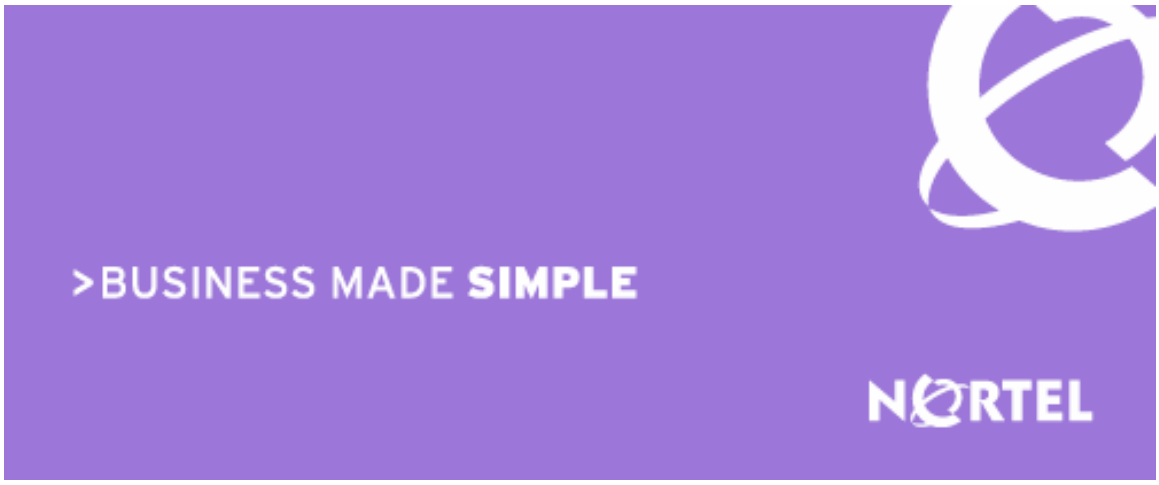

Ethernet Switch
Ethernet Routing Switch
Engineering

> Nortel IP Phone Set Inter-Working With Nortel ES & ERS Switches Technical Configuration Guide

Enterprise Solutions Engineering
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Nortel is a recognized leader in delivering communications capabilities that enhance the human experience, ignite and power global commerce, and secure and protect the world's most critical information. Serving both service provider and enterprise customers, Nortel delivers innovative technology solutions encompassing end-to-end broadband, Voice over IP, multimedia services and applications, and wireless broadband designed to help people solve the world's greatest challenges. Nortel does business in more than 150 countries. For more information, visit Nortel on the Web at www.nortel.com.

Abstract

The purpose of this TCG is to review the many options available on Nortel Ethernet and Ethernet Routing Switches for interoperability with Nortel's IP Phone sets.

Conventions

This section describes the text, image, and command conventions used in this document.

Symbols

Tip – Highlights a configuration or technical tip.

Note – Highlights important information to the reader.

Warning – Highlights important information about an action that may result in equipment damage, configuration or data loss.

Text

Bold text indicates emphasis.

Italic text in a Courier New font indicates text the user must enter or select in a menu item, button or command:

ERS5520-48T# ***show running-config***

Output examples from Nortel devices are displayed in a Lucida Console font:

ERS5520-48T# ***show running-config***

```
! Embedded ASCII Configuration Generator Script
! Model = Ethernet Routing Switch 5520-24T-PWR
! Software version = v5.0.0.011
enable
configure terminal
```

Revision Control

No	Date	Version	Revised by	Remarks
1	07/12/2007	2.2	ESE	Modification to section 4.4.2 on page 45.
2	01/28/2008	3.0	ESE	Modifications
3	02/14/2008	4.0	ESE	Added updates related to ADAC and EAPOL. Added ERS2500 and ERS4500 switches.

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1. Overview

This TCG covers standalone Nortel IP Phone sets and how they can be deployed on various Nortel switches. It will cover features on Nortel switches related to VoIP with configuration examples. Overall, topics that will be covered include the following:

Ethernet switch platforms that support PoE:

- Ethernet Switch 470-PWR
- Ethernet Routing Switch 5520-PWR
- Ethernet Routing Switch 4550T-PWR
- Ethernet Routing Switch 4548GT-PWR
- Ethernet Routing Switch 4526T-PWR
- Ethernet Routing Switch 4526GTX-PWR
- Ethernet Routing Switch 2526T-PWR
- Ethernet Routing Switch 2550T-PWR
- Ethernet Routing Switch 8300

VoIP technologies:

- Power over Ethernet (PoE)
- Auto configuration via DHCP for VoIP Phone sets
- Quality over Service (QoS)
- Authentication using EAPoL (802.1x)
- Auto Detection Auto Configuration (ADAC)
    - ADAC by itself using either MAC address of IP Phone or 802.1AB (LLDP) for auto-discovery and setting Layer 2 and Layer 3 QoS level.
    - On the ERS55xx, ADAC can be used with 802.1AB (LLDP-MED Network Policy) to set the IP Phone set voice VLAN PVID in addition to Layer 2 and Layer 3 QoS values.

2. Nortel Standalone IP Phone Sets

The following table displays the various standalone IP Phone sets available from Nortel.

Table 1: Nortel IP Phone Sets

Feature	Nortel Phone Sets							
	IP Phone 2001	**IP Phone 1110**	**IP Phone 2002**	**IP Phone 1120E**	**IP Phone 2004**	**IP Phone 1140E**	**IP Phone 1150E**	**IP Phone 2007**
Display Size / Type	3x24 Character LCD	144x32 Pixels Graphical LCD	4x24 Character LCD	240x80 Pixels Grayscale LCD	8x24 Character LCD	240x160 Pixels Grayscale LCD	240x160 Pixels Grayscale LCD	320x240 Pixels Color Touch screen LCD
Feature Keys (Excluding Enter + NAV)	11	12	21	22	24	24	30	9 Fixed + Touchscreen
# of Lines	1	1	4	4	6+ Varies w/config	6+ Varies w/config	6+ Varies w/config	6+ Varies w/config
Headset Jack	0	0	1	1	1	1	1	1
Handsfree	Listen only	Listen only	Yes	Yes	Yes	Yes	Yes	Yes
802.3af PoE Class	Class 2	Class 2	Class 2	Class 3	Class 2	Class 3	Class 3	Class 3
Two Port Switch	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gigabit Ethernet	No	No	No	Yes	No	Yes	Yes	No
USB Ports	0	0	0	1	0	1	1	1
Support for Expansion Module Attachment	No	No	Yes (Current 200x KEM)	Yes (new 11xx EM)	Yes (Current 200x KEM)	Yes (new 11xx EM)	Yes (new 11xx EM)	No
Bluetooth Headset	No	No	No	No	No	Yes	Yes (Agent only)	No
XAS (Application Gateway) Support	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EAP (802.1x)	Yes	Yes	Yes	Yes	Yes (Phase II only)	Yes	Yes	Yes
802.1AB	Yes	No	Yes (Phase II only)	Yes	Yes (Phase II only)	Yes	Yes	Yes

The following table displays the new 1200 series IP Phone sets being introduced as part of CS1000 R5.5. I am not sure whether you will put in right away or store for another iteration, but thought good to start collecting the data.

Table 2: Nortel IP Phone Sets – 1200 series

Feature	Nortel Phone Sets – 1200 Series		
	IP Phone 1210	**IP Phone 1220**	**IP Phone 1230**
Display Size / Type	3x24 characters LCD	5x25 characters LCD	9x25 characters LCD
Feature Keys (Excluding Enter + NAV)	14	22	28
# of Lines	1	4+ Varies w/config	6+ Varies w/config
Headset Jack	1	1	1
Handsfree	Yes	Yes	Yes
802.3af PoE Class	Class 2	Class 2	Class 2
Two Port Switch	Yes	Yes	Yes
Gigabit Ethernet	No	No	No
USB Ports	0	0	0
Support for Expansion Module Attachment	No	Yes (LED & LCD)	Yes (LED & LCD)
Bluetooth Headset	No	No	No
XAS (Application Gateway) Support	No	No	No
EAP (802.1x)	Yes	Yes	Yes
802.1AB	Yes	Yes	Yes

2.1 Configuring an IP Phone 2002 and IP Phone 2004 Phone Set

2.1.1 Accessing the Configuration Menu

To access the configuration menu power cycle the IP Phone 2001/2002/2004 and then wait until Nortel appears on the LCD panel. At this point, press the following keys in order from 1 to 4: Function key 1, Function key 2, Function key 3, and finally Function key 4.

Figure 1: IP Phone 2004 Access Configuration Menu

Figure 2: IP Phone 2002 Access Configuration Menu

To power cycle the IP Phone 2004 via the front panel, press the following keys in order from 1 to 9: Mute key, up Navigation key, down Navigation key, up Navigation key, down Navigation key, up Navigation key, Mute, 9, and finally the Goodbye key.

To power cycle the IP Phone 2001 via the front panel, press the following keys in order from 1 to 9: # key, up Navigation key, down Navigation key, up Navigation key, down Navigation key, up Navigation key, #, 9, and finally the Goodbye key.

Figure 3: IP Phone 2004 Power Cycle Phone Set

Figure 4: IP Phone 2002 Power Cycle Phone Set

2.2 IP Phone 2007 Phone Set

2.2.1 Accessing the Configuration Menu

To access the configuration menu, power cycle the IP Phone 2007 and when the Nortel logo appears in the middle of the display, immediately press the following key in sequence: 0, 0, 7, and star (*). If prompted for “Enter Administration Password:”, then press the following keys in sequence: 2, 6, 5, 6, 7, *, 7, 3, 8, OK. Using Navigation Keys scroll down/up to select the configuration options. As an alternative, use the USB port on the back of the IP Phone to use a mouse to scroll and select configuration options.

Figure 5: IP Phone 2007 Phone Set

2.3 IP Phone 1110/1120E/1140E/1150E

2.3.1 Accessing the Configuration Menu

To access the configuration menu, power cycle the IP Phone 11x0 and when the Nortel logo appears in the middle of the display, immediately press the four feature keys at the bottom of the display in sequence from left to right. If prompted for “Enter Administration Password:”, then press the following keys in sequence: 2, 6, 5, 6, 7, *, 7, 3, 8, Down. Use the Navigation Keys scroll down/up to select configuration options. As an alternative, use the USB port on the back of the IP Phone to use a mouse to scroll and select configuration options.

Figure 6: IP Phone 11xx Series Setup

You can also configure the IP Phone 11x0 IP Phone set by pressing the *Services* key twice and select option 3 *Network Configuration*.

2.4 IP Phone 1210/1220/1230

2.4.1 Access the Configuration Menu

To access the configuration menu, power cycle the IP Phone 12x0 and when the Nortel logo appears in the middle of the display, immediately press the four feature keys at the bottom of the display in sequence from left to right. If prompted for “Enter Administration Password:”, then press the following keys in sequence: 2, 6, 5, 6, 7, *, 7, 3, 8, Down. Use the Navigation Keys scroll down/up to select configuration options.

Figure 7: IP Phone 12xx Series Setup

You can also configure the IP Phone 12x0 IP Phone set by pressing the *Services* key twice and select option 3 *Network Configuration*.

2.5 IP Phone Set Configuration Options

2.5.1 Phone Configuration Options

The following table displays the various options available for Nortel IP Phone sets.

Table 3: IP Phone Set Features

Feature	Description
*EAP Enable? [0-N, 1-Y]	If selected, enter the user name and password used for EAP-MD5 authentication.
*Device ID:[]	If EAP is enabled, enter the EAP user id.
*Password:[*******]	If EAP is enabled, enter the EAP user password.
LLDP Enable? [0-N, 1-Y]:	Enable or disable 802.1AB. Default is enabled
DHCP? [0-N, 1-Y]	Either enable or disable DHCP depending on if you wish to configure a static IP address or use DHCP to retrieve an IP address.
SET IP:	If DHCP is set to *No*, enter the static IP address for the IP Phone set.
NETMSK:	If DHCP is set to *No*, enter the IP mask for the IP Phone set.
DEF GW:	If DHCP is set to *No*, enter the default gateway address for the IP Phone set.
SI IP:	If DHCP is set to *partial*, enter the IP address of the IP line node.
S1 PORT:	If DHCP is set to *partial*, enter the UDP port number of the IP line node.
S1 ACTION:	1 for normal Unistim mode, 6 if Unistim Encryption is being used with a Secure Multimedia Controller
*S1 PK:	Unistim Encryption – the private key for the Secure Multimedia Controller to which the IP Phone will connect
S1 RETRY COUNT:	If DHCP is set to *partial*, enter the number of attempts the IP Phone set is allowed to connect to the line node.
S2 IP:	Same a S1 but for second IP line node.
S2 PORT:	Same a S1 but for second IP line node.
S2 ACTION:	Same a S1 but for second IP line node.
*S2 PK:	Unistim Encryption – the private key for the Secure Multimedia Controller to which the IP Phone will connect
S2 RETRY COUNT:	Same a S1 but for second IP line node.
DHCP:0-Full, 1-Partial	If DHCP is set to *Yes*, select *partial* if you only wish to provide an IP address, subnet mask, and default gateway for the IP phone set via DHCP. Otherwise, select *full* to allow the DHCP server to provide an IP address in addition to the IP line node address, UDP port number, action, and retry count.
Speed[0-A, 1-10, 2-100]:	Select Voice port speed. Default is auto.
*Cfg XAS: (0-No, 1-Yes):	Allow access to an external application server. If there is no external application server, enter 0 for no. If you entered 1 for yes, you will also need to enter the IP address of the application server.
Voice 802.1Q[0-N, 1-Y]	Select *No* to pass the voice traffic untagged. Select *1* to enable 802.1Q tagging for the voice VLAN.
VOICE VLAN?[0-N, 1-Y]:	Select 1 if you wish to configure a tagged voice VLAN. Select 0 if untagged.
VLAN Cfg?0-Auto, 1-Man	Select manual if you wish to manually set the VLAN ID using an ID from 1 to 4094. If you select automatic, the IP Phone will obtain the VLAN ID either using DHCP or 802.1ab from the

Feature	Description
	data switch.
DHCP? [0-N, 1-Y]:	If set to yes, the VLAN ID is configured automatically to the value received from the DHCP server.
LLDP MED? [0-N, 1-Y]:	If set to Yes, the VLAN ID is configured automatically using the value received in the LLDP-MED Network Policy TLV. Please note that LLDP must be enabled and auto VLAN configuration must be enabled to prompted for LLDP-MED.
LLDP VLAN? [0-N, 1-Y]:	If set to Yes, the VLAN ID is configured automatically to the value received in the VLAN Name TLV. Please note the LLDP and automatic VLAN configuration must be enabled and LLDP MED must be disabled to be prompted for LLDP VLAN.
VLAN:	If the VLAN setting is set to *Man*, enter the voice VLAN ID.
*VLAN Filter? 0-No, 1-Yes	If set to *Yes*, all unicast Voice traffic is filtered to the data device connected to the 3-port switch on the IP Phone set.
PC Port? [0-OFF, 1-ON]:	Select On if you wish to enable the data port.
Speed[0-A, 1-10, 2-100]:	Select data port speed. Default is auto.
Data 802.1Q[0-N, 1-Y]:	Select *No* to pass the data traffic untagged. Select *1* to enable 802.1Q tagging for the data VLAN and manually set the data VLAN.
PCUntagAll? [0-N, 1-Y]:	If set to yes, data VLAN stripping is enabled. If an 802.1Q tag is received, it is stripped from the packet before the packet is forward to the PC port. It makes no difference if the data VLAN is manually configured or not. If set to no, the packet sent to the PC is not modified.
GARP Ignore? (0-No, 1-Yes)	Provides GARP Spoof attacks between the IP Phone set and the default gateway from a malicious device.
PSK SRTP? [0-N, 1-Y]:	Enables or disabled Secure Real-time Transport Protocol (SRTP) media encryption. Default is 0 for no.

* Denotes IP Phone 2004 Phase II phone, IP Phone 2007, or IP Phone 11xx IP Phone sets only.

2.5.1.1 Full DHCP with Automatic VLAN Assignment

If you select Full DHCP, then the following parameters are retrieved from the DHCP server:

- A valid IP Phone 2004 IP address
- A subnet mask
- The default Gateway for the IP Phone 2004 on the LAN segment to which it is connected
- The S1 node IP address of the IP line node
- The S1 Action
- The S1 retry count. This is the number of times the IP Phone attempts to connect to the server
- The S2 node IP address of the IP line node
- The S2 Action
- The S2 retry count
- The External Application Server (XAS) IP address

2.5.1.2 Partial DHCP

If you select Partial DHCP, then you must enter the following parameters on the IP Phone set:

- S1 IP
- S1 Port
- S1 action
- S1 retry
- S2 IP
- S2 Port

- S2 action
- S2 retry
- Cfg XAS? (0-No,1-Yes)
- XAS IP:
- VLAN? (0-No, 1-Ma, 2-Au)
- Data VLAN? (0 for No, 1 for Yes)
- Duplex (0-Auto, 1-Full)
- GARP Ignore? (0-No,1-Yes)

2.5.1.3 Gratuitous Address Resolution Protocol Protection (GARP)

Gratuitous Address Resolution Protocol Protection (GARP) prevents the IP Phone set from GARP Spoof attacks on the network. In a GARP Spoof attack, a malicious device on the network takes over an IP address (usually the default gateway) by sending unsolicited (or Gratuitous) ARP messages, thus manipulating the ARP table of the victim's machine. This allows the malicious device to launch a variety of attacks on the network, resulting in undesired traffic routing. For example, a GARP attack can convince the victim machine that the malicious device is the default gateway. In this scenario, all traffic from the victim's machine flows through the malicious device.

2.5.1.4 Extensible Authentication Protocol (EAPoL)

Extensible Authentication Protocol (EAP) is a general protocol that fulfills the protocol requirements defined by 802.1x. Presently, Nortel IP phone sets only support EAP with MD-5. EAP-PEAP and EAP-TLS are planned for 2Q08.

2.5.1.5 LLDP (802.1AB)

IEEE 802.1AB LLDP is a Layer 2 neighbor discovery protocol. It defines a standard method for Ethernet network devices such as switches, routers and IP Phones to advertise information about themselves to other nodes on the network and store the information they discover. Certain Nortel IP Phone sets can be setup for ether LLDP Vlan Name or LLDP-MED Network Policy but not both at the same time.

2.5.1.6 3-Port Switch

The three-port switch that is internal / external to the IP Phone set is an unmanaged switch. It passes the packets (unmodified) and does not interpret the 802.1Q header. The three-port switch provides priority based on the port (that is, the IP Phone port traffic takes priority over the Ethernet).

3. POE

3.1 802.3af Overview

The intention of the 802.3af standard is to provide a 10BaseT, 100BaseT, or1000BaseT device with a single interface for the data it requires and the power to process the data. Power is supplied by a Power Sourcing Device (PSE) for one or more Powered Devices (PD). The PSE main function is to only supply power for a PD after it has successfully detected a PD on a link by probing. The PSE can also successfully detect a PD, but then opt to not supply power to the detected PD. The PSE shall only supply power on the same pair as those used for detection.

