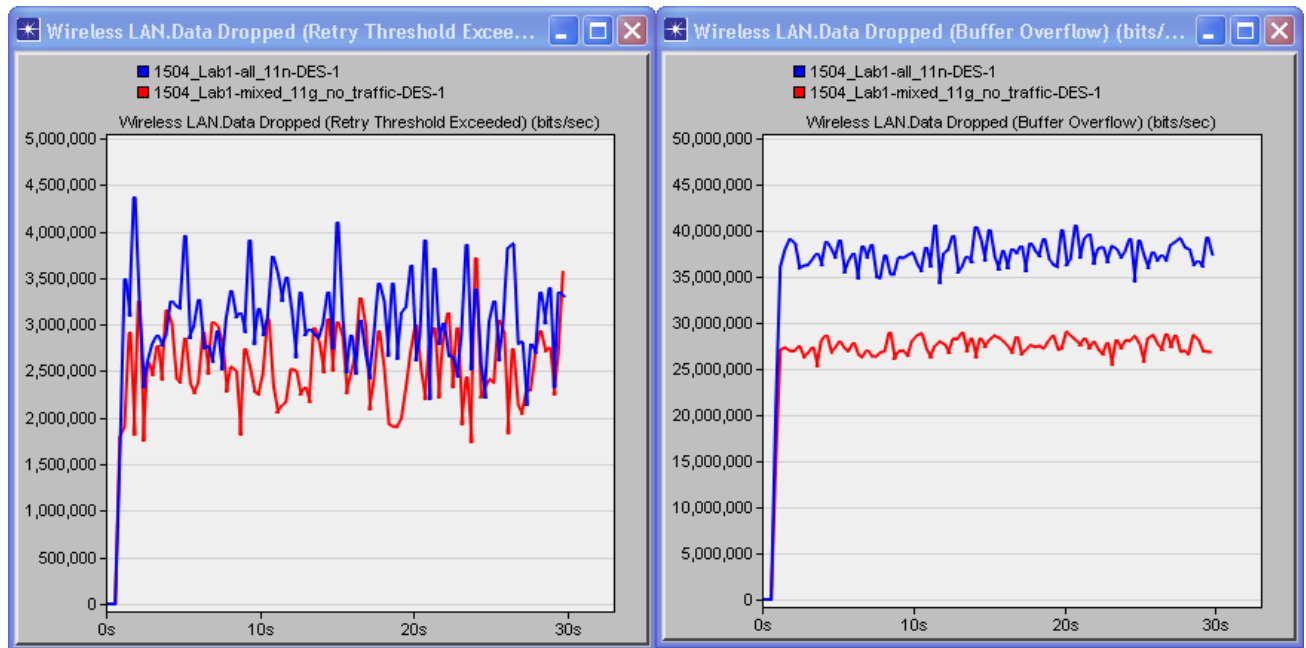
- The network administrator used default frame aggregation settings which has Aggregated MSDU enabled for Interactive Voice (6) traffic category. Aggregated MSDU (A-MSDU) is a huge frame packed with multiple MSDUs. The default maximum A-MSDU size of 3935 bytes is used by the 11n STAs in this study.

- Note that CTS-to-self is enabled by default. In the presence of legacy 802.11g STAs and with CTS-to-self is enabled, a 11n STAs transmits a CTS at 11g data rate ahead of A-MSDU frames transmitted at 11n data rates to protect them from 11g devices.

- Recovery from small CTS frame collisions is much faster compared to recovery from huge A-MSDU frame collisions. Hence having legacy devices indirectly improves network throughput.

EXTRA CREDIT:

Can you suggest the network administrator another way to improve throughput without having legacy 11g nodes in the BSS and using CTS-to-self protection?

Answer: Set RTS Threshold such that huge frames are protected by RTS/CTS frame exchange. When transmitting large packets it is always recommended to precede it with an RTS/CTS frame exchange to improve the overall network throughput.

Conclusion

It is general notion that legacy STAs in the BSS will be detrimental to network performance. Here we see a situation where it actually improves the 11n throughput when CTS-to-self protection is enabled. You can take a look at the **WLAN** example network scenarios **11b_11g_coexistenece** and **11n_11g_11b_roaming**, which study the impact of legacy nodes in other situations. Simulations of WLANs using Modeler reveal such interesting situations and help us plan our network better.

LAB 2: Improving Performance with QoS Aware Wireless LAN Layer

Overview

The network administrator of an enterprise has been asked to dimension the company's wireless network to support voice users. Currently, the wireless network is an 802.11n network and the most used applications are HTTP and Email. The administrator decides to study the feasibility of using the current network to support voice users. If the network does not perform suitably he plans to tune QoS features in the network to prioritize voice users.

Objective

Assess the performance of high-quality voice application together with HTTP application in an 11n infrastructure Wireless LAN BSS operating at 7.2 Mbps

Improve the performance of the network further by adjusting 802.11e parameters based on application load and topology conditions in the network.

Methodology

Create the baseline infrastructure BSS operating at 7.2 Mbps with WLAN workstations running voice and HTTP application, and measure the performance observed at application layer with default 11e settings.

In the second scenario, adjust the related EDCA parameters based on network and traffic conditions and change the acknowledgement policies for the traffic categories corresponding to application traffic, and then compare the performance observed at the application layer against the performance measured with default parameters.