The cable requirements are defined in ISO/IEC 11801-2000 and EIA/TIA 568A/B (T-568A or B, with most using the A standard) which allows for up to 100 meters of cable.

Power Sourcing Devices (PSE) can deliver power on the data pairs (1+2, 3+6), spare pairs (4+5, 7+8), or either, but only on the pair that the Powered Device (PD) is detected on. Power is not to be supplied to non-powered devices and other PSE's.

Figure 7: PD and PSE 8-pin Modular Jack Pin's

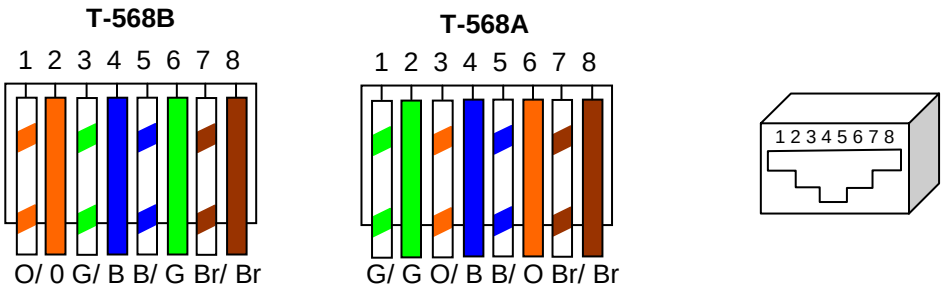


Table 4: PSE Pinout Alternatives

Conductor	Alternative A (MDI-X)	Alternative A (MDI)	Alternative B (All)
1	Negative V_{Port}	Positive V_{Port}	
2	Negative V_{Port}	Positive V_{Port}	
3	Positive V_{Port}	Negative V_{Port}	
4			Positive V_{Port}
5			Positive V_{Port}
6	Positive V_{Port}	Negative V_{Port}	
7			Negative V_{Port}
8			Negative V_{Port}

In regards to the PD, it must fall into the following characteristics:

- 19k to 26.5k ohm DC resistance
- <100nF of capacitance and
- a voltage offset of at least 2VDC in the signature characteristics
- a current of less than 12uA in the signature characteristics

Anything outside of the characteristics listed above will be considered a non-PD device and the PSE will not supply power. Each port from a PSE should be capable of delivering up to 15W of power. 802.3af also adds a class feature that allows the PSE to limit the power based on the class of the PD detected. Table 4 shown below lists the 802.3af power classes.

Table 5: 802.3af PD Power Classification

Class	Usage	Range of MAXIMUM power used by the PD
0	Default	0.44 to 12.95 Watts
1	Optional	0.44 to 3.84 Watts
2	Optional	3.84 to 6.49 Watts
3	Optional	6.49 to 12.95 Watts
4	Not Allowed	Reserved for Future Use

3.2 IP Phone Set Features and Power Requirements

Table 5 displays the average power consumed for each Nortel IP Phone set.

Table 6: IP Phone Set Power Requirements

Device	Average PSE Watts
Phase 0 Phones – Requires Power Splitter (DY4311046)	
Nortel IP Phone 2004	4.8
Nortel IP Phone 2004 w/ External 3-port switch	13.2
Phase 1 Phones – Requires Power Splitter (DY4311046)	
Nortel IP Phone 2002 w/ Integrated 3-port 10/100 switch	4.8
Nortel IP Phone 2004 w/ Integrated 3-port 10/100 switch	4.8
Phase II Phones	
Nortel IP Phone 2001	4.8
Nortel IP Phone 2002 w/ Integrated 3-port 10/100 switch	4.8
Nortel IP Phone 2004 w/ Integrated 3-port 10/100 switch	5.4
Nortel IP Phone 2007 w/ Integrated 3-port 10/100 switch	9.6
1100 Series	
Nortel IP Phone 1110 w/ Integrated 3-port 10/100 switch	4.8
Nortel IP Phone 1120E w/ Integrated 3-port 10/100/1000 switch (running at 100Mbps)	8.4
Nortel IP Phone 1120E w/ Integrated 3-port 10/100/1000 switch (running at 1000Mbps)	10.8
Nortel IP Phone 1140E w/ Integrated 3-port 10/100/1000 switch (running at 100Mbps)	8.4
Nortel IP Phone 1140E w/ Integrated 3-port 10/100/1000 switch (running at 1000Mbps)	10.8
Nortel IP Phone 1150E w/ Integrated 3-port 10/100/1000 switch (running at 100Mbps)	6.8
Nortel IP Phone 1150E w/ Integrated 3-port 10/100/1000 switch (running at 1000Mbps)	9.6
1200 Series	
Nortel IP Phone 1210 w/ Integrated 3-port 10/100 switch	3.2 Typical / 4.6 Max
Nortel IP Phone 1220 w/ Integrated 3-port 10/100 switch	3.2 / 4.6
Nortel IP Phone 1230 w/ Integrated 3-port 10/100 switch	3.2 / 4.6
Wireless Access Points	
AP 2330	10.6
AP 2230	10.0
AP 2220	8.5

3.3 Nortel IP Phone Power Splitters

Certain vintages of Nortel IP phones are non-802.3af compliant and require a splitter when connecting to an 802.3af compliant switch. This includes the following Nortel IP phones sets: IP Phone 2004 Phase 0, IP Phone 2004 Phase I, and IP Phone 2002 Phase 1. All Phase II versions of the IP Phone 2002 and IP Phone 2004 do not require splitters. The IP Phone 2004 Phase 0 IP Phones can be identified by the label on the back of the phone set and begins with NTEX00. All Phase I IP phone sets are identified with NTDU76/82 for the IP Phone 2002 or IP Phone 2004 IP Phone sets.

The part number for the universal splitter is DY4311046.

3.4 PoE for Nortel PSE Stackable Switches

3.4.1 ES470PWR and ERS5520PWR

Both the Ethernet Switch 470-PWR and Ethernet Routing Switch 5520-PWR can supply power via their own internal power supply and also with the addition on a Redundant Power Supply 15 (RPS 15). The addition of the RPS 15 provides power redundancy and additional PoE power as shown in table 6 below. Overall, both switch families provide the following features:

- IEEE 802.3af standard compliance
- Supplies power on pins 1+2, 3+6
- Enable/disable power per port
- PoE power limit per port from 3W to 15.4W
- Per port current monitoring, power consumption statistics
- Port power protection against short or cross connection
- Per port power priority to determine which ports will be supplied power first upon power cycle

Table 7: Ethernet Switch 470-PWR and Ethernet Routing Switch 5520-PWR PoE

Device	PoE Pins	Maximum PoE with internal power supply	Maximum power with RPS 15	RPS 15 only	Max. PoE per port	
					AC only	w/ RPS 15
ES470-24PWR	1+2, 3+6	370 W	370 W	370 W	15.4 W	15.4 W
ES470-48PWR	1+2, 3+6	370 W	740 W	370 W	7.7 W	15.4 W
ERS5520-24PWR	1+2, 3+6	320 W	370 W	320 W	13.3 W	15.4 W
ERS5520-48PWR	1+2, 3+6	320 W	740 W	320 W	6.7 W	15.4 W

Note: The Redundant Power Supply 15 (RPS 15) chassis can hold up to three power supply modules where each module supporting a single Ethernet Switch 470-PWR or Ethernet Routing Switch 5520-PWR with the appropriate cable. A separate DC-DC converter is not required for these switches as the appropriate RPSU cable plugs directly into the back of the switch.

3.4.2 Ethernet Routing Switch 2500

Depending on the switch model, the ERS2500 supplies power via the following ports:

- The ERS2526T-PWR supplies power on port 1 to 12
- The ERS2550T-PWR supplies power on port 1 to 24

Table 8: Ethernet Switch 2526T-PWR and Ethernet Routing Switch 2550T-PWR PoE

Device	Max PoE ports	PoE Pins	Maximum PoE with internal power supply	Maximum power with RPS 15	RPS 15 only	Max. PoE per port	
						AC only	w/ RPS 15
2526T-PWR	12	1+2, 3+6	165 W	N/A	N/A	6.6 W	N/A
2550T-PWR	24	1+2, 3+6	165 W	N/A	N/A	6.6 W	N/A

3.4.3 Ethernet Routing Switch 4500

The Ethernet Routing Switch 4550T-PWR and the 4548-GT-PWR can supply power via their own internal power supply and also with the addition on a Redundant Power Supply 15 (RPS 15). The addition of the RPS 15 provides power redundancy and additional PoE power as shown in table 8 below. Overall, both switch families provide the following features:

- DTE power
- powered device (PD) discovery and classification
- capacitive detection to support legacy PD devices, including the Nortel and Cisco Legacy IP Phones
- per-port power management and monitoring
- AC and DC disconnection
- load under voltage/current and over voltage/current detection
- at least 320 watts (W) power available for PSE ports from the internal power supply
- up to 6.6 W for each port on all 48 ports or 20 ports at a maximum power of 15.4 W for each port
- a total of 740 W power available for PSE ports using both the internal and external power supply
- 15.4 W (Max) for each port on a 48 port unit
- per-port PoE status LED
- port prioritizing to guarantee DTE power available on high-priority ports
- port pruning to prevent system failure

Table 9: Ethernet Routing Switch 4500 PoE

Device	PoE Pins	Maximum PoE with internal power supply	Maximum power with RPS 15	RPS 15 only	Max. PoE per port	
					AC only	w/ RPS 15
4526T-PWR	1+2, 3+6	320 W	740 W	320 W	6.6 W	15.4 W
4550T-PWR	1+2, 3+6	320 W	740 W	320 W	6.6 W	15.4 W
4526GTX-PWR	1+2, 3+6	320 W	740 W	320 W	6.6 W	15.4 W
4548GT-PWR	1+2, 3+6	320 W	740 W	320 W	6.6 W	15.4 W

3.5 PoE for Nortel PSE Chassis - Ethernet Routing Switch 8300

The number of power supplies installed in an Ethernet Routing Switch 8300 chassis depends on the number of modules installed in a chassis, PoE requirements, and whether you require

optional redundant power. The 8348TX-PWR and 8348GTX-PWR modules support the following features:

- IEEE 802.3af standard compliance
- Can supply power on pins 1+2, 3+6
- Supply up to 15.4W per port with a voltage range from 44 to 57 VDC
- Enable/disable power per port
- PoE power limit per port from 4W to 15.4W
- Per port current monitoring, power consumption statistics
- Port power protection against short or cross connection
- Per port power priority to determine which ports will be supplied power first upon power cycle

Table 10: Recommended Number of 8301AC Power Supplies

Chassis	Number of modules	Number of 8301AC Power Supplies	
		Required	Redundant configuration
8306	1-6	1	2
8310	1-6	1	2
	7-10	2	3

Table 11: ERS8306/8610 Chassis Available System Power

Power supply rating	Number of power supplies	Redundancy	Power supply module	PoE per module	Max PoE redundant PoE power reserved	Total
100-120VAC 1140W	1	No	400 W	200 W	0 W	1140 W
	2	Yes 1+1	800 W	400 W	400/200 W	1140 W
	3	Yes 2+1	1200 W	600 W	400/200 W	2280 W
200-240VAC 1770W	1	No	800 W	400 W	0 W	1770 W
	2	Yes 1+1	1600 W	800 W	800/400 W	1770 W
	3	Yes 2+1	2400 W	1200 W	800/400 W	3540 W

The Ethernet Routing Switch 8300 can vary the amount of PoE power provided at both the system and module levels. The PoE power at a module level can vary form the default setting of 200 watts to the minimum of 50 watts or the maximum of 800 watts. The maximum PoE power available for allocation determines the maximum number of 8348TX-PWR and 8348GTX-PWR modules that can be supported as shown in table 10 below.

Table 12: Ethernet Routing Switch 8300 Module Power

Maximum PoE power available for allocation (watts)	Maximum number of PoE modules supported based on PoE module allocation settings (watts)		
	Min 50	Default 200	Max 800
200 watts	4	1	1
400 watts	8	2	1
800 watts	8	4	1
1600 watts	8	8	2

3.6 Configuring PoE

3.6.1 Ethernet Routing Switch 2500, 4500 and Ethernet Switch 470-PWR series

By default, PoE Power Management is enabled by default with all PoE ports power enabled at power up. The following commands apply to the switches listed above.

3.6.1.1 Displaying PoE Status and Statistics

To display the PoE status and statistics, you can use the following commands:

To view the Global PoE status, enter the following command:

```
5520-24T-PWR#show poe-main-status
5520-24T-PWR#show poe-main-status unit <1-8>
```

To view the PoE port status, enter the following command:

```
5520-24T-PWR#show poe-port-status
5520-24T-PWR#show poe-main-status unit <1-8>
```

To view power used on a PoE port, enter the following command:

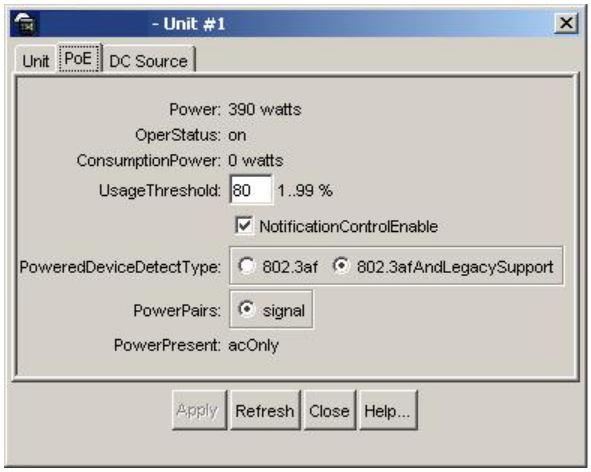
```
5520-24T-PWR#show poe-power-measurement
5520-24T-PWR#show poe-power-measurement <slot/port>
```

JDM:

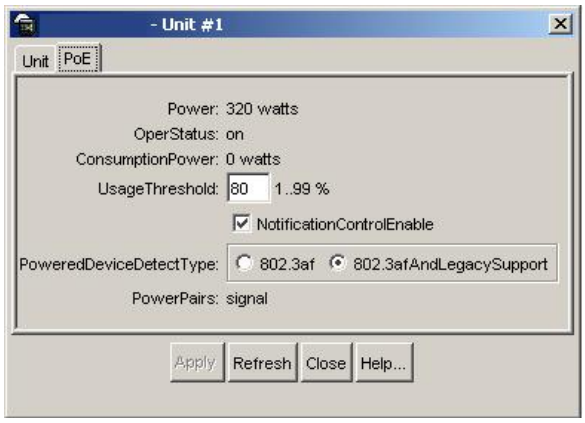
To view or configure the PoE global settings, enter the following:

- Select the switch so that it is high-lighted with a yellow box
- Go to Edit>Unit>PoE

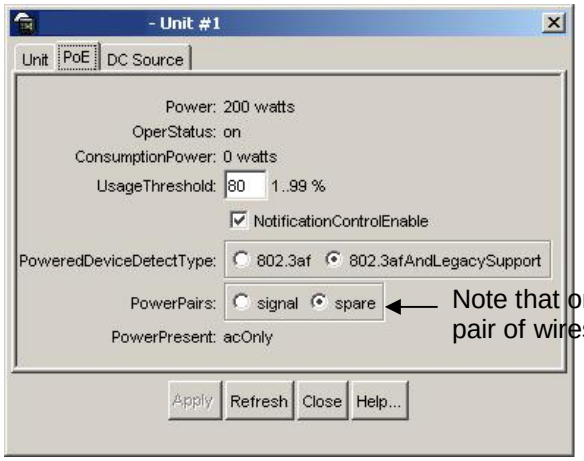
a) Ethernet Switch 470-PWR



b) Ethernet Routing Switch 5520-PWR

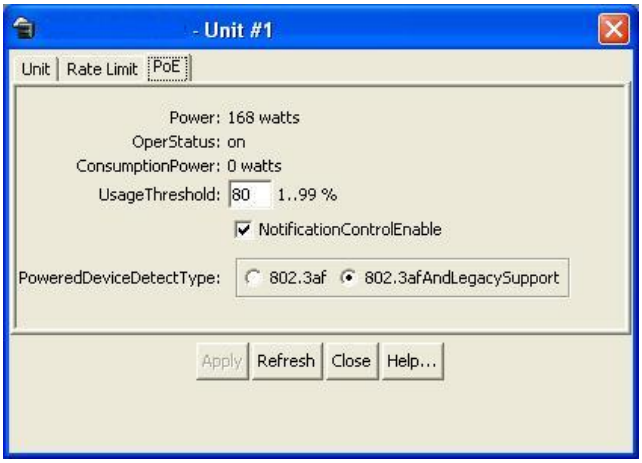


c) Ethernet Switch 470-PWR

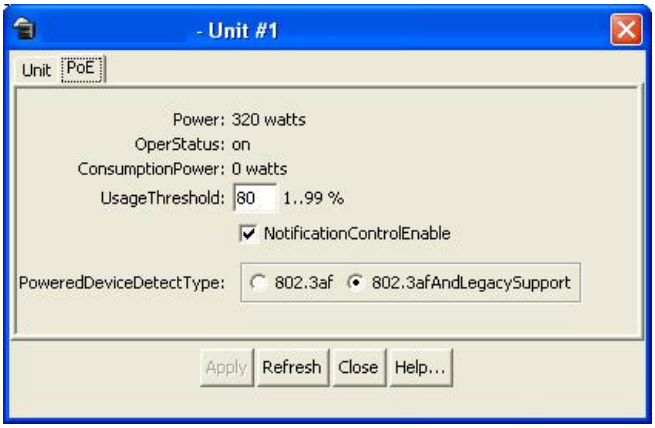


Note that only the ES760 supports power on either pair of wires. Please see section 3.1 for details.

d) Ethernet Routing Switch 2526T-PWR



e) Ethernet Routing Switch 4550T-PWR



3.6.1.2 Disable PoE

To disable PoE on a port, enter the following command

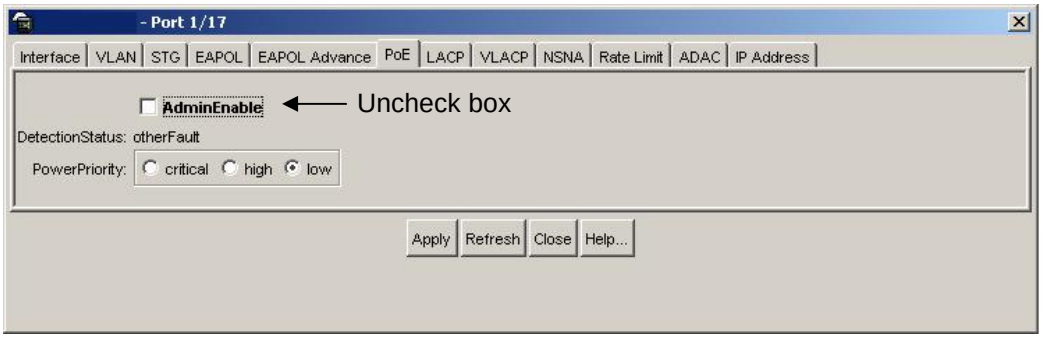
NNCLI:

To disable PoE at a port level, enter the following commands:
`5520-24T-PWR(config)#`***`interface fastEthernet all`***
`5520-24T-PWR(config-if)#`***`poe poe-shutdown port <port #>`***
`5520-24T-PWR(config-if)#`***`exit`***

JDM:

To disable PoE on a port via JDM, perform the following:

- right-click on the port> *Edit>PoE*
  - If you wish to configure multiple port, press the Ctrl key and left click each port you wish to configure
- uncheck *AdminEnable*



3.6.1.3 Limit PoE Power

By default, all ports with 802.3af Power Class of 0 providing up to 15.4W per port. If you wish, you can limit the power level from 3W to 16W on a per port basis using the following commands:

NNCLI:

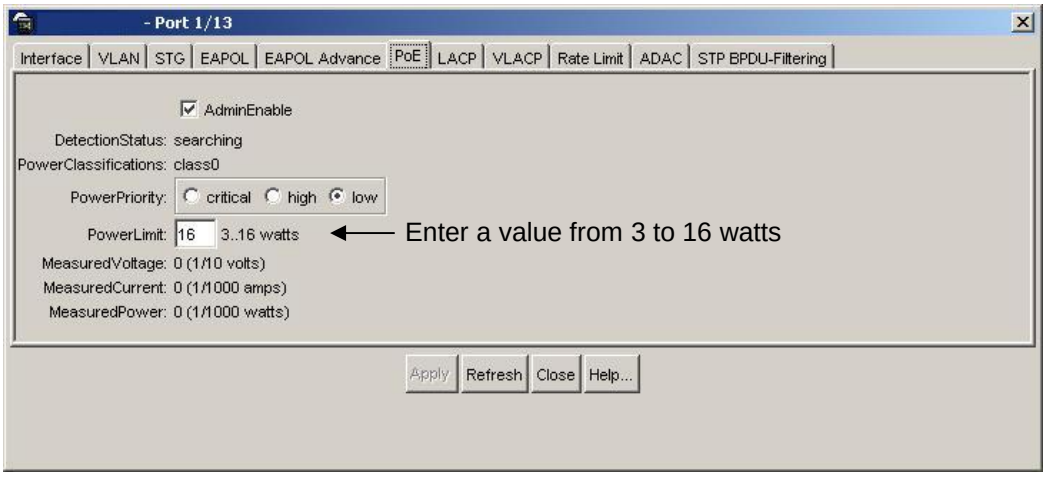
To configure the PoE power level, enter the following commands:

```
5520-24T-PWR(config)#interface fastEthernet all
5520-24T-PWR(config-if)#poe poe-limit port <port #> <3-16>
5520-24T-PWR(config-if)#exit
```

JDM:

To set the PoE power level on a port via JDM, perform the following:

- right-click on the port> *Edit>PoE*
  - If you wish to configure multiple port, press the Ctrl key and left click each port you wish to configure
- Go to *PowerLimit* and enter a PoE power limit



3.6.1.4 Setting PoE Boot-up Port Priority

Each slot and port on the Ethernet Routing Switch 8300 can be assigned a PoE priority of low, high, or critical with the default being low for both. During a power cycle, the power allocation is associated by the slot priority and port priority.

NNCLI:

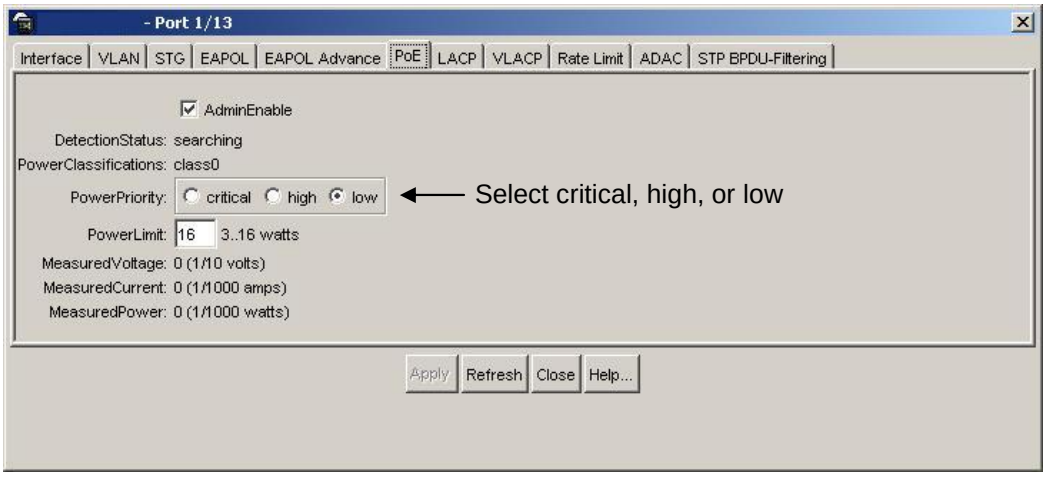
To set the PoE port priority, enter the following commands:

```
5520-24T-PWR(config)#interface fastEthernet all
5520-24T-PWR(config-if)#poe poe-priority port <port #> <low|high|critical>
5520-24T-PWR(config-if)#exit
```

JDM:

To set the PoE power level on a port via JDM, perform the following:

- right-click on the port> *Edit>PoE*
  - If you wish to configure multiple port, press the Ctrl key and left click each port you wish to configure
- Go to *PowerPriority* and select the boot up power priority



3.6.1.5 Usage Threshold Notification

By default, the Ethernet Routing Switch 8300 will send a trap when the overall power consumption reaches 80% or above of the overall available power on a per slot basis. If you wish, you can change the threshold from 0 to 99% by typing in the following command:

NNCLI:

To change the trap threshold, enter the following commands:

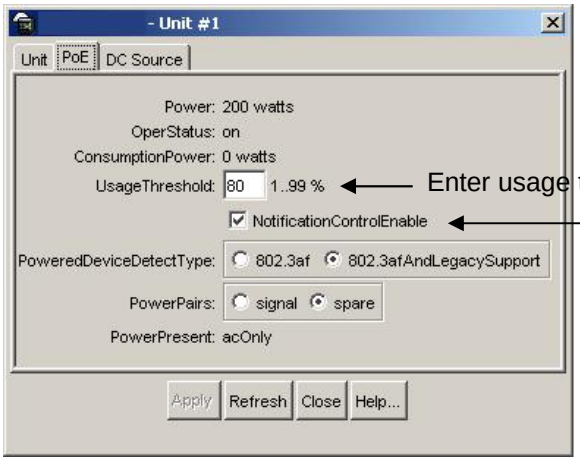
```
5520-24T-PWR(config)#poe poe-power-usage-threshold <1-99>
5520-24T-PWR(config)#poe poe-power-usage-threshold unit <1-8> <1-99>
```

If you wish to not send a notification message, enter the following command:

```
5520-24T-PWR(config)#no poe-trap
5520-24T-PWR(config)#no poe-trap unit <1-8>
```

JDM:

- Click on unit you wish to configure, it should be high-lighted in yellow box
- Go to *Edit>Unit>PoE*



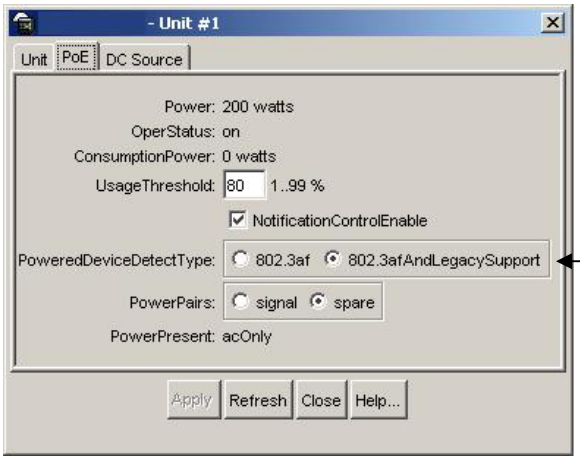
3.6.1.6 PD Type

NNCLI:

To set the PD detection type, enter the following command:
`5520-24T-PWR(config)#` ***`poe poe-pd-detect-type <802dot3af|802dot3ad_and_legacy>`***
`5520-24T-PWR(config)#` ***`poe poe-pd-detect-type unit <1-8> <802dot3af|802dot3ad_and_legacy>`***

JDM:

- Click on unit you wish to configure, it should be high-lighted in yellow box
- Go to *Edit>Unit>PoE*



3.6.2 Ethernet Routing Switch 8300

By default, PoE Power Management is enabled by default with all PoE ports power enabled at power up.

3.6.2.1 Displaying PoE Status and Statistics

To display the PoE status and statistics, you can use the following commands:

PPCLI:

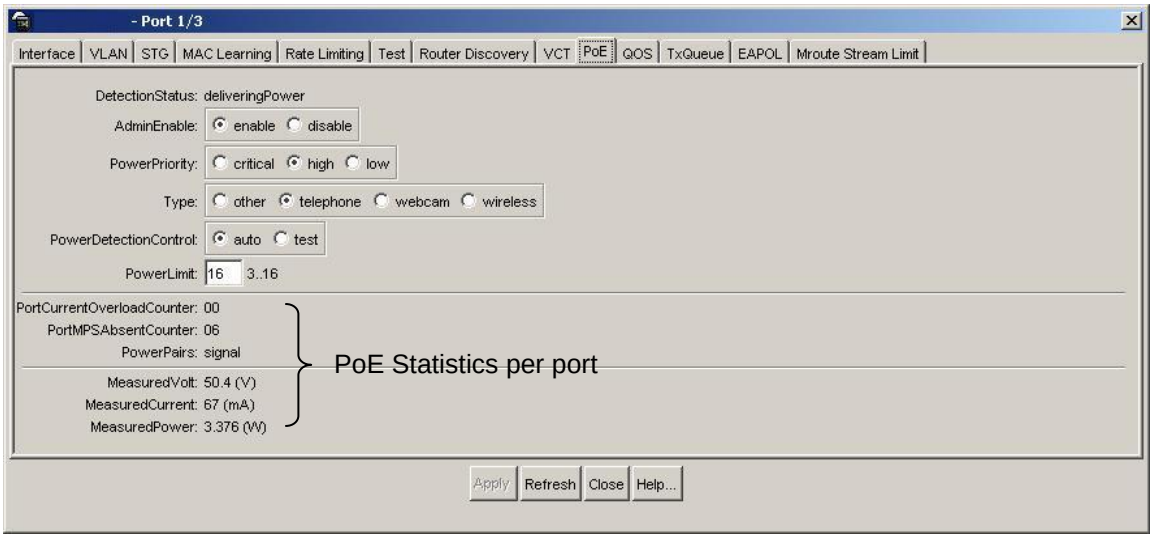
To view the Global PoE status per module, enter the following command:
ERS-8310:5# ***show poe card info***
To view the PoE port status, enter the following command:
ERS-8310:5# ***show poe port info***
To view the PoE port stats, enter the following command:
ERS-8310:5# ***show poe port stats***
To view power used on a PoE port, enter the following command:
ERS-8310:5# ***show poe port power-measurement <slot/port>***
To view the PoE system status, enter the following command:
ERS-8310:5# ***show poe sys info***

NNCLI:

To view the Global PoE status per module, enter the following command:
ERS-8310:5# ***show poe main-status***
To view the PoE port status, enter the following command:
ERS-8310:5# ***show poe port-status***
To view the PoE port stats, enter the following command:
ERS-8310:5# ***show poe port-stats***
To view power used on a PoE port, enter the following command:
ERS-8310:5# ***show poe port power-measurement <slot/port>***
To view the PoE system status, enter the following command:
ERS-8310:5# ***show poe sys-status***

Port Level

- Right-click on the port> *Edit>PoE*
  - If you wish to configure multiple ports, press the Ctrl key and left click each port you wish to configure



3.6.2.2 Disable PoE

PPCLI:

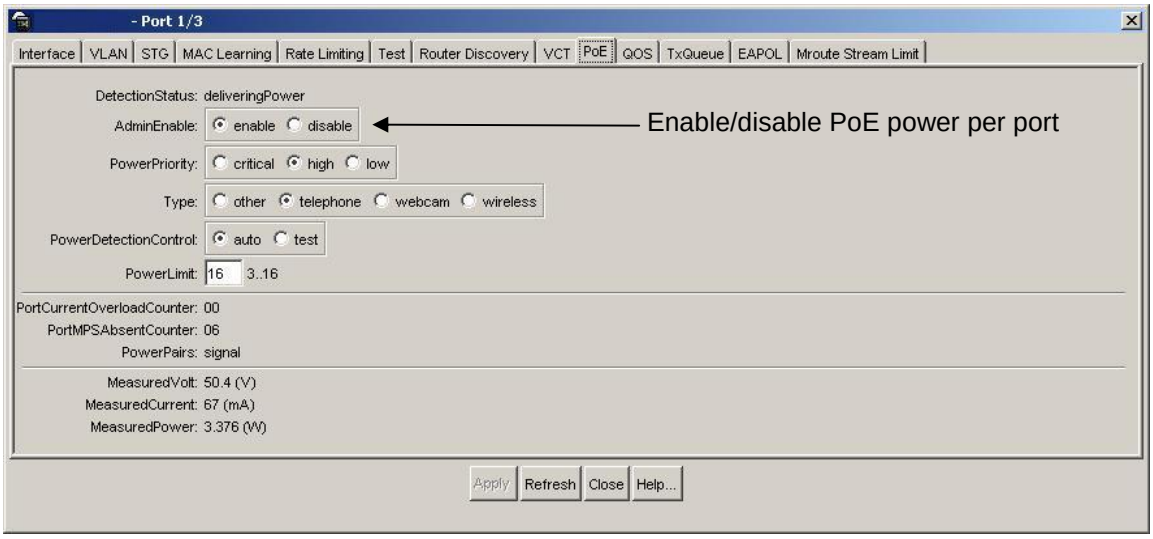
To disable PoE on a port, enter the following command:
ERS-8310:5# ***config poe port <slot/port> admin disable***

NNCLI:

To disable PoE on a port, enter the following command:
ERS-8310:5(config)#***interface fastEthernet <slot/port>***
ERS-8310:5(config-if)#***poe shutdown***
ERS-8310:5(config-if)#***exit***

JDM:

- Right-click on the port> *Edit>PoE*
- If you wish to configure multiple ports, press the Ctrl key and left click each port you wish to configure



You can also disable power on a per slot basis by using the following command:

PPCLI:

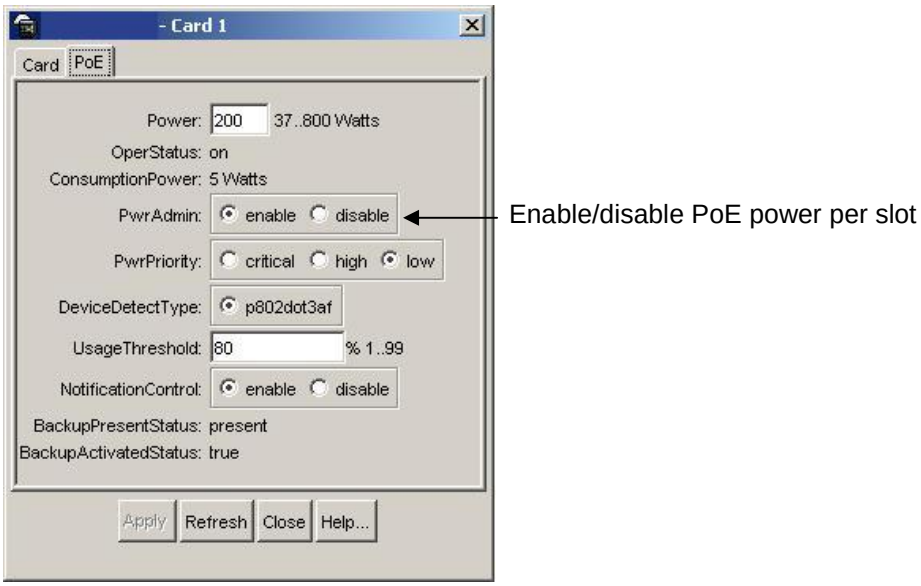
To disable PoE on a slot basis, enter the following command:
ERS-8310:5# ***config poe card <slot #> admin disable***

NNCLI:

To disable PoE on a slot basis, enter the following command:
ERS-8310:5(config)# ***poe shutdown slot <slot #>***

JDM:

- Select slot that you wish to configure, it should be high-lighted in a yellow box
- Right-click the card and select *Edit>PoE*



3.6.2.3 Limit PoE Power

By default, the Ethernet Routing Switch 8300 classifies all ports with 802.3af Power Class of 0 providing up to 15.4W per port. If you wish, you can limit the power level from 3W to 16W on a per port basis using the following commands:

PPCLI:

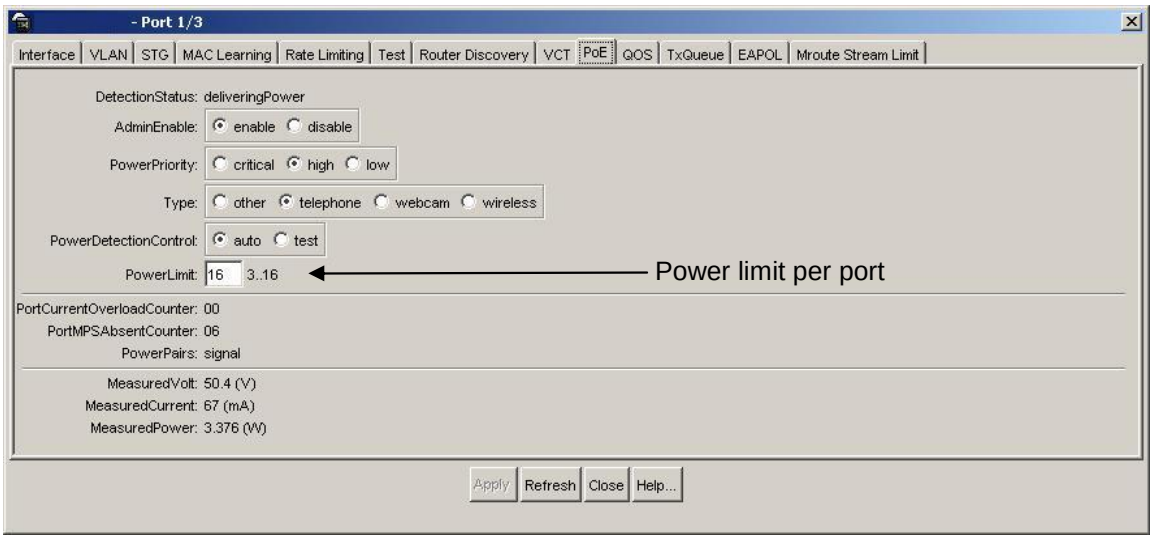
To limit PoE power at a port level, enter the following command:
ERS-8310:5# ***config poe port <slot/port> power-limit <3-16>***

NNCLI:

To limit PoE power at a port level, enter the following command:
ERS-8310:5(config)#***interface fastEthernet <slot/port>***
ERS-8310:5(config-if)# ***poe limit <3-16>***
ERS-8310:5(config-if)#***exit***

JDM:

- Right-click on the port> *Edit>PoE*
- If you wish to configure multiple port, press the Ctrl key and left click each port you wish to configure



You can also limit the total amount of PoE power per module from 37 to 800W by using the following command

PPCLI:

To limit PoE power at a module level, enter the following command:
ERS-8310:5# ***config poe card 1 power-limit <slot #> <37-800>***

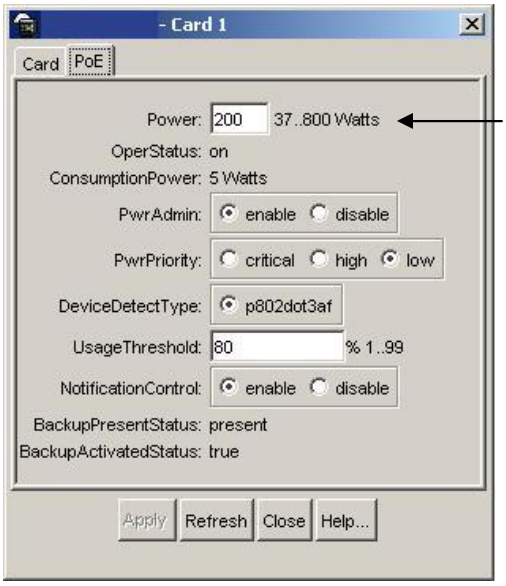
NNCLI:

To limit PoE power at a module level, enter the following command:

```
ERS-8310:5(config)#poe limit slot <slot #> <37-800>
```

JDM:

- Select slot that you wish to configure, it should be high-lighted in a yellow box
- Right-click the card and select *Edit>PoE*



Power Level available per slot

3.6.2.4 Setting PoE Boot-up Port Priority

Each slot and port on the Ethernet Routing Switch 8300 can be assigned a PoE priority of low, high, or critical with the default being low for both. During a power cycle, the power allocation is associated by the slot priority and port priority.