Observe baseline network running 802.11n

Open the scenario

1. Start **Riverbed Modeler Academic Edition 17.5**, if it is not already started.

2. Select **File/Open** and select **1504_Lab2** and click **Open** to open the project for lab 2.

3. Maximize the project by clicking on the **maximize** button on the top right corner of the project editor.

4. Make sure that you are in "**voice_baseline**" scenario.
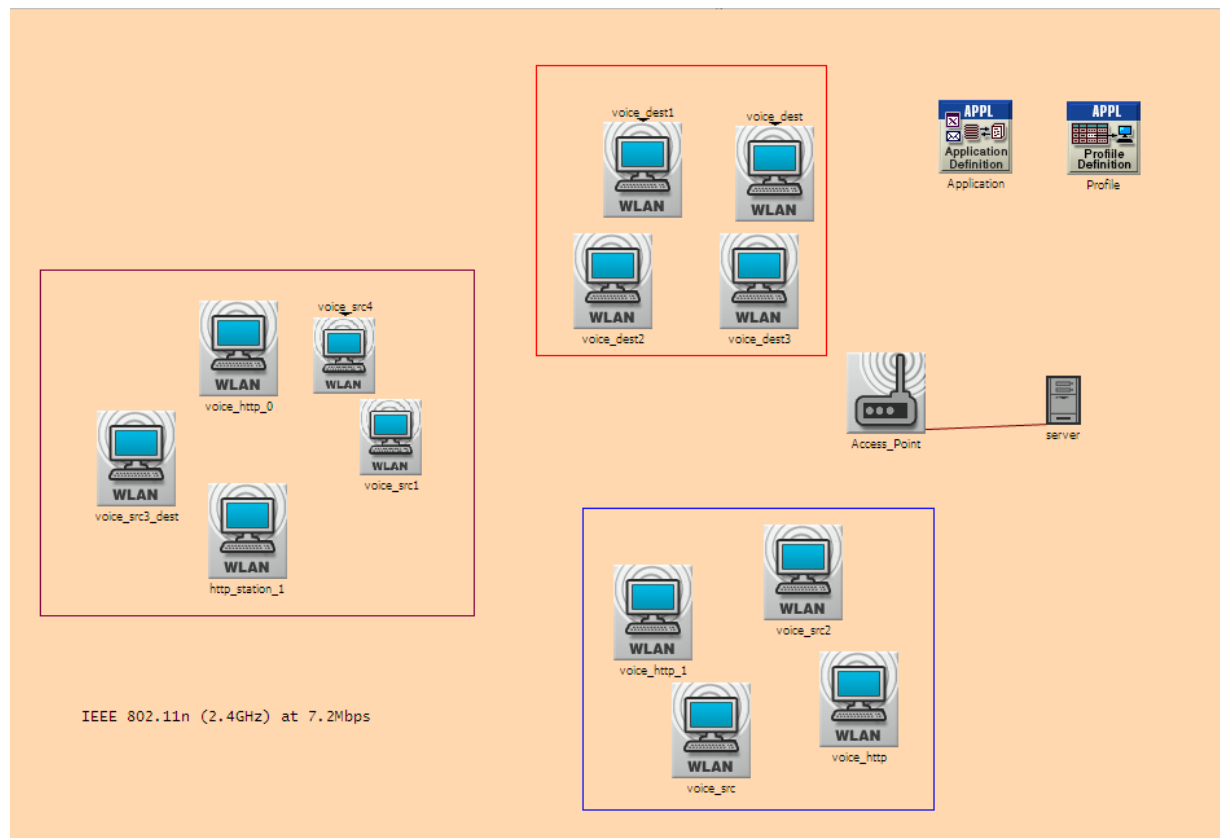
5. Application configuration in the network is as follows:

    a. There are total of 8 workstations running voice application as voice data source and calling 5 workstations configured as voice destinations ("**voice_src3_dest**" is configured both as voice source and voice destination).

    b. All voice source and destination nodes belong to the same BSS and hence all voice traffic has to flow through AP.

    c. The voice application is configured to generate G.711 encoded voice traffic at 64kbps.

    d. There are 4 workstations running HTTP web browsing application (the stations whose names start with prefix "**voice_http**" are running both voice and HTTP browsing applications).

    e. HTTP clients connect their server node "**server**" through the access point.

Wireless LAN workstation settings

1. All the nodes are configured with **HT PHY 2.4GHz (802.11n)** with data rate **"6.5 Mbps (base) / 60 Mbps (max)"**.

    a. **Number of Spatial Streams** is set to 1, **40MHz Operation Parameters** is set to Disabled and Guard interval is set to **Short (400ns)**. Therefore the physical data rate that will be used is 7.2Mbps.

2. The attribute **Wireless LAN Parameters \ HCF Parameters** is set to **Default** on all wireless LAN workstation nodes.
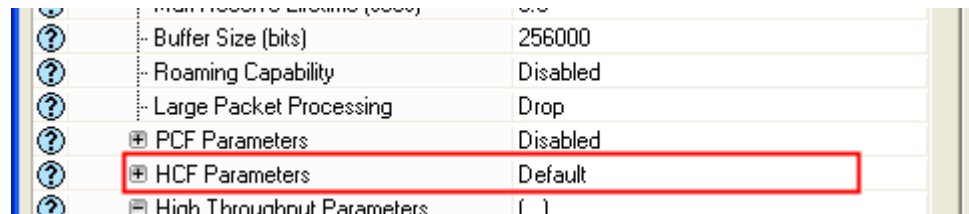
3. The attribute **Wireless LAN Parameters \ HCF Parameters** is set to **Default (QAP)** on the **Access_Point**.
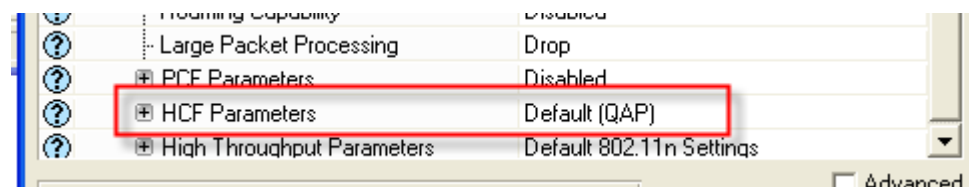
4. Click **Cancel** to close dialog box if opened.

All WLAN nodes in the network are 11e-capable such that they will contend for the medium according to EDCA rules, and the values of EDCA parameters are set to 802.11e recommended values.