PPCLI:

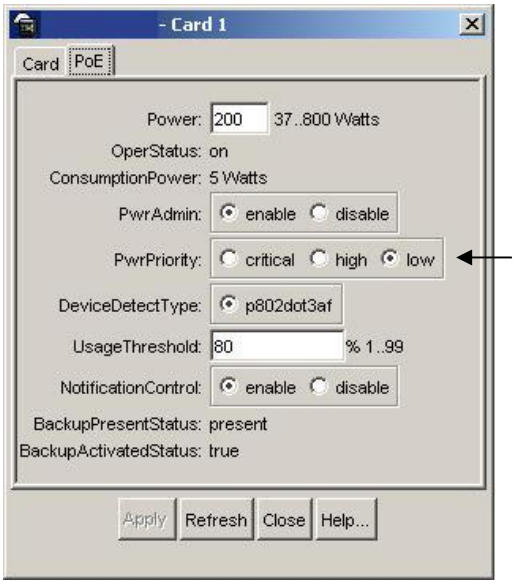
To set the PoE slot priority, enter the following command:
ERS-8310:5# ***config poe card <card #> power-priority <low|high|critical>***

NNCLI:

To set the PoE slot priority, enter the following command:
ERS-8310:5(config)#***poe priority slot <slot #> <low|high|critical>***

JDM:

- Select slot that you wish to configure, it should be high-lighted in a yellow box
- Right-click the card and select *Edit>PoE*



PoE boot-up priority per slot

To set the PoE port priority, enter the following commands:

PPCLI:

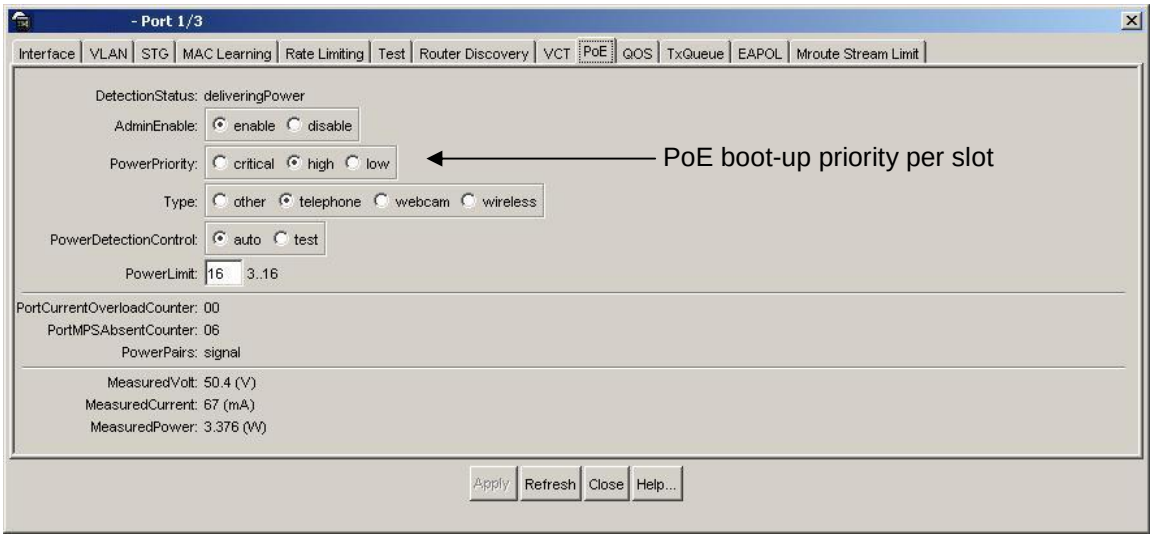
To set the PoE priority at a port level, enter the following command:
ERS-8310:5# ***config poe port <slot/port> power-priority <low|high|critical>***

NNCLI:

To set the PoE priority at a port level, enter the following command:
ERS-8310:5(config)#***interface fastEthernet <slot/port>***
ERS-8310:5(config-if)#***poe priority <low|high|critical>***
ERS-8310:5(config-if)#***exit***

JDM:

- Right-click on the port> *Edit>PoE*
- If you wish to configure multiple port, press the Ctrl key and left click each port you wish to configure



3.6.2.5 PoE Detection Control

The PSE Power Management Admin Status is enabled by default with power detection set on all ports to auto mode. Power detection can be set for either auto or test where test mode implies the port is in continuous discovery without supplying power. Under normal operation, the Ethernet Routing Switch 8300 will not supply power unless a PD (Powered Device) is requesting power. To change the detection control, enter the following commands.

PPCLI:

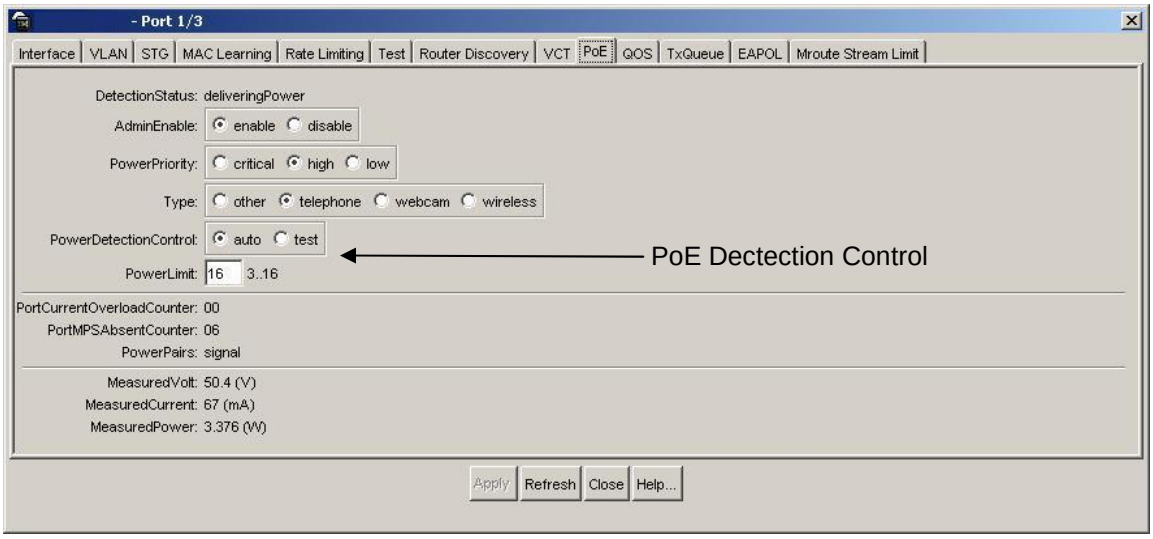
To set the PoE detection control, enter the following command:
ERS-8310:5# ***config poe port <slot/port> power-detection-control <auto|test>***

NNCLI:

To set the PoE detection control, enter the following command:
ERS-8310:5(config)#***interface fastEthernet <slot/port>***
ERS-8310:5(config-if)#***poe detect-control <auto|test>***
ERS-8310:5(config-if)#***exit***

JDM:

- Right-click on the port> *Edit>PoE*
- If you wish to configure multiple port, press the Ctrl key and left click each port you wish to configure



3.6.2.6 Setting PoE PD Type

For information purposes, you can configure the type of Powered Device (PD) on a port by using the following command:

PPCLI:

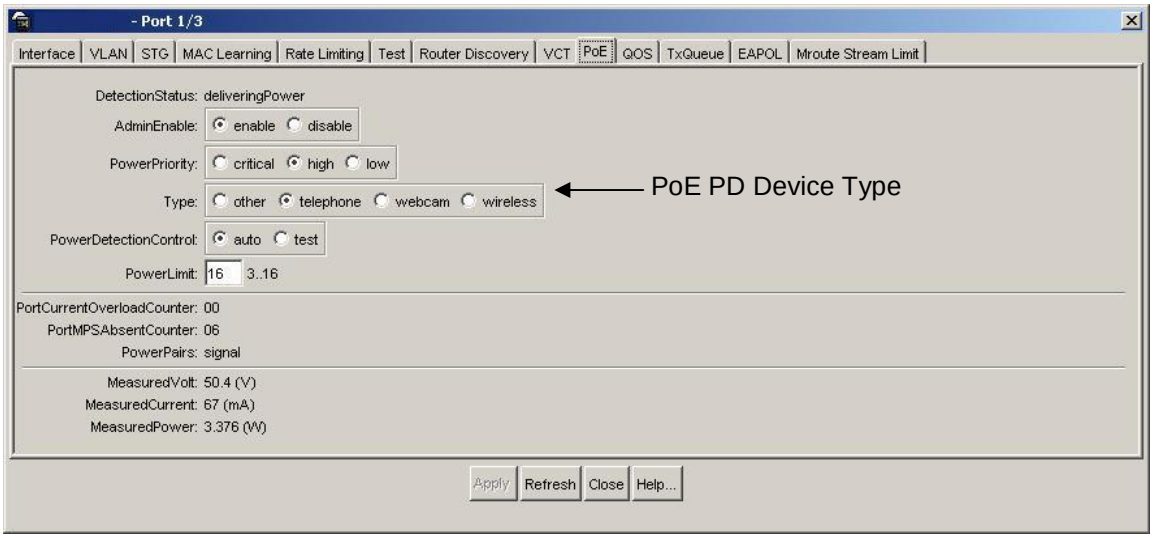
To set the Power Device (PD) Type, enter the following command:
ERS-8310:5# ***config poe port 1/1 type <other|telephone|webcam|wireless>***

NNCLI:

To set the Power Device (PD) Type, enter the following command:
ERS-8310:5(config)#***interface fastEthernet <slot/port>***
ERS-8310:5(config-if)# ***poe type <other|telephone|webcam|wireless>***
ERS-8310:5(config-if)#***exit***

JDM:

- Right-click on the port> *Edit>PoE*
- If you wish to configure multiple ports, press the Ctrl key and left click each port you wish to configure



3.6.2.7 Usage Threshold Notification

By default, the Ethernet Routing Switch 8300 will send a trap when the overall power consumption reaches 80% or above of the overall available power on a per slot basis. If you wish, you can change the threshold from 0 to 99% by typing in the following command:

PPCLI:

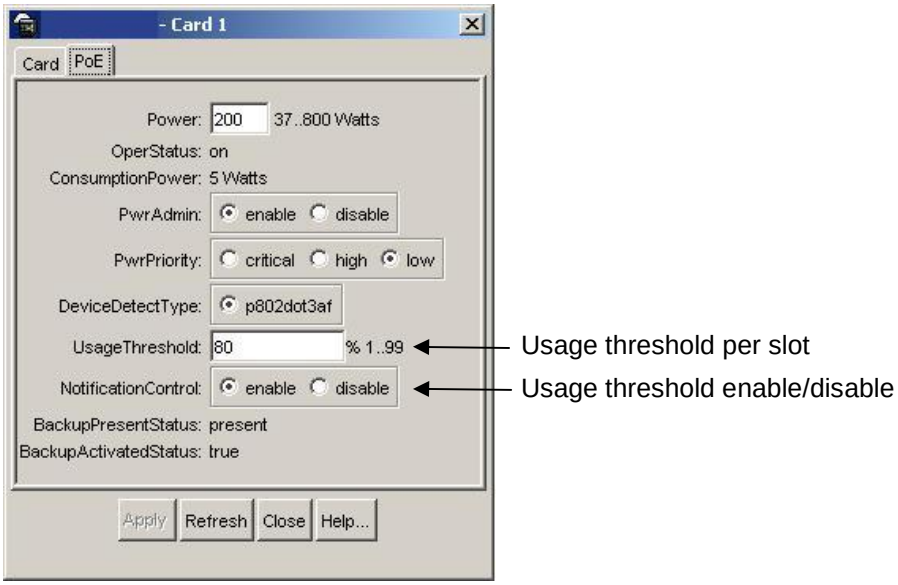
To set the PoE Trap Threshold , enter the following command:
ERS-8310:5# ***config poe card <slot #> power-usage-threshold <0-99>***

NNCLI:

To set the PoE Trap Threshold , enter the following command:
ERS-8310:5(config)# ***poe usage-threshold slot <slot #> <0-99>***

JDM:

- Select slot that you wish to configure, it should be high-lighted in a yellow box
- Right-click the card and select *Edit>PoE*



If you wish to not send a notification message, enter the following command:

PPCLI:

To disable PoE threshold notification , enter the following command:
ERS-8310:5# ***config poe card notification-control <enable|disable>***

NNCLI:

To disable PoE threshold notification , enter the following command:
ERS-8310:5(config)# ***no poe notification slot <slot#>***

4. QoS

By default, Nortel's IP phones will mark traffic using DiffServ class of Premium. If the voice traffic is tagged, the 802.1p bit will be set to 6 in addition to the DiffServ value set to Explicit Forwarding (EF) with a DSCP value of 0x2e.

By default, most switches that the IP phone set connects to will remark both the p-bit and DSCP value to 0. In the case of the Ethernet Routing Switch or Ethernet Routing Switch 8300, both switches can be enabled to trust the DiffServ value. This is not the case with the Ethernet Switch 470-PWR, and the Ethernet Routing Switch 5520. If ADAC is supported, then this feature can be used to automatically enable DiffServ for the VoIP VLAN. If ADAC is not supported, then a layer 2 filter can be used to filter on the voice VLAN and configured to provide Premium service.

4.1 QoS Mapping

Table 11 display's the default QoS Nortel service class mapping. This is the default mapping used with all the Nortel switches mentioned in the TCG.

Table 13: Nortel QoS Class Mappings

DSCP	TOS	Binary	Decimal DSCP/ToS	NNSC	PHB
0x0	0x0	000000 **00**	0	Standard	CS0
0x0	0x0	000000 **00**	0		DE
0x8	0x20	001000 **00**	8/32	Bronze	CS1
0xA	0x28	001010 **00**	10/40		AF11
0x10	0x40	010000 **00**	16/64	Silver	CS2
0x12	0x48	010010 **00**	18/72		AF21
0x18	0x60	011000 **00**	24/96	Gold	CS3
0x1A	0x68	011010 **00**	26/104		AF31
0x20	0x80	100000 **00**	32/128	Platinum	CS4
0x22	0x88	100010 **00**	34/136		AF41
0x28	0xA0	101000 **00**	40/160	Premium	CS5
0x2E	0xB8	101110 **00**	46/184		EF
0x30	0xC0	110000 **00**	48/192	Network	CS6
0x38	0xE0	111000 **00**	56/224	Critical	CS7

4.2 QoS Support on IP Phone Set

Table 12 shown below display the default QoS behaviour for each Nortel IP Phone set.

Table 14: Default QoS Marking for IP Phone Sets

Phone Set	Mark default DSCP to EF for all voice traffic	Mark default Ethernet 802.1p for value of 6 if Voice traffic is tagged
IP Phone 2001	Yes	Yes
IP Phone 2002	Yes	Yes
IP Phone 2004	Yes	Yes
IP Phone 2007	Yes	Yes
IP Phone 11x0 Series	Yes	Yes
IP Phone 12x0 Series	Yes	Yes

4.3 Queue Sets

4.3.1 Ethernet Switch 470-PWR

The 10/100 Mbps Ethernet ports on the Ethernet Switch 470-PWR have four hardware queues as shown in table 13 below. The first queue, strict priority, is always serviced first. The remaining three queues are serviced using a weighted-round-robin (WRR) scheduler.

Table 15: Ethernet Switch 470-PWR 10/100 Ethernet Queues

Queue ID	Scheduler	Service Order	Bandwidth %	Queue Size (bytes)	p-bit Queue Assignment	DSCP Queue Assignment
1	Priority	1	100	16,384	6, 7	Premium
2	WRR	2	50	24,567	4, 5	CS3, AF31 CS4, AF41
3	WRR	2	38	32,768	2, 3	CS1, AF11 CS2, AF21
4	WRR	2	12	90,112	0, 1	DE, CS0

The cascade port used on the Ethernet Switch 470 has two hardware queues as shown in table 14 below. These two queues are serviced in an absolute priority fashion.

Table 16: Ethernet Switch 470-PWR Cascade Ports

Queue ID	Scheduler	Service Order	Bandwidth %	Queue Size (bytes)	p-bit Queue Assignment
1	Priority	1	100	25,600	6, 7
2	Priority	2	100	102,400	0, 1, 2, 3, 4, 5

The fixed GBIC slot on the Ethernet Switch 470 supports eight queues as shown in table 15 below. The first queue is serviced in absolute priority fashion while the remaining queues are serviced at the next priority level or service order using a WRR scheduler. Hence, queue id 2 and 3 is serviced prior to queue ids 4 through 8. Both of these have a higher service order.

Table 17: Ethernet Switch 470-PWR GBIC Slot Queues

Queue ID	Scheduler	Service Order	Bandwidth %	Queue Size (bytes)	p-bit Queue Assignment
1	Priority	1	100	16,384	7
2	WRR	2	50	24,576	6
3	WRR	2	50	24,576	5
4	WRR	3	25	24,576	4
5	WRR	3	25	24,576	3
6	WRR	3	12	32,768	2
7	WRR	3	12	90,112	0, 1
8	WRR	3	12	24,576	

4.3.2 Ethernet Routing Switch 4500

The Ethernet Switch 4500 has four hardware queues as shown in table 16 below. The first queue, strict priority, is always serviced first. The remaining three queues are serviced using a weighted-round-robin (WRR) scheduler.

Table 18: Ethernet Routing Switch 4500 Queues

Queue ID	Scheduler	Service Order	Bandwidth %	Queue Size (bytes)	p-bit Queue Assignment	DSCP Queue Assignment
1	Priority	1	100	262,912	6	EF, CS5
2	WRR	2	65	209,920	7	CS7, CS6
3	WRR	2	26	176,640	5	AF1x, CS1
4	WRR	2	9	136,960	0, 1, 2, 3, 4	AF4x, AF3x, AF2x, CS4, CS3, CS2, DF (CSO), all unspecified DSCPs

QoS Guidelines

QoS resources are shared on the Ethernet Routing Switch 4500 across groups of ports. Each hardware device (ASIC) contains 24 to 26 ports as per table 17 below and supports the following scaling:

- Up to 128 classifiers for each mask precedence for each ASIC.
- Up to 64 meters for each mask precedence for each ASIC.
- Up to 64 counters for each mask precedence for each ASIC.
- Up to 8 precedence masks for each port.
- Up to 16 range checkers for each ASIC.

Table 19: Ethernet Routing Switch 4500 ASIC

Model	ASIC Device 1	ASIC Device 2
4526FX, 4526T, 4526T-PWR, 4526GTX, 4526GTX-PWR	Port 1 -24 or 26	Not Applicable
4550T, 4550T-PWR, 4548GT, 4548GT-PWR	Port 1 -24	Port 25 – 48 or 50

The QoS resources used can be viewed by using the following command:

- 4550T-PWR#***show qos diag unit <1-8>***

A maximum of 16 port ranges are supported for each hardware device (ASIC).

4.3.3 Ethernet Routing Switch 5520

Prior to software release 4.0, the Ethernet Routing Switch 5500 supported a single queue set with eight queues, one absolute queue and seven WRR queues.

With the introduction of software release 4.0, eight different queue sets where made available. Each queue set has different characteristics in regards to number of queues and service weights allowing the user to select a queue set based on the user's particular needs. With eight queue settings and three resource sharing options, the Ethernet Routing Switch 5500 supports a total of 24 different queues and buffer setting combinations. Prior to making any changes to the egress queue, the buffer resource sharing feature must be enabled.

Resource Sharing

The three (3) possible resource sharing settings in version 4.0 or greater software release are regular, large, and maximum. These settings allow the user to change the amount of buffer which can be allocated or shared to any port. Note that the switch must be rebooted if any changes are made.

Table 20: Ethernet Routing Switch 5500 Resource Sharing

Setting	Description
Regular	1 port may use up to 16% of the buffers for a group of 12 ports.
Large	1 port may use up to 33% of the buffers for a group of 12 ports.
Maximum	1 port may use 100% of the buffers for a group of 12 ports.

Resource Sharing Commands

- 5520-24T-PWR(config)# ***qos agent buffer <large | maximum | regular>***

  The qos agent buffer <regular | large | maximum > command allows the user to specify the level of resource sharing on the switch. This parameter is global and requires a reset to activate a change. This command is in the CLI priv-exec mode.

- 5520-24T-PWR(config)# ***default qos agent buffer***

  The default qos agent buffer command sets the switches agent buffer back to a default setting of regular. In order for this command to take affect, a reset of the switch must occur. This command is in the CLI priv-exec mode.

Resource Sharing Recommendations

Nortel recommends you use the default resource-sharing setting of regular. If you change the setting, the resulting performance may increase for some ports, and at times, decrease for other ports.

Generally speaking, smaller buffers achieve lower latency (RTT) but reduce the throughput ability which is better for VoIP etc. and sensible jitter application.

You should use the Maximum resource sharing setting:

- If you are using your 5520 for big file transfers (like backup of servers)
- If you are using (the AppleTalk Filing Protocol) AFP, use large or maximum resource sharing (AFP use a fix windows size set to 65,535K).

You should use the large resource sharing setting:

- If you are using your 5520 for high bandwidth application such as video.
- If you are using large TCP windows for your traffic, use large resource sharing (you can also reduce the TCP windows size on windows operating system - see Microsoft TechNet article 224829).
- If you have 4 or fewer ports connected per group of 12 ports.

You should use the Regular resource sharing setting:

- If you are using your 5520 in a VOIP environment.
- If you have 5 or more ports connected per group of 12 ports.

Egress CoS Queuing

The following charts describe each possible egress CoS queuing setting. The mapping of 802.1p priority to egress CoS queue, dequeuing algorithm, and queue weight is given. Additionally, the memory and maximum number of packets which can be buffered per egress CoS queue and resource sharing settings is shown.

Table 21: Ethernet Routing Switch 5500 Egress CoS Queuing

Setting	Internal Priority	Egress CoS Queue	Dequeuing Algorithm	Weight	Regular Memory/ # of 1518 Byte Packets	Large Memory/ # of 1518 Byte Packets	Max Memory/ # of 1518 Byte Packets
8 CoS	7	1	Strict	100%	36864B 24	49152B 32	131072B 86
	6	2	Weighted Round Robin	41%	36864B 24	47104B 31	123392B 81
	5	3		19%	27648B 18	45056B 29	115712B 76
	4	4		13%	18432B 12	43008B 28	108032B 71
	3	5		11%	18432B 12	39936B 26	97792B 64
	2	6		8%	18432B 12	36864B 24	85504B 56
	1	7		5%	18432B 12	33792B 22	70656B 46
	0	8		3%	18432B 12	30720B 20	54272B 35

7 CoS	7	1	Strict	100%	36864B	49152B	144640B
					24	32	95
	6	2	Weighted Round Robin	45%	32768B	46080B	131840B
					21	30	86
	5	3		21%	26624B	39936B	120064B
					17	26	79
	4	4		15%	19968B	33280B	109824B
					13	21	72
	3	5		10%	18432B	31232B	100864B
					12	20	66
	2	6		6%	18432B	31232B	92800B
					12	20	61
	1	7		3%	18432B	31232B	86400B
	0				12	20	56

6 CoS	7	1	Strict	100%	36864B	51200B	163840B
					24	33	107
	6	2	Weighted Round Robin	52%	33792B	49152B	151040B
					22	32	99
	5	3		24%	31744B	47104B	137472B
					20	31	90
	4	4		14%	26624B	43008B	124160B
					17	28	81
	3	5		7%	21504B	37376B	111360B
	2				14	24	73
	1	6		3%	18432B	34304B	98560B
	0				12	22	64

5 CoS	7	1	Strict	100%	46080B	64000B	199680B
					30	42	131
	6	2	Weighted Round Robin	58%	41984B	59904B	181760B
					27	39	119
	5	3		27%	35840B	53760B	158720B
	4				23	35	104
	3	4		11%	28160B	46080B	133120B
	2				18	30	87
	1	5		4%	19968B	38400B	113152B
	0				13	25	74

4 CoS	7	1	Strict	100%	57344B	81920B	262912B
	6				37	53	173
	5	2	Weighted Round Robin	65%	51200B	74240B	209920B
	4				33	48	138
	3	3		26%	38912B	61440B	176640B
	2				25	40	116
	1	4		9%	24576B	44544B	136960B
	0				16	29	90

3 CoS	7	1	Strict	100%	65536B	109568B	393316B
	6				43	72	259
	5	2	Weighted Round Robin	75%	57344B	87040B	262144B
	4				37	57	172
	3						
	2	3		25%	49152B	65536B	131072B
	1				32	43	86

2 CoS	7	1	Strict	100%	106496B	180224B	524288B
	6						
	5				70	118	345
	4						
	3	2	Weighted Round Robin	100%	61440B	81920B	262144B
	2						
	1				40	53	172

1 CoS	7	1	Strict	100%	131072B	262144B	786432B
	6						
	5						
	4						
	3				86	172	518

Egress CoS Queuing CLI Commands

- 5520-24T-PWR(config)#***show qos queue-set-assignment***

  The show qos queue-set-assignment command displays in the CLI the 802.1p priority to egress CoS and QoS queue mapping for CoS setting 1-8. This command is in the CLI priv-exec mode.

- 5520-24T-PWR(config)#***show qos queue-set***

  The show qos queue-set command displays the queue set configuration. The display includes the general discipline of the queue, the percent bandwidth (Kbps), and the queues size in bytes. This command is in the CLI priv-exec mode.

- 5520-24T-PWR(config)#***qos agent queue set <1-8>***

  The qos agent queue set <1-8> command sets the egress CoS and QoS queue mode (1-8) in which the switch will operate. This parameter is global and requires a reset to activate a change. This command is in the CLI priv-exec mode.

- 5520-24T-PWR(config)#***qos queue-set-assignment queue-set <1-8> 1p <0-7> queue <1-8>***

  The qos queue-set-assignment queue-set <1-8> 1p <0-7> queue <1-8> command gives the user the ability to specify the queue to associate an 802.1p priority. This command is in the CLI priv-exec mode.

- 5520-24T-PWR(config)#***default qos agent queue-set***

  The default qos agent queue-set command will default the egress CoS and QoS queue set. The default CoS/QoS queue mode is 8. This command is in the CLI priv-exec mode.

- 5520-24T-PWR(config)#***show qos agent***

  The show qos agent command displays the current attributes for egress CoS and QoS queue mode, resource sharing mode, and QoS NVRAM commit delay. This command is in the CLI priv-exec mode.

- 5520-24T-PWR(config)#***qos agent nvram delay***

  The qos agent nvram delay command will modify the maximum time in seconds to write config data to non-volatile storage. This command is in the CLI priv-exec mode.

- 5520-24T-PWR(config)#***qos agent reset-default***

  The qos agent reset-default command resets QoS to its configuration default. This command is in the CLI priv-exec mode.

Egress Queue Recommendations

If you are running all untagged traffic and do not change default port priority settings, use setting 1 CoS.

4.3.4 Ethernet Routing Switch 8300

Each Ethernet port on the Ethernet Routing Switch 8300 supports eight hardware queues as shown in table 18 below. Each of the eight queues is mapped to one of the eight QoS levels while each queue can be configured using one of three scheduling arbitration groups, i.e. strict priority, DWRR0, and DWRR1 where strict always have the highest precedence followed by DWRR1 and then DWRR0. This allows you to have the flexibility, if you wish to change all eight queues to Strict Priority. In addition, each per queue shaping can be enabled for shaping with a minimum shaping rate of 1 Mbps

Table 22: Ethernet Routing Switch 8300 Egress Queue

Queue	Traffic Class Queue	Drop Precedence	Scheduling Group	DWRR Weight	Size (8348TX)	Size (8324GTX)	Size (8348GTX)	Size (8393SF)
1	7 (highest)	Low	Strict Priority	N/A	16	32	64	48
2	6	Low	DWRR1	36	16	32	64	48
3	5	Low	DWRR1	12	16	32	64	48
4	4	Low	DWRR1	10	16	32	64	48
5	3	Low	DWRR1	8	32	32	64	48
6	2	Low	DWRR1	6	32	32	64	48
7	1	Low	DWRR1	3	32	48	64	48
8	0 (lowest)	Low	DWRR1	3	32	48	64	48
Queue	**Traffic Class Queue**	**Drop Precedence**	**Scheduling Group**	**DWRR Weight**	**Size (8394SF)**	**Size (8308XPF)**		
1	7 (highest)	Low	Strict Priority	N/A	192			
2	6	Low	DWRR1	36	192			
3	5	Low	DWRR1	12	192			
4	4	Low	DWRR1	10	192			
5	3	Low	DWRR1	8	192			
6	2	Low	DWRR1	6	192			
7	1	Low	DWRR1	3	192			
8	0 (lowest)	Low	DWRR1	3	192			

Weight:

Specifies the proportion (in units of 256 bytes) of bandwidth assigned to this queue relative to the other queues in the arbitration group. The range is from 1 to 256. Nortel recommends that the minimum weight (weight * 256) be greater than the port MTU.

Egress TX Queue CLI Commands

PPCLI :

Use the following command to change the Tx Queue settings:
ERS-8310:5# ***config ethernet <slot/port> tx-queue <0-7> [transmit <value>] [size <value>] [scheduler <value>] [weight <value>] [shaper <value>] [rate <value>] [burst-size <value>]***

NNCLI:

Use the following command to change the Tx Queue settings:
ERS-8310:5(config)#***interface <fastEthernet| gigabitEthernet> <slot|port>***
ERS-8310:5(config-if)#***tx-queue <0-7> transmit [size <value>] [scheduler <value>] [weight <value>] shaper [rate <value>] [burst-size <value>]***
ERS-8310:5(config-if)#***exit***
To disable a queue:
ERS-8310:5(config-if)# ***no tx-queue <0-7> transmit***
ERS-8310:5(config-if)#***exit***

Where :

config ethernet <ports> tx-queue <queue-id> (PPCLI) **tx-queue (NNCLI)** followed by:	
[burst-size <value>]	Sets the shaper burst size in Kilobytes (KB). The default value is 4 KB. The range is an integer value in the range 4 and 16000 KB. • burst-size <*value*> allows you to set the shaper burst size in KB. The available range is 1 and 16000 KB.
[rate <value>]	Sets the shaping rate in Mb/s. The default value is 10 Mb/s. The range is an integer value in the range 1 and 10000 Mb/s. • rate <*value*> allows you to set the shaper maximum rate in Mb/s. The available range is 1 and 10000 Mb/s. Note: the actual shaping rate can be different from the configured rate due to the rate granularity of the shaper.

[scheduler <value>]	Sets the scheduling Arbitration group. *value* allows you to set one of the three following scheduling arbitration groups: • Strict priority - This Arbitration Group is served first, where the priority goes from the highest queue index to the lowest. • DWRR1 - This Arbitration Group may transmit packets when there is no traffic from the SP Arbitration Group. • DWRR0 - This Arbitration Group may transmit packets when there is no traffic from the DWRR Group 1. Note: Within each DWRR Arbitration Group, each queue is guaranteed its proportional minimal bandwidth according to its configured weight.
shaper <value>] (PPCLI only)	Enables or disables transmission of shaper on the port. • shaper <*value*> allows you to enable or disable the feature.
[size <value>]	Specifies the number of packet descriptors allocated for the queue. • size <*value*> sets the number of descriptors in resolution of 16 {16..384}
[transmit <value>] (PPCLI only)	Enables or disables transmission on the queue. • transmit <*value*> enables or disables the feature
[weight <*value*>]	Specifies the proportion (in units of 256 bytes) of bandwidth assigned to this queue relative to the other queues in the arbitration group. • *value* is an integer value in the range 1 and 256, which represents units of bandwidth in the DWRR. The default value is 8 units, which is 8 * 256 (2048). Note: Nortel recommends that the minimum weight (N * 256) be greater than the port MTU.

4.4 Configuring QoS on a Nortel Switch

The easiest method to enable QoS on an Ethernet Switch or Ethernet Routing Switch is simply to create a layer 2 filter to filter only on the voice VLAN and configure the filter to provide DiffServ Premium service or configure the filter to trust the DiffServ Markings from the IP Phone set.

For more details on configuring filters on the Ethernet Routing Switch 5500, please go to www.nortel.com/support, select documentation for Ethernet Routing Switch 5520, select *filter and sort* and select *Operational Configuration*, and finally, select the document titled *BS5510 Technical Configuration Guide for CoS*.

For more details on configuring filters and QoS on the Ethernet Routing Switch 8300, please go to www.nortel.com/support, select documentation for Ethernet Routing Switch 8300, select *filter and sort* and select *Operational Configuration*, and finally, select any of following documents:

- PP8300 Technical Configuration Guide for QOS (NNCLI or CLI)
- PP8300 Technical Configuration Guide for Filters (NNCLI or CLI)

4.4.1 Default QoS Action

If the voice VLAN is untagged, you can configure the switch port members as either trusted or unrestricted. If you wish to support both voice and data on the same port, the switch can be configured for either untrusted or unrestricted. If you choice to use untrusted, you will have have to configure an ACL or Policy to match the voice VLAN and remark the traffic to Premium CoS. If you choice to use unrestricted, you will have to configure a Policy to match the voice VLAN with an in-profile action of Null. This will pass the QoS markings from the IP Phone set as-is. In either case, the out-of-profile action should be set to remark the data traffic to Standard CoS.

Table 23: QoS Interface Class Options

Type of filter	Action	Trusted	Untrusted	Unrestricted
ERS4500, ERS5500, ES470				
IPv4 filter criteria or Layer 2 filter criteria matching IPv4	DSCP	Does not change	• Tagged--Updates to 0 (Standard) • Untagged--Updates using mapping table and port's default value	Does not change
	IEEE 802.1p	Updates based on DSCP mapping table value	Updates based on DSCP mapping table value ES470: • Tagged—Updates to 0 • Untagged--Updates to port's default value	Does not change

On the ERS4500, either Policies or ACL's can be used to configure QoS.

4.4.2 Policy Configuration Option: Configuring L2 QoS on a Ethernet Routing Switch 5500 or 4500 using Layer 2 element, classifiers and policy for Tagged Voice VLAN

The following demonstrates two methods used to configure a simple layer 2 filter depending on if the port is configured as untrusted or unrestricted. In our example VLAN 220 will be used for the Voice VLAN. The procedure is to a) configure a layer 2 element to match the Voice VLAN, b) add a classifier to match the layer 2 element, and finally c) add a policy.

4.4.2.1 Configure a layer 2 element.

When configuring a layer 2 element, enter the voice VLAN value and set the EtherType to 0x0800. An EtherType value of 0x0800 signifies IP traffic. For example, assuming the voice VLAN is 220, enter the command as shown below. Assuming if no previous layer 2 elements have been configured, start with element ID = 1.

In reference to the ERS4500 only, either elements or ACL's can be used. If you use ACL's, you do not have to configure a classifier or classifer blocks. Please see next section if you wish to enable ACLs on the ERS4500.