As per the QoS prioritization at the WLAN layer, Voice and HTTP traffic will be mapped to WLAN Voice and Best Effort access categories, respectively.

In the figure below, we can see that HTTP is configured to use Type of Service "**0**".
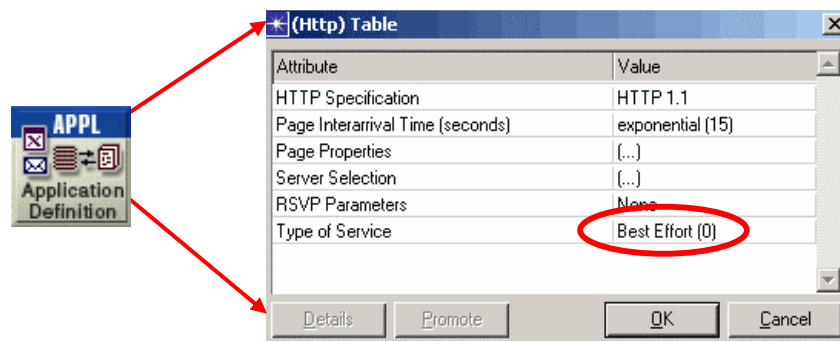
The table below, excerpted from IEEE 802.11e standard, shows the mapping of User Priority (Type of Service) values to the access categories.

Table 20i—UP-to-AC mappings

| Priority	UP (Same as 802.1D user priority)	802.1D designation	AC	Designation (informative)
Lowest	1	BK	AC_BK	Background
	2	—	AC_BK	Background
	0	BE	AC_BE	Best Effort
	3	EE	AC_BE	Best Effort
	4	CL	AC_VI	Video
	5	VI	AC_VI	Video
	6	VO	AC_VO	Voice
Highest	7	NC	AC_VO	Voice

* Source: IEEE Std 802.11e-2005

Similarly voice application is configured to use Type of Service "**6**", which is mapped to voice AC as seen in the table above.
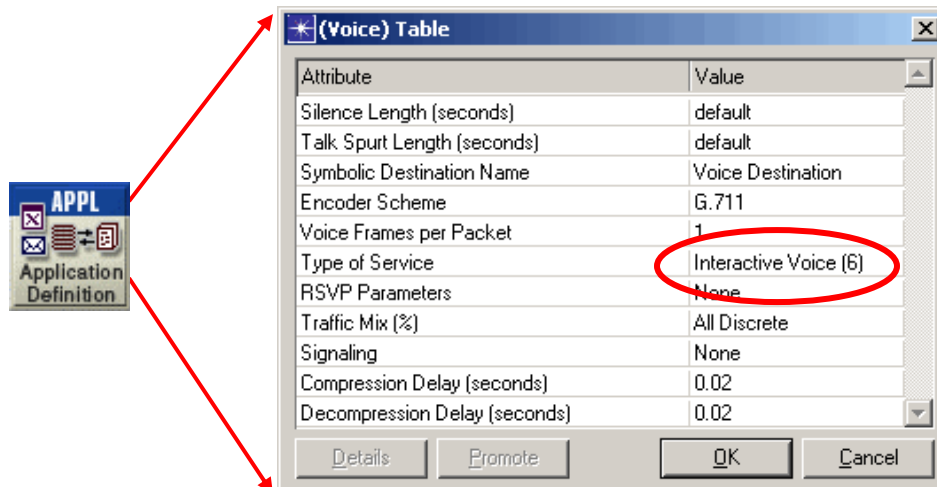
5. Click **Cancel** all the way to close the dialog boxes.

Run simulation and load results

1. Click on the **Configure/Run Discrete Event Simulation (DES)** button .

2. Note that the simulation **Duration** is "**120 seconds".**

3. Click **Run.**

   The simulation will take about 1 to 2 minute to execute.

4. When the simulation completes click on the **Close** button.

5. Click on the **Hide/Show Graph Panels** button ⬚.

6. Select **DES/Panel Operations/Panel Templates/Load with Latest Results.**

   The panels will be updated with the latest results.

Results analysis

- The performance of HTTP application is poor. Only one page is downloaded before 60 seconds and no object or page information is downloaded after 60 seconds, due to increasing voice traffic in the network.
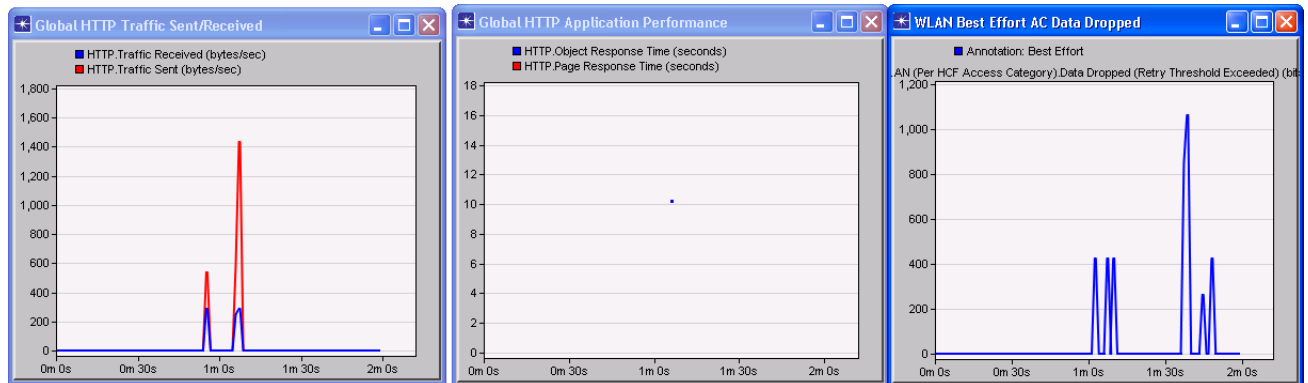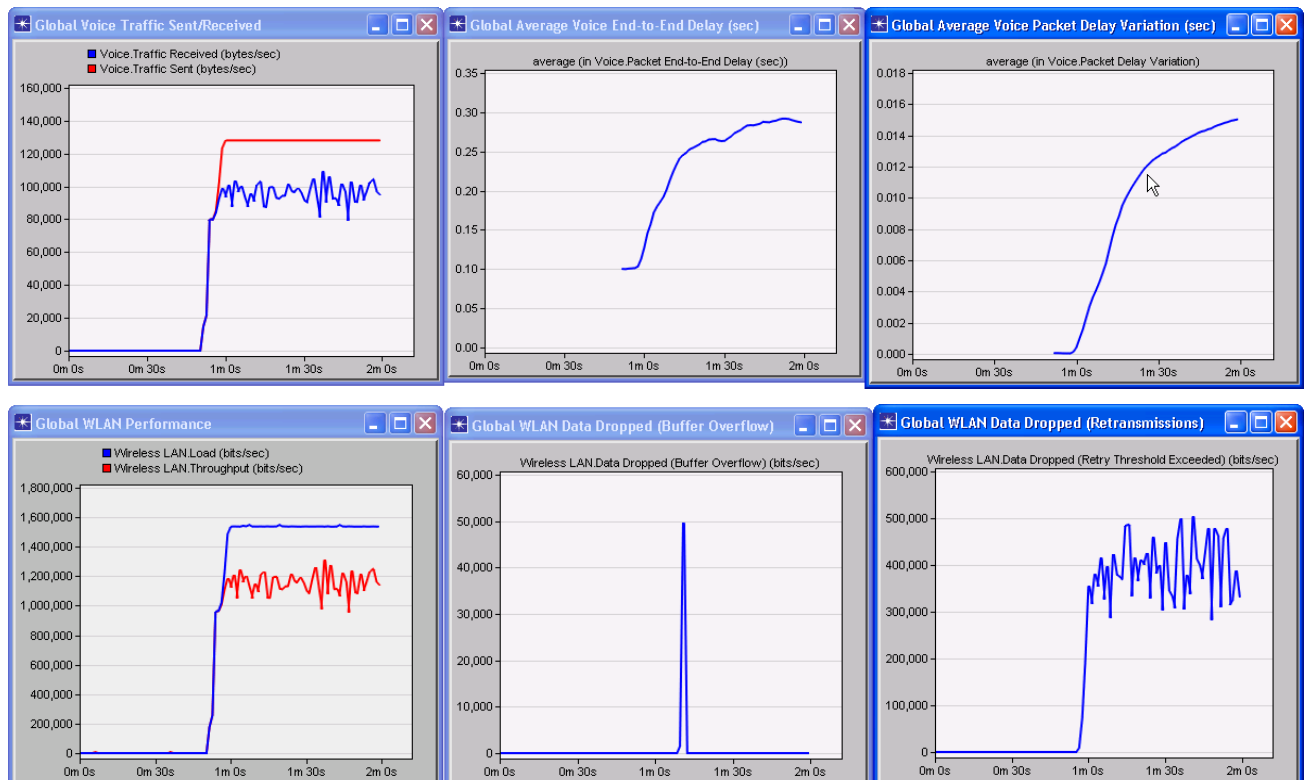
- The Data Dropped due to buffer overflow is fairly low.

- Considerable amount of data drops due to excessive retransmissions indicating tough contention conditions and possibly a "too-small" contention window used by contending stations.

- In conclusion, with default 11e parameters it is observed that voice application has a better throughput than the HTTP but still has some losses and longer delays while secondary application, HTTP, is still not networkable.

- High number of WLAN layer retransmissions implies the main bottleneck at layer-2 needs to be tackled for further improvement.

- The network administrator decides that using QoS would be beneficial and has potential to address the requirements but realizes that he would have to fine tune parameters to satisfy performance constraints before deployment.
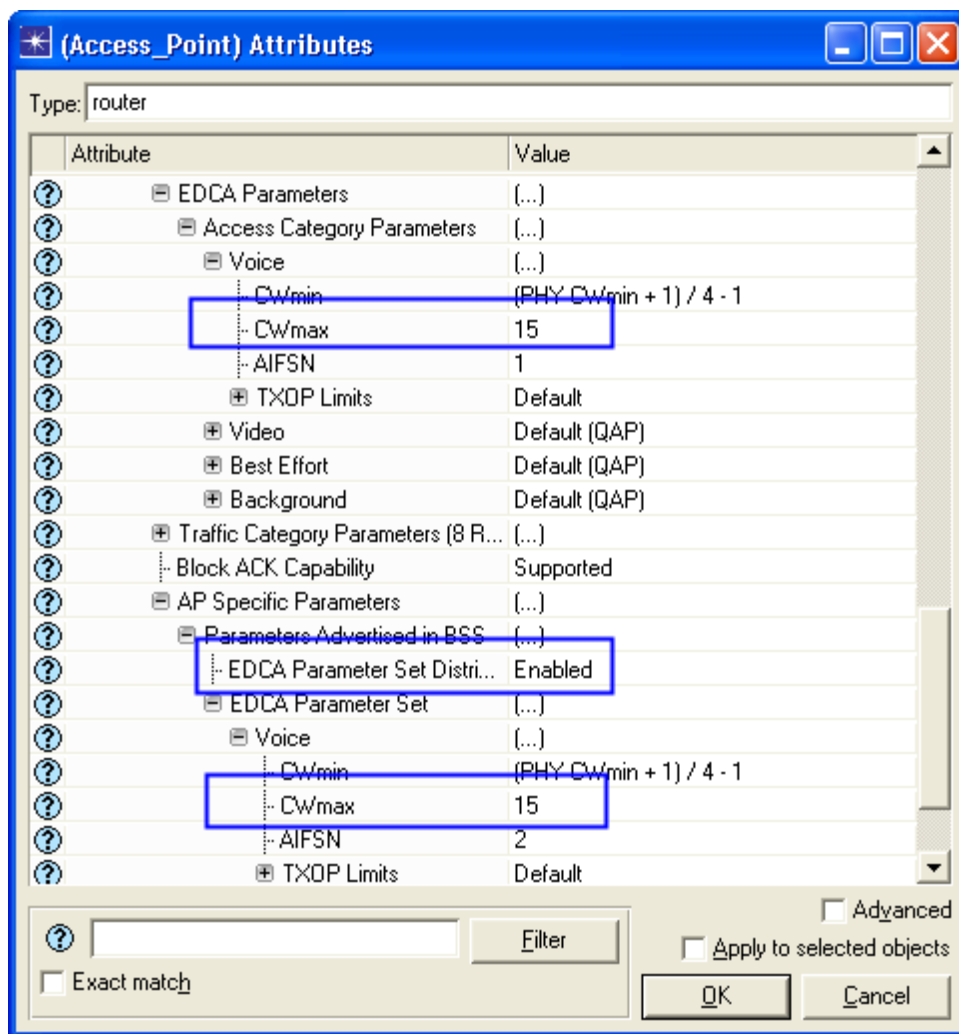
Performance tuning for 11e network