ERS4500/5500: Step 1 – Create a new layer 2 element, assign Voice VLAN and set the EtherType to 0x0800

```
5520-24T-PWR(config)#qos l2-element 1 vlan-min 220 vlan-max 220 ethertype 0x800
```

4.4.2.2 Add classifier element

Next, configure a classifier element and add the layer 2 element configured above. Again, assuming no previous classifiers have been configured, start with classifier ID = 1.

ERS4500/5500: Step 1 – Add layer 2 element to a classifier by starting with classifer id 1 and adding layer 2 element id 1 from step above

```
5520-24T-PWR(config)#qos classifier 1 set-id 1 name VoIP_Class element-type l2
element-id 1
```

In reference to the ERS4500 only, if you selected to configure an ACL, this step is not required. An element is automatically created which can be viewed by using the following command

- `4550T-PWR(config)#show qos classifier`

```
  Id      Classifier     Classifier Criteria Criteria  Session      Storage
             Name          Set Id     Type      Id        Id          Type
_____ _______________ __________ ________ ________ __________ _________
55001 UntrustedClfrs1 55001      L2       55001    0          Other
55002 UntrustedClfrs2 55002      L2       55002    0          Other
55004 vlan_fil        55004      L2       55004    0          Other
```

4.4.2.3 Add Policy

Method 1: Remark Voice Traffic

Method 1 is to configure a Policy and add the classifier element configured above to remark the in-profile traffic to Premium by matching the voice VLAN and setting the out-of-profile traffic to QoS level of Standard. The end result is all the voice traffic will be remarked to Premium CoS while the out-of-provile data traffic will be remarked to Standard CoS. Assuming we wish to name the policy 'VoIP_Policy' and apply it to all interfaces using the default interface role, enter the following commands.

ERS5500: Step 1 – Add a policy, for this example named VoIP_Policy, add classifier id 1 configured above, set in-profile-action to remark to Premium CoS, and set the non-match action to remark to Standard CoS.

```
5520-24T-PWR(config)#qos policy 1 name VoIP_Policy if-group allQoSPolicyIfcs
clfr-type classifier clfr-id 1 in-profile-action 7 non-match-action 2
```

ERS4500: Step 1 – Add a policy, for this example named VoIP_Policy, add classifier id 1 configured above, set in-profile-action to remark to Premium CoS, and set the non-match action to remark to Standard CoS.

```
4550T-PWR(config)#qos policy 1 name "VoIP_Policy" if-group allQoSPolicyIfcs
clfr-type classifier clfr-id 1 in-profile-action 7 precedence 3
```

You can also apply the policy to an individual port member instead of an interface role with multiple port members. For example, assuming only wish to apply the policy to port

12, enter the following command:

- 5520-24T-PWR(config)#***qos policy 1 name VoIP_Policy port 12 clfr-type classifier clfr-id 1 in-profile-action 7 non-match-action 2***

Method 2: Trust Voice Markings

Method 2 is to configure a Policy to trust the QoS markings from the IP Phone by honoring the QoS settings from the IP Phone. If you wish to use this method, you must first create a new interface group with a class of unrestricted and then add a Policy to with an in-profile action of null for the voice VLAN and out-of-profile action of Standard. By using a null action for the voice traffic, the switch will pass QoS markings from the IP Phone sets as-is while remarking the data traffic to Standard CoS.

ERS5500: Step 1 – Add a new interface group with a class of unrestricted and add port members. For this example, we will name the if-group "unrestricted".
5520-24T-PWR(config)#***qos if-group name unrestricted class unrestricted*** 5520-24T-1(config)#***qos if-assign port 1-24 name unrestricted***
ERS5500: Step 2 – Add a policy, for this example named VoIP_Policy, add classifier id 1 configured above, set the in-profile-action action to Null and the non-match action to Standard_Service.
5520-24T-PWR(config)#***qos policy 1 name VoIP_Policy if-group unrestricted clfr-type classifier clfr-name VoIP_Class in-profile-action-name Null_Action non-match-action-name Standard_Service precedence 10***

Note that you can use either ID's or names for the classifiers and policy actions. Method 1 shows and example using ID's while method 2 shows names.

To understand what the in-profile-action and non-match-action refer to, enter the following command:

5520-24T-PWR#***show qos action***

Id	Name	Drop	Update DSCP	802.1p Priority	Set Drop Precedence	Extension	Storage Type
1	Drop_Traffic	Yes	Ignore	Ignore	High Drop		ReadOnly
2	Standard_Service	No	0x0	Priority 0	High Drop		ReadOnly
3	Bronze_Service	No	0xA	Priority 2	Low Drop		ReadOnly
4	Silver_Service	No	0x12	Priority 3	Low Drop		ReadOnly
5	Gold_Service	No	0x1A	Priority 4	Low Drop		ReadOnly
6	Platinum_Service	No	0x22	Priority 5	Low Drop		ReadOnly
7	Premium_Service	No	0x2E	Priority 6	Low Drop		ReadOnly
8	Network_Service	No	0x30	Priority 7	Low Drop		ReadOnly
9	Null_Action	No	Ignore	Ignore	Low Drop		ReadOnly
55001	UntrustedClfrs1	DPass	Ing 1p	Ignore	Low Drop		Other
55002	UntrustedClfrs2	DPass	0x0	Priority 0	High Drop		Other

4.4.3 ACL Configuration Option: Configuring L2 QoS on a Ethernet Routing Switch 4500 using ACLs for the Tagged Voice VLAN

If you choice to enable ACL's on the ERS4500 instead of classifiers, enter the following commands.

4.4.3.1 Add layer 2 ACL

ERS4500: Step 1 – If you choice to use ACL's instead of elements, then the command step will be as follows assuming you name the ACL 'vlan_fil':

```
4550T-PWR(config)#qos l2-acl name vlan_fil vlan-min 220 vlan-max 220 ethertype
0x800 update-dscp 46 update-1p 6
```

Please note that the DSCP value is entered as a decimal value. The decimal value for CoS level Premium is 46. You should also update the p-bit in case the Voice VLAN port members are set to tagged. Please refer to table 11.

4.4.3.2 Assign ACL to port members

ERS4500: Step 1 – Assign the ACL vlan_fil to the appropriate port members; for example, port member 14 and 16:

```
4550T-PWR(config)# qos acl-assign port 14,16 acl-type l2 name vlan_fil
```

4.4.4 Configuring L2 QoS on an Ethernet Switch 470 for Tagged Voice VLAN

The following demonstrates two methods used to configure a simple layer 2 filter depending on if the port is configured as untrusted or unrestricted. In our example VLAN 220 will be used for the Voice VLAN. The procedure is to a) configure a layer 2 element to match the Voice VLAN, b) add a classifier to match the layer 2 element, and finally c) add a policy.

4.4.4.1 Configure a layer 2 element.

When configuring a layer 2 element, enter the voice VLAN value and set the EtherType to 0x0800. An EtherType value of 0x0800 signifies IP traffic. For example, assuming the voice VLAN is 220, enter the command as shown below. Assuming if no previous layer 2 elements have been configured, start with element ID = 1.

ES470: Step 1 – Create a new layer 2 element, assign Voice VLAN and set the EtherType to 0x0800

```
470-24T-PWR(config)#qos l2-filter 1 create ethertype 0x800 vlan 220
```

4.4.4.2 Add classifier element

Next, configure a classifier element and add the layer 2 element configured above. Again, assuming no previous classifiers have been configured, start with classifier ID = 1.

ES470: Step 1 – Add layer 2 element to a classifier by starting with classifer id 1 and adding layer 2 element id 1 from step above

```
470-24T-PWR(config)#qos l2-filter-set 1 create set 1 name VoIP_set_1 filter 1
filter-prec 1
```

4.4.5 Add Policy

Method 1: Remark Voice Traffic

Method 1 configures a Policy by adding the classifier element configured above to remark the in-profile traffic to Premium and remark the out-of-profile traffic to Standard. Assuming we wish to name the policy 'VoIP_Policy' and apply it to all interfaces using the default interface role, enter the following command.

ES470: Step 1 – Add a policy, for this example named VoIP_Policy, add classifier id 1 configured above, set the in-profile-action to remark to Premium CoS, and set the out-profile-action to remark to Standard CoS.

```
470-24T-PWR(config)#qos policy 1 create name VoIP_Policy if-group unrestricted
filter-set-type l2 filter-set 1 in-profile-action 65534 out-profile-action
65527 order 1
```

Method 2: Trust Voice L3 DSCP Markings

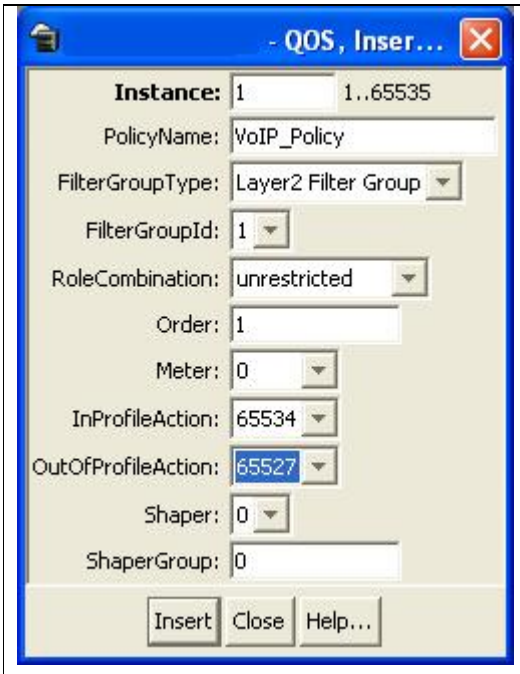
Method 2 configures a Policy to trust the QoS markings by honoring the DSCP settings from the IP Phone. If you wish to use this method, you must first create a new interface group with a class of unrestricted and then add a Policy with an in-profile action of null for the voice VLAN and an out-of-profile traffic of Standard for the data traffic. Please note that the DSCP is used and the p-bit is ignored.

ES470: Step 1 – Add a new interface group with a class of unrestricted and add port members. For this example, we will name the if-group "unrestricted".

```
470-24T-PWR(config)#qos if-assign-list del portlist 1-24
470-24T-PWR(config)# qos if-assign-list add portlist 1-24 name unrestricted
```

ES470: Step 2 – Add a policy, for this example named VoIP_Policy, add classifier id 1 configured above, set in-profile-action to set the action to Null and the non-match action to Standard_Service. Please note that JDM must be used at this time in order to set the out-profile-action. CLI does not support the out-profile-action at this time.

Via JDM, goto ***QoS/COPS>QOS>Policies***



To understand what the in-profile-action and non-match-action numbers refer to, enter the following command:

470-48T-PWR(config)#***show qos actions***

```
Id          Name          Drop  Update      Set Drop       802.1p Priority  Mirror
                                DSCP        Precedence                      Frame

_____ _________________ _____ ______ ________________ _______________ _______
65526 Drop_Traffic      True  Ignore Ignore           Ignore          Ignore
65527 Standard_Service  False 0x0    Not Loss Sensitive Priority 0     Ignore
65528 Bronze_Service    False 0xA    Loss Sensitive     Priority 2     Ignore
65529 Silver_Service    False 0x12   Loss Sensitive     Priority 3     Ignore
65530 Gold_Service      False 0x1A   Loss Sensitive     Priority 4     Ignore
65531 Platinum_Service  False 0x22   Loss Sensitive     Priority 5     Ignore
65532 Premium_Service   False 0x2E   Loss Sensitive     Priority 6     Ignore
65533 Network_Service   False 0x30   Loss Sensitive     Priority 7     Ignore
65534 Trusted_IP        False Ignore Use Egress Map     Use Egress Map Ignore

65535 Trusted_NonIP     False Ignore Ignore             Ignore         Ignore
```

4.4.6 Configure L2 QoS on a Ethernet Routing Switch 8300

By default, the Ethernet Routing Switch 8300 trusts the 802.1p value with a default behavior as shown in table 22 below. Providing the VoIP VLAN is tagged, no additional configuration steps are required.

Table 24: Default QOS Behavior for the Ethernet Routing Switch 8300

Traffic Type	802.1p		DSCP	
	Behavior	**Queue**	**Behavior**	**Queue**
Bridged, i.e. VLAN without IP address				
Tagged	Passed as-is	As per traffic class and queue mapping	Passed as-is	As per p-bit
Untagged	N/A	N/A	Passed as-is	Queue 1
Routed, i.e. VLAN with IP address assigned				
Tagged	Passed as-is	As per traffic class and queue mapping	Passed as-is	As per p-bit
Untagged	N/A	N/A	Passed as-is	Queue 1

If the IP Phone set voice VLAN is not tagged, you could set up a filter to trust the DSCP value, classify traffic based on VLAN value, or remark the DSCP value.

4.4.6.1 Trust DSCP Value Configuration

To setup a filter to trust the DSCP value, please enter the following commands

PPCLI:

ERS8300: Step 1 – Create a new ACL with an action to trust the DSCP value. Assuming no ACLs have been configured, start with ACL 1

```
ERS8300:5# config filter acl 1 create ip
ERS8300:5# config filter acl 1 ace 1 action permit trust-dscp enable
```

ERS8300: Step 2 – Create an ACG group and add ACL configured in step 1 above. Assuming no ACG have been configured, start with ACG 1

```
ERS8300:5# config filter acg 1 create 1
```

ERS8300: Step 3 – Add the ACG created in step 2 to all appropriate port members

```
ERS8300:5# config ethernet <port #> filter create 1
```

NNCLI:

ERS8300: Step 1 – Create a new ACL with an action to trust the DSCP value. Assuming no ACL have been configured, start with ACL 1

```
ERS8300:5(config)#filter acl 1 ip
ERS8300:5(config)#filter acl 1 action 1 permit trust-dscp enable
```

ERS8300: Step 2 – Create an ACG group and add ACL configured in step 1 above. Assuming no ACG have been configured, start with ACG 1

```
ERS8300:5(config)#filter acg 1 1
```

ERS8300: Step 3 – Add the ACG created in step 2 to all appropriate port members

```
ERS8300:5(config)#interface fastEthernet <slot/port>
ERS8300:5(config-if)#filter 1
ERS8300:5(config-if)#exit
```

4.4.7 Classify traffic based on VLAN basis

For IP subnet and Protocol-based VLANs you can set up a default traffic class level based on the VLAN id. The VLAN QoS level can be assigned a value from 0 (lowest) to 7 (highest) with a default setting of 1. Note that you cannot apply a VLAN QoS level to port-based VLANs. For example, assuming the VoIP VLAN is 220 with port members 1/3 to 1/11, enter the following commands:

PPCLI:

ERS8300: Step 1 – Create VLAN 220 and add port members

```
ERS8300:5# config vlan 220 create byprotocol 1 ip
ERS8300:5# config vlan 1 ports remove 1/1-1/11
ERS8300:5# config vlan 220 ports add 1/1-1/11
```

ERS8300: Step 2 – Assign QoS level

```
ERS8300:5# config vlan 220 qos-level 6
```

ERS8300: Step 3 – Enable Dynamic MAC QoS Update

```
ERS8300:5# config vlan 220 update-dynamic-mac-qos-level enable
```

NNCLI:

ERS8300: Step 1 – Create VLAN 220 and add port members

```
ERS8300:5(config)#vlan create 220 type protocol-ipether2 1
ERS8300:5(config)#vlan members remove 1 1/1-1/11
ERS8300:5(config)#vlan members add 220 1/1-1/11
```

ERS8300: Step 2 – Assign QoS level

```
ERS8300:5(config)#vlan qos-level 220 6
```

ERS8300: Step 3 – Enable Dynamic MAC QoS Update

```
ERS8300:5(config)#vlan update-dynamic-mac-qos-level 220
```

4.4.8 Classify traffic based on a filter

Assuming we wish to filter on the VoIP VLAN with the MAC address range belonging to the IP Phone sets and set the DiffServ value to EF (0x2e). This can be accomplished by using the commands shown below.

4.4.8.1 Create an ACT.

PPCLI:

ERS8300: Step 1 – Create a new ACT to allow ACL filtering on MAC addresses

```
ERS8300:5# filter act 2 ethernet ip src-mac ff:ff:ff:ff:ff:ff dst-mac
ff:ff:ff:ff:ff:ff vlan-mask 0x0fff name "act_2_ip-mac"
```

ERS8300: Step 2 – Enable the ACT to also allow ACL filtering on the DSCP value

```
ERS8300:5# config filter act 2 ip ip 0.0.0.0 tos 0xff
```

NNCLI:

ERS8300: Step 1 – Create a new ACT to allow ACL filtering on MAC addresses

```
ERS8300:5(config)#filter act 2 ethernet ip src-mask ff:ff:ff:ff:ff:ff dst-mask
ff:ff:ff:ff:ff:ff vlan-mask 0x0fff name act-2-ip-mac
```

ERS8300: Step 2 – Enable the ACT to also allow ACL filtering on the DSCP value

```
ERS8300:5(config)#filter act 2 ip tos 0xff
```

4.4.8.2 Create an ACL

For our example, we will assume the voice VLAN is 220 while the MAC address range is from 00:0a:e4:00:00:00 to 00:0a:e4:ff:ff:ff.

PPCLI:

ERS8300: Step 1 – Add ACL 1 using the name ACL-1_VoIP, add ACT 2 created above, and enable the ACL to filter on the specified MAC address in VLAN 220 to remark traffic using Premium CoS and remark all other traffic as Standard CoS

```
ERS8300:5# config filter acl 1 create ip acl-name ACL-1_VoIP act-id 2
ERS8300:5# config filter acl 1 ace 1 action permit remark-dscp phbef "ACE-
1_remark" precedence 1
ERS8300:5# config filter acl 1 ace 1 ethernet src-mac 00:0a:e4:00:00:00 range
00:0a:e4:ff:ff:ff vlan-id 220
ERS8300:5# config filter acl 1 ace default action permit remark-dscp phbcs0
```

NNCLI:

ERS8300: Step 1 – Add ACL 1 using the name ACL-1_VoIP, add ACT 2 created above, and enable the ACL to filter on the specified MAC address in VLAN 220 to remark traffic using Premium CoS and remark all other traffic as Standard CoS

```
ERS8300:5(config)#filter acl 1 ip acl-name ACL-1_VoIP act-id 2
ERS8300:5(config)# filter acl 1 action 1 permit remark-dscp phbef ACE-1_remark
precedence 1
ERS8300:5(config)#filter acl 1 ethernet 1 src-mac 00:0a:e4:00:00:00 range
00:0a:e4:ff:ff:ff vlan-id 220
ERS8300:5(config)#filter acl 1 action default permit remark-dscp phbcs0
```

4.4.8.3 Create an ACG

Configure and ACG and add ACL created above. For this example, we will name the ACG ACG-1_Voip.