- Please refer to presentation for a discussion on WLAN protocol behavior related to the attribute configurations we will perform in this part of the lab.

Adjust contention window for Voice access category

1. Select **Scenarios/Switch To Scenario.**

2. Select "**voice_11e_better**" scenario.

   This is the same network as in "**voice_baseline"** scenario.

3. Configure AP to use a larger CWmax for Voice access category.

   a. Right click on "**Access_Point**" and choose **Edit Attributes.**

   b. Expand the attribute **Wireless LAN/Wireless LAN Parameters.**

   c. Set the attribute **HCF Parameters/EDCA Parameters/Access Category Parameters/Voice/CWmax** to "**15**"

   d. Do not close the window. Continue reading.

4. Make all other WLAN workstations use a larger CWmax for Voice access category too by setting the following attribute on the node "**Access Point**".

   a. Set the attribute **HCF Parameters/AP Specific Parameters/Parameters Advertised in BSS/EDCA Parameter Set/Voice/CWmax** to "**15**".

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b. Since EDCA parameters used by the WLAN nodes in the BSS are advertised by the access point (because **EDCA Parameter Set Distribution** is "**Enabled**") this change is sufficient to make all the WLAN workstations use the new CWmax value for their Voice access categories.

c. Do not close the window. Continue reading.

Switch to "No Acknowledgement" policy for voice traffic

To help with the reduction of end-to-end delays for voice traffic and to improve the WLAN layer performance for both applications by lowering its overhead, we will turn off layer-2 acknowledgements for Voice Access Category traffic.

After this configuration change, WLAN protocol will start performing RTS/CTS frame exchange before the first frame of Voice AC TXOPs (transmission opportunities) in order to provide protection for the unacknowledged voice traffic at layer-2 by reserving the medium in a confirmed manner.

Hence retransmissions (of RTS frames instead of data frames) and packets due to reaching retry limit are still probable.

5. Set Service Class of Voice Traffic Category to "No Acknowledgement" on AP

    a. Edit the attribute **Traffic Category Parameters** by left clicking on its value and selecting **Edit…**.

    b. Set **Service Class** for **TID** (Traffic Identifier) "**6 (Interactive Voice)**" to "**No Acknowledgement**".

    c. Since priority (ToS) of voice application traffic is set to "6" in application configuration, the voice traffic is mapped to TID "6 (Interactive Voice)" at WLAN layer.

    d. Click on the **OK** buttons twice to complete AP's configuration.

6. Make the same configuration for all WLAN workstations.

    a. Right click on one of the workstations and choose **Select Similar Nodes.**

    b. Right click on one of the selected nodes and choose **Edit Attributes.**

    c. Check the **Apply changes to selected objects** box.

    d. Expand the attribute **Wireless LAN/Wireless LAN Parameters/HCF Parameters.**

    e. Edit the attribute **Traffic Category Parameters** by left clicking on its value and selecting **Edit…**.

    f. Set **Service Class** for **TID** (Traffic Identifier) "**6 (Interactive Voice)**" to "**No Acknowledgement**"

    g. Click on the **OK** buttons twice to complete the attribute configuration.

### *Promote HTTP traffic from Best Effort to a higher WLAN access category*

7. Configure HTTP traffic to use a better ToS, namely "Streaming Multimedia (4)".

    a. This will make HTTP traffic be mapped to "**Video**" access category at the WLAN layer.

Table 20i—UP-to-AC mappings

Priority	UP (Same as 802.1D user priority)	802.1D designation	AC	Designation (informative)
Lowest	1	BK	AC_BK	Background
	2	—	AC_BK	Background
	0	BE	AC_BE	Best Effort
	3	EE	AC_BE	Best Effort
	4	CL	AC_VI	Video
Highest	5	VI	AC_VI	Video
	6	VO	AC_VO	Voice
	7	NC	AC_VO	Voice

* Source: IEEE Std 802.11e-2005

    b. Right click on "**Application"** node and select **Edit Attributes.**

    c. Set the attribute **Application Definitions/http (Description)/Http/Type of Service** to "**Streaming Multimedia (4)**".

    d. Close all windows by clicking **OK** on all of them.
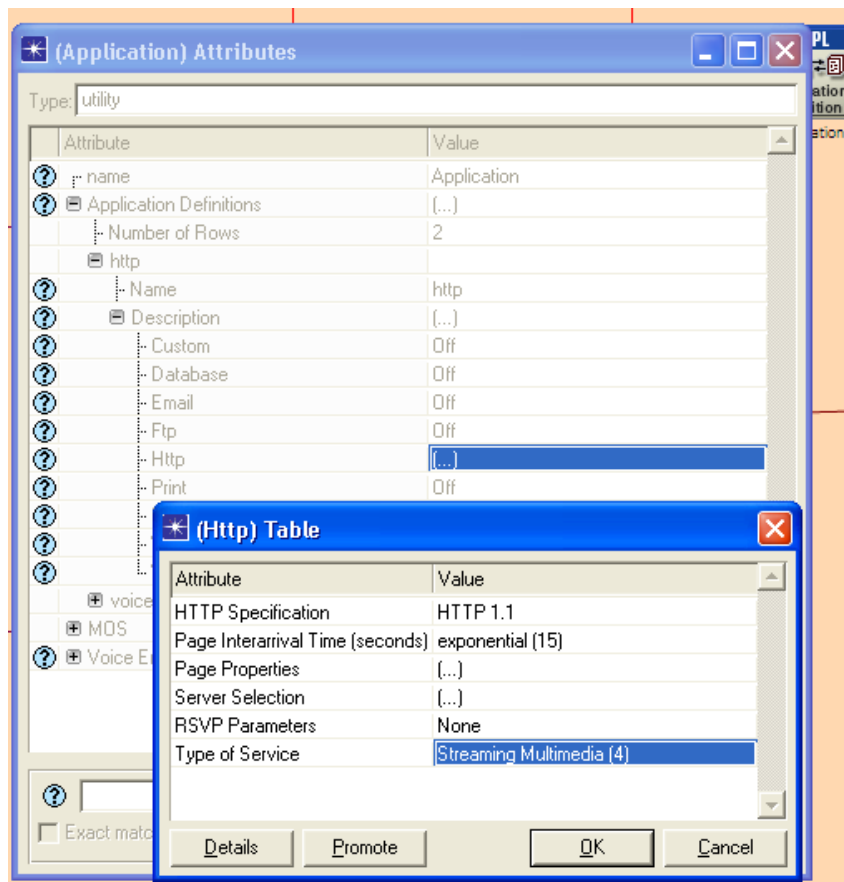
As HTTP is mapped to a higher priority access category, although it is still a lower priority than the one used by voice traffic, now we expect HTTP traffic to perform better at the WLAN layer.

Run simulation and load results

1. Click on the **Configure/Run Discrete Event Simulation (DES)** button .

2. Note that the simulation **Duration** is "**120 seconds".**

3. Click **Run.**

   The simulation will take about 1 minute to execute.

4. When the simulation completes click on the **Close** button.
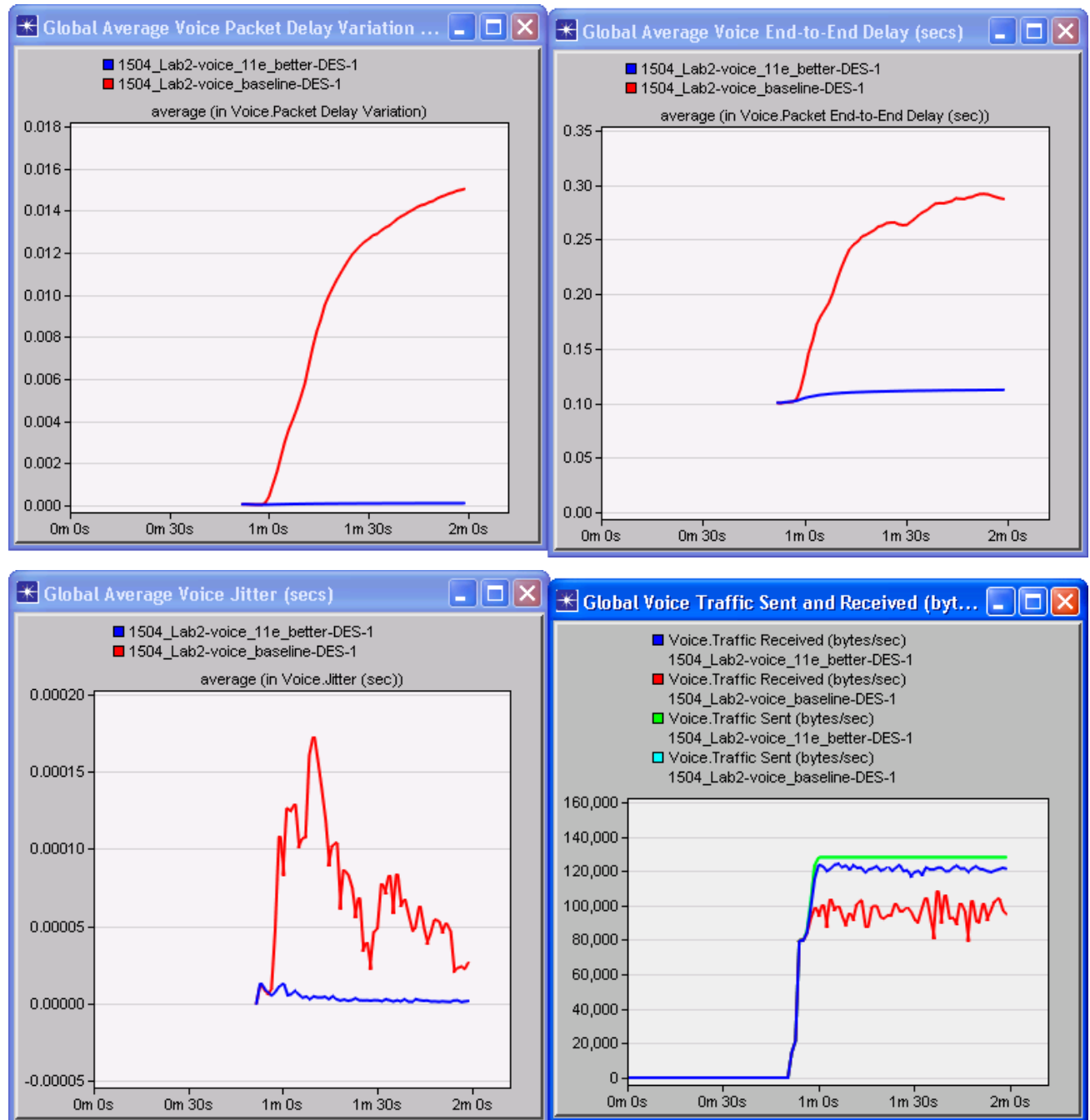
5. Click on the **Hide/Show Graph Panels** button .