PPCLI:

ERS8300: Step 1 – Create a new ACT to allow ACL filtering on MAC addresses
ERS8300:5# ***config filter acg 1 create 1 acg-name ACG-1_Voip***

NNCLI:

ERS8300: Step 1 – Create a new ACT to allow ACL filtering on MAC addresses
ERS8300:5(config)#***filter acg 1 1 acg-name ACG-1_Voip***

4.4.8.4 Add ACG to interface(s)

Add the ACG 'ACG-1_Voip' to all appropriate interfaces and disable p-bit override.

PPCLI:

ERS8300: Step 1 – Add ACG 'ACG-1_Voip' to interface level and
ERS8300:5# ***config ethernet <slot/port> filter create 1***
ERS8300:5# ***config ethernet <slot/port> qos 8021p-override enable***

NNCLI:

ERS8300: Step 1 – Add ACG 'ACG-1_Voip' to interface level and
ERS8300:5(config)#***interface fastEthernet <slot/port>***
ERS8300:5(config-if)#***filter 1***
ERS8300:5(config-if)#***qos 8021p-override***
ERS8300:5(config-if)#***exit***

5. Anti-Spoofing Best Practices

Overview – ARP Poison

ARP spoofing simply involves spoofing an IP address of a victim thereby allowing frames destined for the remote host to be forwarded to the attacker. For example, by sending Gratuitous ARP (GARP) frames between an attacker to a victim and a default gateway router within a VLAN of a Layer 2 switch, a man-in-the-middle (MITM) attack can occur.

Overview – IP Spoofing

IP spoofing refers to the creatation of IP packets with a spoofed source IP adresss other than the local network address. By forging the source IP address, an attacker can make the packet appear as it it was sent by a different machine. The victim that receives the spoofed packets will send responses back to the forged source address.

Defense against Spoofing

Nortel IP Phone sets supports GARP feature – please see section 2.5.1.3. However, this feature only prevents ARP spoofing one way from the IP Phone set to the default gateway address. Therefore, if the voice call is to another phone set that is off-net (to a phone on a different subnet or switch) an attacker can only poison the phone one-way. The attacker can only record the voice traffic from a remote phone sent to the the local phone set and not from the local phone to the remote phone. The IP Phone GARP also does prevent an on-net attack. On-net refers to the same VLAN on a switch where both IP phone are connected.

To prevent ARP Spoofing, it is recommended to enabled DHCP Snooping and ARP Spoofing when available on the local switch where the IP Phone sets are connected. Both of these mechanisms will prevent Man-in-the-middle (MITM) attacks agains spoofing a victims IP address. In addition, it is also recommended to enable IP Spoofing either on the local switch where the IP Phone sets are attached or in the core.

Summary Chart

The following chart provides a summary of Off-Net and On-Net MITM attacks.

Notes:

- An ‘X” indicated MITM attack (ARP Spoofing can occur) in both directions, i.e. the ability to capture traffic from a local phone set to the remote phone set and vise-versa.
- An “✓” indicates a MITM attack does not occur
- An “⇨” indicates a one-way MITM attack from an remote phone set to the local phone set only
- Off-Net indicates traffic off the local subnet
- On-Net indicated traffic between two devices within the same VLAN, i.e. same subnet, on a local switch

Switch	Traffic Type	Off-Net	On-Net
Generic L2 switch	Data	X	X
	Voice	X	X
	Voice with GARP disabled on IP Phone	X	X
	Voice with GARP enabled on IP Phone	⇨	✓
ERS55xx with ARP Spoofing Prevention enabled	Data	✓	✓
	Voice	✓	✓
	Voice with GARP enabled on IP Phone	✓	✓

Support on Nortel Switches

Table 25: Anti-Spoofing support on Nortel Switches

Switch	Feature		
	DHCP Snooping	**ARP Inspection**	**IP Spoofing**
ERS5500	✓ (5.0)	✓ (5.0)	✓ (5.1)
ERS4500	✓ (5.1)	✓ (5.1)	
Core			
ERS8600			✓ (4.1)*

*Requires software release 4.1 with R-modules (does not require R-mode)

6. DHCP Configuration

A Nortel IP phone set can be manually provisioned or provisioned via DHCP.

If manually provisioned, you must enter a static IP address, mask and default gateway for the phone set in addition to statically entering the Call Server and other assorted information.

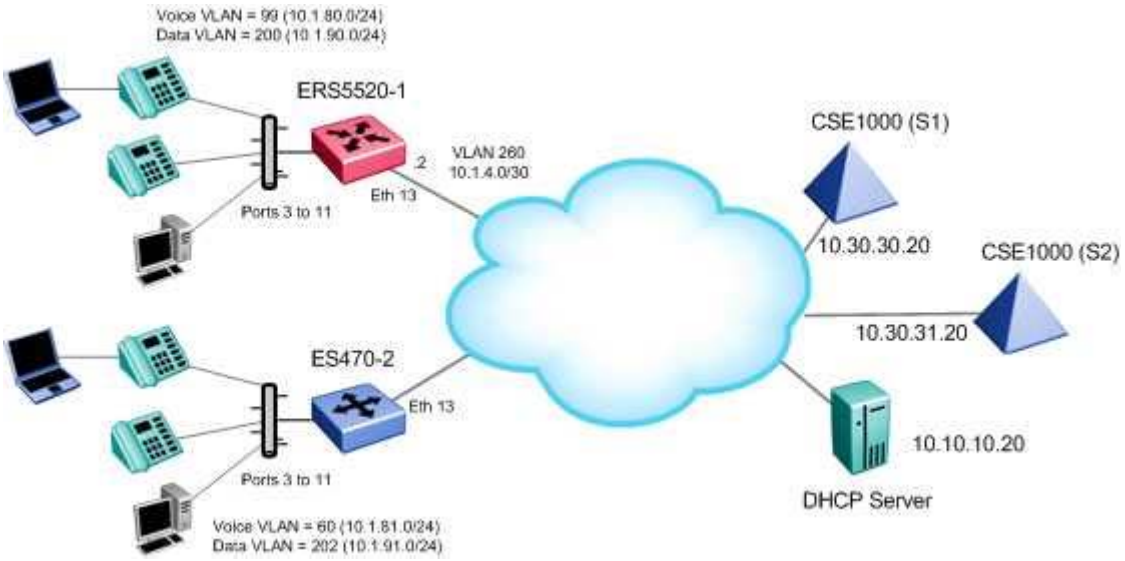
If DHCP is selected, the IP phone can be provisioned in one of two methods – partial or full DHCP.

In the case of partial DHCP, the IP Phone set can be setup to simply just retrieve an IP address, network mask and default gateway via DHCP. In this case, you still have to statically enter the Call Server and other assorted information.

In the case of full DHCP, you can setup the Nortel IP phone set such that the IP phone set will retrieve an IP address and also Call Server information. Some settings may still have to be set manually.

6.1 Configuration Example: Auto Configuration Using Ethernet Routing Switch 5520-PWR and Ethernet Switch 470-PWR

The following configuration example covers setting up a network to support both voice and data to support Auto-Configuration on Nortel's IP Phone sets. We will cover how to setup the edge switch for both L2 and L3 operations and also how to setup the DHCP Server.



For this configuration example, we will configure the following:

- Setup Ethernet Routing Switch 5520-1 for L3 with Voice VLAN 99 and Data VLAN 200, enable DHCP Relay for VLANs 99 and 200, enable Spanning Tree Fast-Start on ports 3 to 11, and disable STP on port 13
- Setup Ethernet Switch 470-2 with Voice VLAN 60 and Data VLAN 202 such that ports 3 to 11 allow traffic for the untagged data VLAN 202 and tagged voice VLAN 60
- Change POE priority level for all VoIP ports to high
- Setup the DHCP Server, in this case a Windows 2003 server.

6.1.1 Configuration

6.1.1.1 Go to configuration mode.

ERS5520-1 Step 1 - Enter configuration mode

```
5520-1>enable
5520-1#configure terminal
```

ES470-1 Step 1 - Enter configuration mode

```
470-1>enable
470-1-1#configure terminal
```

6.1.1.2 Create VLANs

ERS5520-1 Step 1 – Remove port members from default VLAN 1 and create VLANs 99, 200, and 260

```
5520-1(config)#vlan members remove 1 3-11,13
5520-1(config)#vlan create 99 name voice type port
5520-1(config)#vlan create 200 name data type port
5520-1(config)#vlan create 260 name trunk type port
```

ES470-1 Step 1 – Remove port members from default VLAN 1 and create VLANs 99, 200, and 260

```
470-1(config)#vlan members remove 1 3-11,13
470-1(config)#vlan create 60 name voice type port
470-1(config)#vlan create 202 name data type port
```

6.1.1.3 Set the default VLAN PVID on the access port member

ERS5520-1 Step 1 – Configure port members 3 to 11 with a default PVID of 200

```
5520-1(config)#vlan ports 3-11 tagging untagpvidOnly pvid 200
```

ES470-1 Step 1 – Configure port members 3 to 11 with a default PVID of 202 and enable port 13 to tagall

```
470-1(config)#vlan ports 3-11 tagging untagpvidOnly pvid 202
470-1(config)#vlan ports 13 tagging tagall
```

6.1.1.4 Add VLAN port members

ERS5520-1 Step 1 – Add port members for VLANs 99, 200, and 260

```
5520-1(config)#vlan members add 200 3-11
5520-1(config)#vlan members add 99 3-11
5520-1(config)#vlan members add 260 13
```

ES470-1 Step 1 – Add port members for VLANs 60 and 202

```
470-1(config)#vlan members add 60 3-11,13
470-1(config)#vlan members add 202 3-11,13
```

6.1.1.5 Spanning Tree Configuration

ERS5520-1 Step 1 – Enable STP Fast-Start on port 3 to 11 and disable STP on port 13

```
5520-1(config)#interface fastEthernet all
5520-1(config-if)#spanning-tree port 3-11 learning fast
5520-1(config-if)#no spanning-tree port 13
5520-1(config-if)#exit
```

ERS470-1 Step 1 – Enable STP Fast-Start on port 3 to 11

```
470-1(config)#interface fastEthernet all
470-1(config-if)#spanning-tree port 3-11 learning fast
470-1(config-if)#exit
```

6.1.1.6 Set POE priority level to high.

ERS5520-1 Step 1 – Enable STP Fast-Start on port 3 to 11 and disable STP on port 13

```
5520-1(config)#interface fastEthernet all
5520-1(config-if)#poe poe-priority port 3-11 high
5520-1(config-if)#exit
```

ES470-1 Step 1 – Enable STP Fast-Start on port 3 to 11 and disable STP on port 13

```
470-1(config)#interface fastEthernet all
470-1(config-if)#poe poe-priority port 3-11 high
470-1(config-if)#exit
```

By default, the POE priority level is set to low on all ports. It is recommended to change this setting to either high or critical for all VoIP port. Also, by default POE power limit is set to 16W maximum per port. You can also change this value from 3 to 16 watts using the command poe poe-limit port <port #> <3-16>.

6.1.1.7 Add QoS for Voice VLAN

Please see sections 4.4.2 and 4.4.4.

6.1.1.8 IP and DHCP configuration.

ERS5520-1 Step 1 – Add IP address to each VLAN and set DHCP mode to DHCP only for VLAN 99 and 200

```
5520-1(config)#interface vlan 99
5520-1(config-if)#ip address 10.1.80.1 255.255.255.0
5520-1(config-if)#ip dhcp-relay mode dhcp
5520-1(config-if)#exit
5520-1(config)#interface vlan 200
5520-1(config-if)#ip address 10.1.90.1 255.255.255.0
5520-1(config-if)#ip dhcp-relay mode dhcp
5520-1(config-if)#exit
5520-1(config)#interface vlan 260
5520-1(config-if)#ip address 10.1.4.2 255.255.255.252
5520-1(config-if)#exit
```

6.1.1.9 Enable IP routing and add IP static routes.

ERS5520-1 Step 1 – Add IP address to each VLAN and set DHCP mode to DHCP only for VLAN 99 and 200

```
5520-1(config)#ip routing
5520-1(config)#ip route 10.0.0.0 255.0.0.0 10.1.4.1 1
5520-1(config)#ip route 172.0.0.0 255.0.0.0 10.1.4.1 1
```

6.1.1.10 Add DHCP relay agents.

ERS5520-1 Step 1 – Add DHCP relay agenets

```
5520-1(config)#ip dhcp-relay fwd-path 10.1.80.1 10.10.10.20 enable
5520-1(config)#ip dhcp-relay fwd-path 10.1.90.1 10.10.10.20 enable
```

6.1.1.11 Enable IP Anti-Spoofing

ERS5520-1 Step 1 – Enable IP DHCP Snooping for data VLAN 99 and Voice VLAN 200

```
5520-1(config)#ip dhcp-snooping vlan 99
5520-1(config)#ip dhcp-snooping vlan 200
5520-1(config)#ip dhcp-snooping enable
```

ERS5520-1 Step 2 – Enable IP Arp Inspection for data VLAN 99 and Voice VLAN 200

```
5520-1(config)#ip arp-inspection vlan 99
5520-1(config)#ip arp-inspection vlan 200
```

ERS5520-1 Step 3 – Enable core port 13 as a trusted port

```
5520-1(config)#interface fastEthernet 13
5520-1(config-if)#ip dhcp-snooping trusted
5520-1(config-if)#ip arp-inspection trusted
5520-1(config-if)#exit
```

6.1.2 Phone Setup

6.1.3 IP Phone 2004 Phase I Setup

i2004 Step 1 – IP Phone 2004 Phase I Phone Set
DHCP? (0-No, 1-Yes): **1** DHCP: 0-Full, 1-Partial: **0** VLAN? (0-No, 1-Ma, 2-Au): **2**
i2004 Step 1 – IP Phone 2004 Phase II Phone Set
DHCP? (0-No, 1-Yes): **1** DHCP: 0-Full, 1-Partial: **0** Voice VLAN? 0-No, 1-Yes: **1** VLAN Cfg? 0-Auto, 1-Man: **0** VLAN Filter? 0-No, 1-Yes: **1** Data VLAN? 0-No, 1-Yes: **0** GARP Ignore? [0-N, 1-Y]: **1**

6.1.4 DHCP Server Setup

The following setup applies to configuring a Windows 2003 server for DHCP with auto configuration.

With the advent of C4I firmware (UNIStim 2.2) for the 1100 series of IP sets, and with the introduction of the 1200 series of IP sets, there are now two alternative methods of delivering IP set configuration via DHCP – for purposes of simplicity will refer to “Default DHCP Options” and “Expanded DHCP Options”.

“Default DHCP Options” is the original mode of operation and continues to be supported with the 2000, 1100 and 1200 series of IP sets. Customers using this functionality already require no change on their configuration.

“Expanded DHCP Options” is introduced for the 1100 series (C4I firmware) and 1200 series only, and as the name implies this allows additional paramaters to be configured via DHCP.

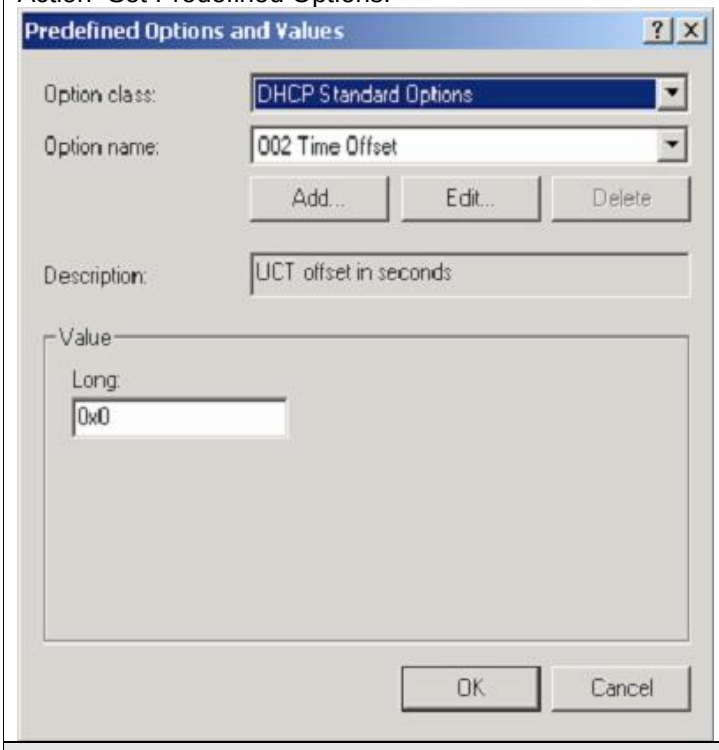
6.1.4.1 Default DHCP Options

Default DHCP Options continues to pass specific parameters by the DHCP private options 128, 144, 157, or 191.

Windows 2003 Server Step 1 – Go to the following
Start>Administrative Tools>DHCP
Windows 2003 Server Step 2 – Create DHCP Options by high-lighting the name on of your

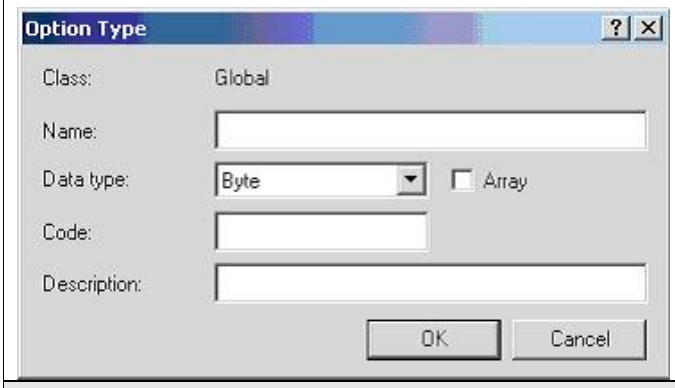
DHCP server from the top menu and select the following

Action>Set Predefined Options.