6. Select **DES/Panel Operations/Panel Templates/Load with Latest Results**.

   The panels will be updated with the latest results.

STOP

Results analysis

- Great news for voice users: with the adjustment of related WLAN 802.11e parameters, we increased the quality of voice calls across our network by reducing end-to-end, delay variation and jitter values as well as increasing the percentage of voice traffic that could be successfully delivered from source to destination.
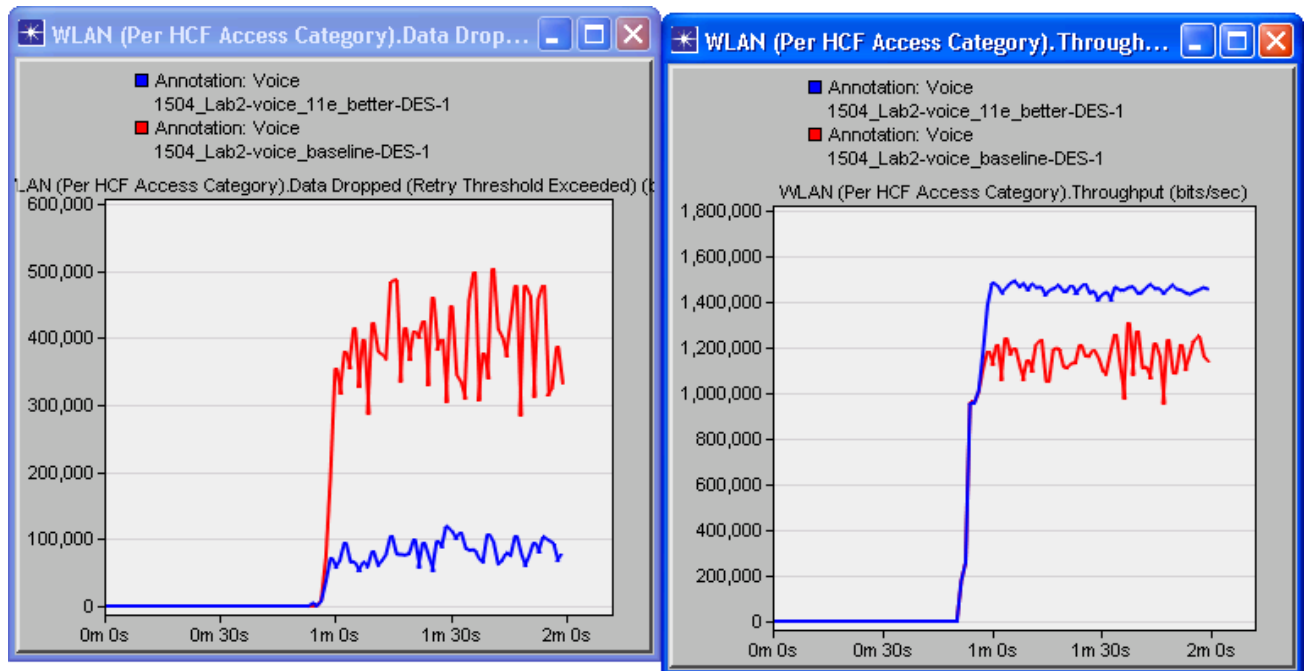
- In addition to the increase in Voice AC throughput, we also achieved a decrease in amount of dropped Voice AC data due to reaching retry limit.

- The dropped data due to retry threshold exceeded has significantly reduced for Voice access category compared to previous scenario.

- Apparently our adjustment of maximum contention window size worked out and made Voice ACs of the WLAN nodes contend for the medium more efficiently.
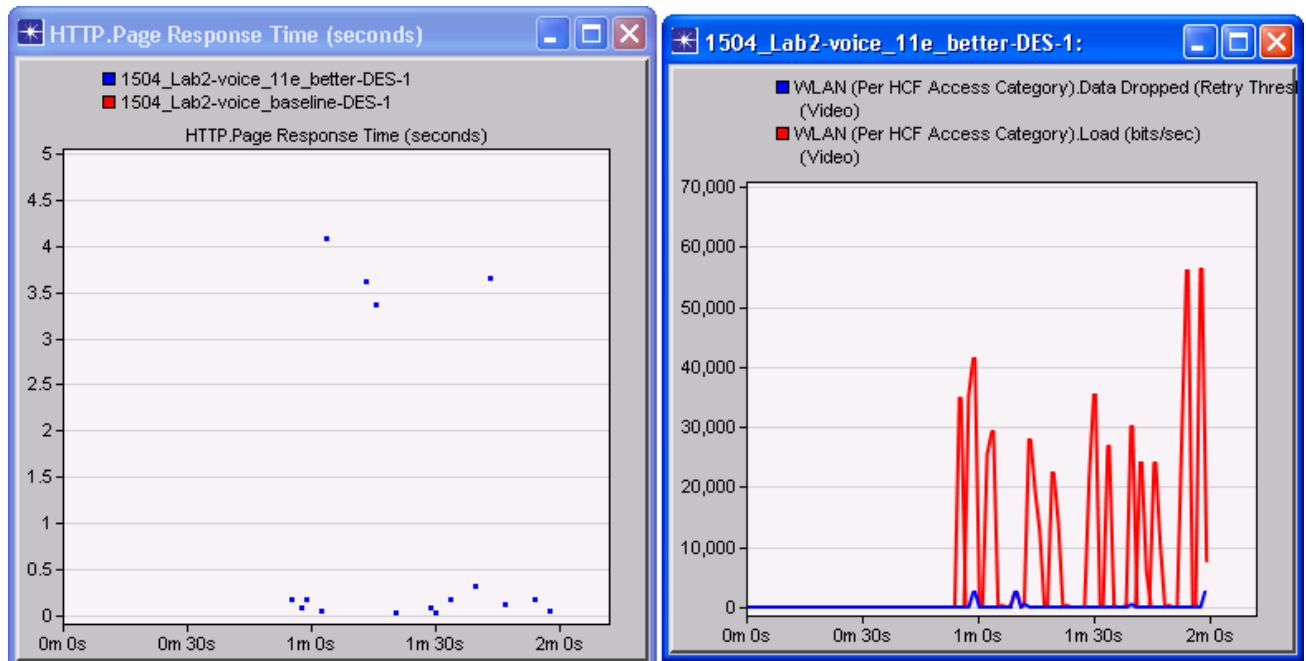
- Now we have also good news for HTTP clients: their HTTP application traffic is not blocked by voice traffic anymore. Page downloads complete even when all the voice users are active.

- The percentage of HTTP packet drops at WLAN layer (i.e., drops reported by Video access category) is low.

- Any lost HTTP data is retransmitted by the TCP layer.

- To conclude, by adjusting Traffic Category parameters and EDCA parameters used in prioritized medium access based on the conditions in our network, we configured the WLAN layer, such that now it performs at a level that provides acceptable quality for all applications running in our network.
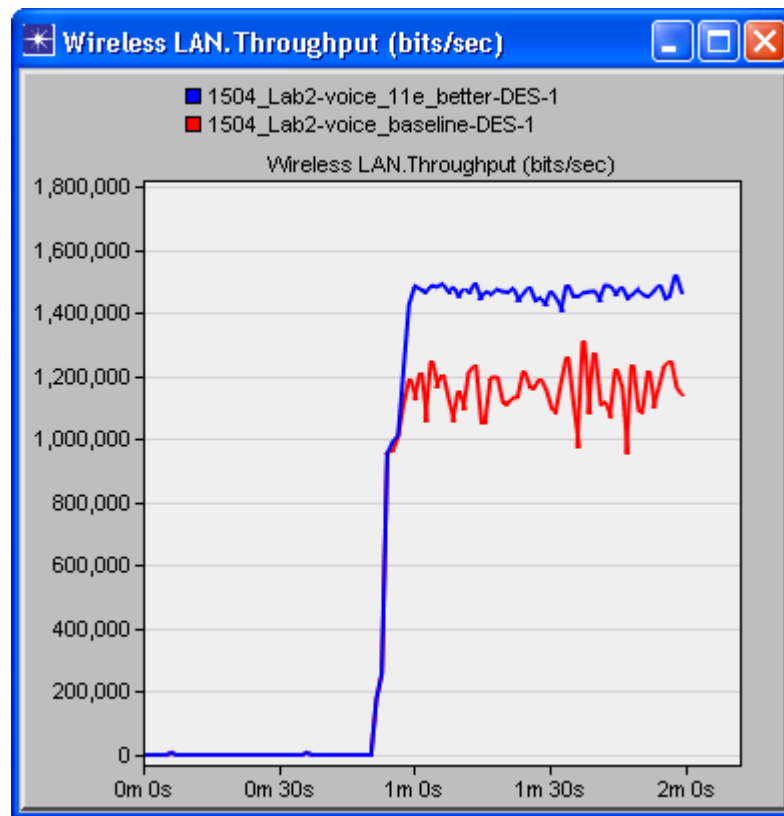
- The considerable increase in global WLAN layer throughput with the same physical layer also confirms the positive outcome of our parameter adjustments.

1. Click on the **Hide/Show Graph Panels** button to hide the graphs.
2. Type **Ctrl**+**S** to save the project

List of ACRONYMS

Riverbed Acronyms

- DES: Discrete Event Simulation
- TMM: Terrain Modeling Module

General IEEE 802.11 related

- IEEE: Institute of Electrical & Electronics Engineers
- LAN: Local Area Network
- WLAN: Wireless LAN (a name used for IEEE 802.11 Technology)
- BSS: Basic Service Set
- MAC: Medium Access Control
- PHY: Physical (layer)
- AP: Access Point
- STA: A station that contains a WLAN MAC/PHY interface
- MANET: Mobile Ad Hoc Network

IEEE 802.11 Acronyms (PHY Related)

- FHSS: Frequency Hopping Spread Spectrum
- DSSS: Direct Sequence Spread Spectrum
- IR: Infrared Light
- OFDM: Orthogonal Frequency Division Multiplexing
- ERP-OFDM: Extended Rate PHY-OFDM
- CCK: Complimentary Code Keying

IEEE 802.11 Acronyms (Medium Access)

- CSMA/CA: Carrier-Sense Multiple Access with Collision Avoidance
- DCF: Distributed Coordination Function
- CP: Contention Period
- PCF: Point Coordination Function
- CFP: Contention Free Period
- NAV: Network Allocation Vector
- CW: Contention Window
- RTS: Request To Send frame
- CTS: Clear To Send frame
- ACK: Acknowledgement frame
- IFS: Inter-frame Space
- SIFS: Short IFS
- PIFS: PCF IFS
- DIFS: DCF IFS
- EIFS: Extended IFS
- AIFS: Arbitration Inter-frame Space

IEEE 802.11 Acronyms (802.11e Related)

- HCF: Hybrid Coordination Function
- EDCA: Enhanced Distributed Channel Access
- AC: Access Category
- TXOP: Transmission Opportunity
- AIFS: Arbitration Inter-frame Space
- AIFSN: Arbitration Inter-frame Space Number
- ToS: Type of Service
- QoS: Quality of Service
- TC: Traffic Category
- BAR: Block Acknowledgement Request
- BA: Block Acknowledgement
- ADDBA: Add Block-ACK
- DELBA: Delete Block-ACK