Windows 2003 Server Step 3 – Add a new DHCP option

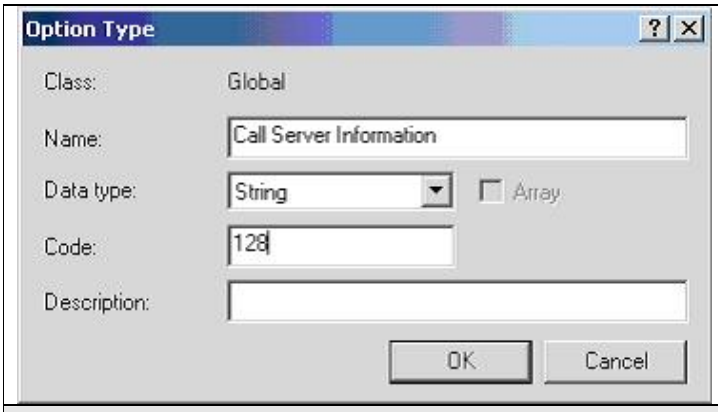
Click on *Add* to open the following screen



Windows 2003 Server Step 4 – Create the DHCP option for the Call Server

For the name, type in 'Call Server Information' and add the following

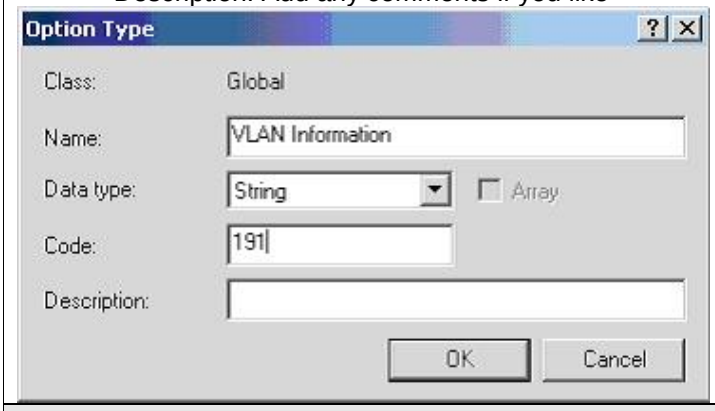
- Set Date type: String
- Code: 128
- Description: Add any comments if you like



Windows 2003 Server Step 5 – Create the DHCP option for the VLAN ID

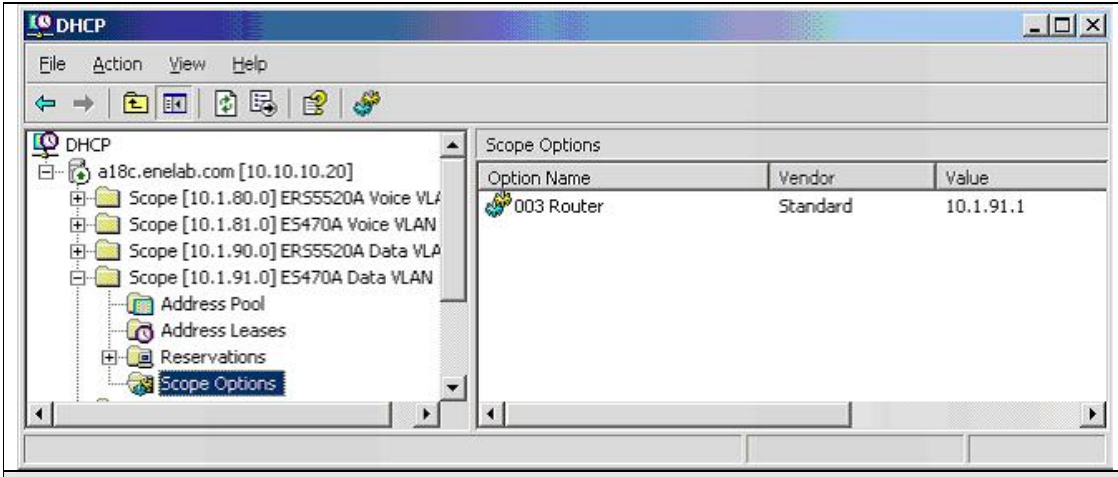
Select *Add* again and fill in the information as shown below for the VLAN Auto-Discovery with the identifier set to *191*.

- Set Date type: String
- Code: 191
- Description: Add any comments if you like

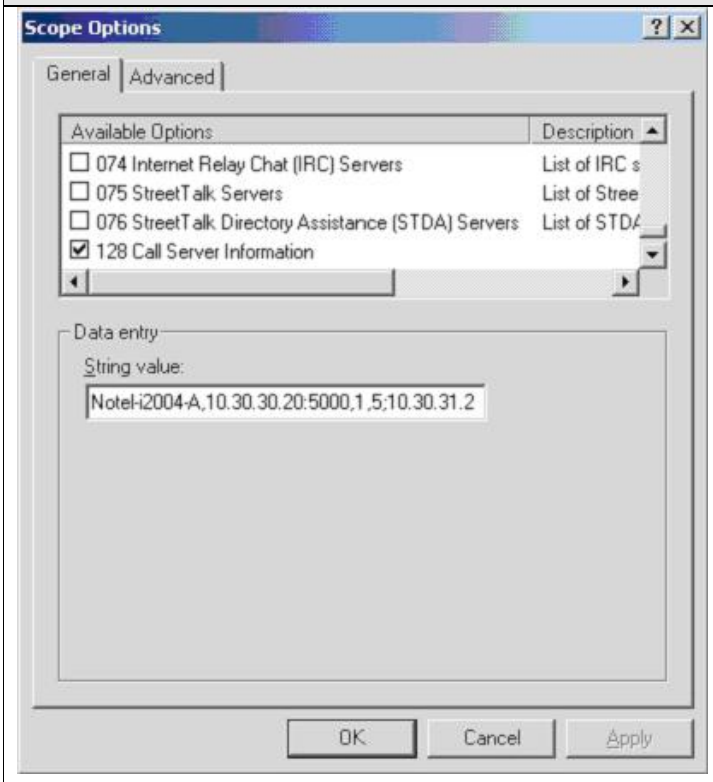


Windows 2003 Server Step 6 – Add a new DHCP Scope by right-clicking your DHCP server name and selecting *New Scope*

Add the appropriate IP address scope, default router, and other various DHCP options for the data VLAN. Once you complete this step, you can then add the required DHCP options for the Nortel IP Phone sets.



Windows 2003 Server Step 7 – Right-click *Scope Option* from the newly create DHCP scope then select Configure Options. Scroll down to the two DHCP Option you just created and check off the box to enable the 128 Option.



Enter the string as shown above. These values will be different depending on your environment. The DHCP Option #128 pertains to the Call Server information that the IP Phone set requires in order to connect to the Call Server.

The format of the String for Option #128 is as shown below. Note that the string always begins with 'Nortel-i2004-A' where 'A' refers to the revision of the Nortel DHCP/VLAN specification.

Nortel-i2004-A,iii.iii.iii.iii:ppppp,aaa,rrr;iii.iii.iii.iii:ppppp,aaa,rrr.

Where
"Nortel-i2004-A" = Option #128 begins with this string for all Nortel IP

phone sets

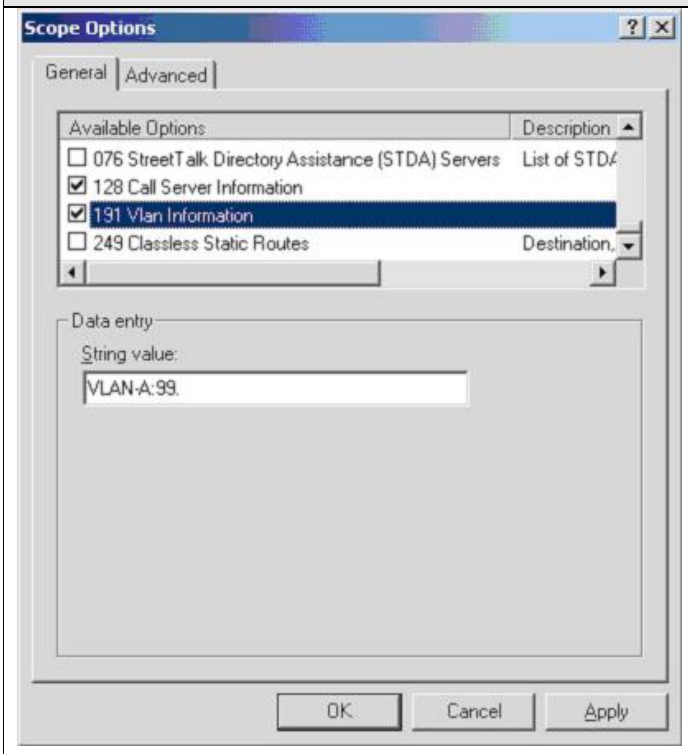
"iii.iii.iii.iii" = the IP Address of the Call Server (S1 or S2)
"ppppp" = port number for the Call Server
"aaa" = the Action for the Server
"rrr" = the Retry Count for the Server

The IP Address must be separated from the port number by a colon (:). The parameters for the Primary (S1) and the Secondary (S2) Call Servers are separated by a semicolon (;). The string must end a period (.).

For this example, enter the following:

Nortel-i2004-A,10.30.30.20:5000,1,5: 10.30.31.20:5000,1,5.

Windows 2003 Server Step 8 – Right-click *Scope Option* from the newly create DHCP scope then select Configure Options. Scroll down to the two DHCP Option you just created and check off the box to enable the 191 Option



The Site Specific Option #191 pertains to the VLAN ID information that the IP Phone set will require for the voice VLAN. The format for the String pertaining to Option 128 is shown above. Note that the string always begins with 'VLAN-A' where 'A' refers to the revision of the Nortel DHCP/VLAN specification

VLAN-A:vvvv.

Where: "VLAN-A" = Option #191 begins with this string for all Nortel IP Phone sets
"vvvv" = The VLAN ID in Decimal

For this example, enter the following:

- **VLAN-A:99.**

There must be a colon (:) separating the Hardware Revision from the VLAN ID. The string must also end in a period (.)

6.1.4.2 Expanded DHCP Options

Expanded DHCP Options allows additional parameters to be passed to the IP set via the DHCP server, over and above what is possible with the Default DHCP Options.

In the case of Expanded DHCP Options the DHCP private options 128, 131, 144, 157, 188, 191, 205, 219, 223, 224, 227, 230, 232, 235, 238, 241, 244, 247, 251 or 254 can be used – so there is wider choice than in the case of Default DHCP Options. Another change with Expanded DHCP Options is that multiple options can be used to pass information – this is necessary as the theoretical maximum size otherwise exceeds what is allowed for any one DHCP option.

Even where Expanded DHCP Options are used for the 1100 or 1200 series, the Default DHCP Options may still be configured – to support existing 2000 series IP sets for example. In such a case, for an 1100 series (C4I or greater) or 1200 series set the Expanded DHCP Options will take precedence over the Default DHCP Options.

In the case of Expanded DHCP Options and multiple options being used, if information is repeated in a later option then it will take precedence over what came in an earlier option.

The priority rules are:

- "Nortel-i2004-B" option's priority is higher than the "Nortel-i2004-A" option's.
- Vendor specific DHCP options' priorities are higher than the site specific DHCP options'.
- The option with lower DHCP option number has higher priority than the option with higher DHCP option number.
- In the same DHCP option, the rear sub-string has higher priority than the front sub-string.

Setup of the DHCP server is very similar to what is done for the Default DHCP Options. The Predefined Options still need to be defined initially and then enabled for the scope, using the choice of private options as noted above.

The main change comes in defining the string for the Call Server information in the case of Expanded DHCP Options, as the format is different. The Default DHCP Options uses the string Nortel-i2004-A at the start of the DHCP option string; the Expanded DHCP Options uses the string Nortel-i2004-B instead. The screenshot below shows the DHCP server with two private options (#224 and #227) configured for the Expanded DHCP Options, in addition to the private earlier option (#128) for the Default DHCP Options.

Scope Options

Option Name	Vendor	Value
003 Router	Standard	47.166.93.1
066 Boot Server Host Name	Standard	47.166.93.200
128 Call Server Information	Standard	Nortel-i2004-A,47.166.93.10:4100,1,5;47.166.93.10:4100,1,5.
224 Nortel-i2004-B	Standard	Nortel-i2004-B,s1ip=47.166.93.10;p1=4100;a1=1;r1=10;;lldp=y;pc=n;srtp=y;
227 Nortel-i2004-B	Standard	Nortel-i2004-B,cachedip=y;igarp=y;
006 DNS Servers	Standard	47.166.93.200
044 WINS/NBNS Servers	Standard	47.166.93.200

The format of the Expanded DHCP option is obviously different to the earlier mode of operation; it is easier to understand as it consists of a series of "parameter=value" combinations, each followed by a semi colon.

Note that the string always begins with 'Nortel-i2004-B' where 'B' refers to the revision of the Nortel DHCP/VLAN specification.

Nortel-i2004-B,param=value;param=value;param=value; …

Where

"Nortel-i2004-B" = the selected private option(s) for Expanded DHCP Options begins with this string for 1100 series (C4I upwards) or 1200 series IP sets

"param" = a defined string representing one of the values that can be set via Expanded DHCP Options

"value" = a valid value for the corresponding parameter

All parameters are separated by a semicolon (;). The string must end a semi colon (;).

As noted earlier, there can be multiple Nortel-i2004-B strings in order to pass the full range of parameters possible, which in theory could exceed (at 310 bytes) the maximum length allowed for any one DHCP option (255 bytes).

Following are the parameters that can be set via Expanded DHCP Options, and the valid set of values for each. Parameter names may be all capitals or all lowercase, similarly for any of the values containing characters.

Parameter	Values	Comments
S1IP	<IP address>	Primary Server IP Address
P1	<port>, e.g. 4100 for CS1000	Primary Server Port
A1	<action code>	Primary Server Action Code
R1	<retry count>	Primary Server Retry Count
S2IP	<IP address>	Secondary Server IP Address
P2	<port>, e.g. 4100 for CS1000	Secondary Server Port
A2	<action code>	Secondary Server Action Code
R2	<retry count>	Secondary Server Retry Count
XIP	<IP address>	XAS Server IP address
XP	<port>	XAS Server Port
XA	<action code>	XAS Server Action Code
UNID	Up to 32 characters accepted in a string	Unique Network ID
MENULOCK	• "F" for Full • "P" for Partial • "U" for Unlock	Menu Lock Mode
VQ	"Y" or "N"	Enable / disable 802.1Q for voice VLAN
VCP	Digit value between 0 and 7	802.1Q control p bit for voice VLAN
VMP	Digit value between 0 and 7	802.1Q media p bit for voice VLAN
VLANF	"Y" or "N"	Enable / disable VLAN filter
PC	"Y" or "N"	Enable / disable PC Port
PCS	• "A" for Autonegotiate • "10" for 10 Mbps	PC Port Speed

	• "100" for 100 Mbps	
PCD	• "A" for Autonegotiate • "F" for Full Duplex • "H" for Half Duplex	PC Port Duplex
DQ	"Y" or "N"	Enable / disable 802.1Q for PC Port or Data VLAN
DV	"Y" or "N"	Enable / disable VLAN for PC Port or Data VLAN
DVID	Digit value from 0 to 4095	VLAN ID for Data VLAN
DP	Digit value from 0 to 15	802.1Q p bit for PC Port or Data VLAN
PCUNTAG	"Y" or "N"	PC Port Untag All
LLDP	"Y" or "N"	Enable / disable 802.1ab (LLDP)
PK1	16 character string	S1 PK
PK2	16 character string	S2 PK
CACHEDIP	"Y" or "N"	Enable / disable cached IP
IGARP	"Y" or "N"	Ignore GARP
SRTP	"Y" or "N"	Enable / disable PSK SRTP
DIM	"Y" or "N"	Enable / disable dim function on 2007 IP set
BT	"Y" or "N"	Enable / disable Bluetooth

An example of the new Nortel-i2004-B Expanded DHCP Options is as follows.

Option 224

Nortel-i2004-B,s1=10.10.10.5;p1=4100;a1=1;r1=10;s2=10.10.10.10;p2=4100;a2=1;r2=10;menulock=p;pc=n;

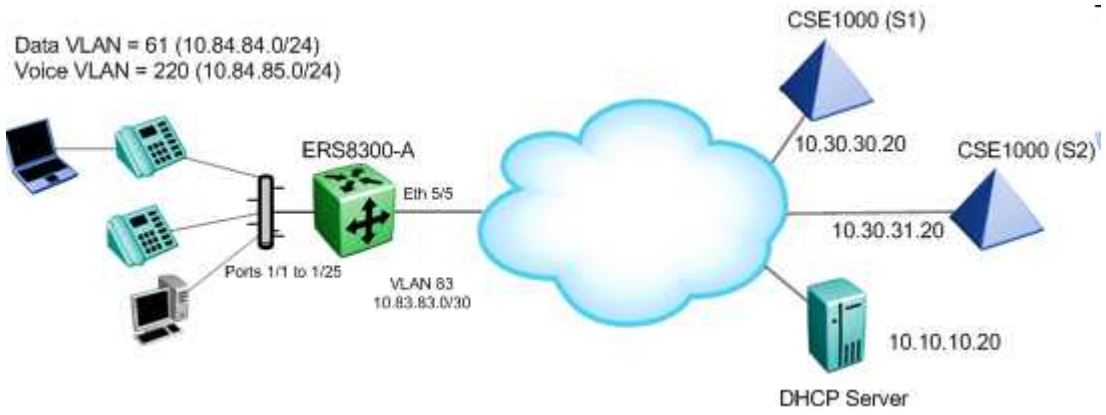
Option 227

Nortel-i2004-B,cachedip=n;igarp=y;srtp=n;

There is no change in the operation of the Voice VLAN Auto Discovery process as part of Extended DHCP Options. That continues to use the same "VLAN-A" option type as with Default DHCP Options.

6.2 Configuration Example: Auto Configuration Using Ethernet Routing Switch 8300

The following configuration example covers setting up a network to support both voice and data to support Auto-Configuration on Nortel's IP Phone sets. We will cover how to setup the edge switch, in this example an Ethernet Routing Switch 8300, for L3 operations using RIP.



Overall, we will configure the following:

- Create Voice VLAN 220 with port members 1/1 to 1/25
- Create Data VLAN 61 with port members 1/1 to 1/25
- Create Trunk VLAN 83 with port member 5/5
- Enable DHCP relay for VLAN 220 and 61
- Enable Spanning Tree Fast-Start on ports 1/1 to 1/25 and disable STP on port 5/5
- Configure all voice ports, 1/1 to 1/25, with POE priority of high
- Enable RIP on all VLANs

For the QoS configuration, please go to section 4.4.6.

6.2.1 Via PPCLI

Please perform the following step for ERS8300A:

6.2.1.1 Enable VLAN tagging on access port members

ERS8300-A Step 1 – Enable VLAN tagging on ports 1/1 to 1/25

```
ERS8300-A:5# config ether 1/1-1/25 perform-tagging enable
```

6.2.1.2 Create Data VLAN 61

ERS8300-A Step 1 – Remove port members from the default VLAN 1 and create VLAN 61, add port members, enable RIP, and enable DHCP relay

```
ERS8310-A:5# config vlan 1 port remove 1/1-1/25
ERS8310-A:5# config vlan 61 create byport 1
ERS8310-A:5# config vlan 61 name Data
ERS8310-A:5# config vlan 61 ports add 1/1-1/25
```

```
ERS8310-A:5# config vlan 61 ip create 10.84.84.1/24
ERS8310-A:5# config vlan 61 ip dhcp-relay mode dhcp
ERS8310-A:5# config vlan 61 ip dhcp-relay enable
ERS8310-A:5# config vlan 61 ip rip enable
```

6.2.1.3 Enable Spanning Tree Faststart on access port

ERS8300-A Step 1 – Enable STP Faststart on ports 1/1 to 1/25 and disable STP on port 5/5

```
ERS8310-A:5# config ethernet 1/1-1/25 stg 1 faststart enable
ERS8310-A:5# config ethernet 5/5 stg 1 stp disable
```

6.2.1.4 Create Voice VLAN 220

ERS8300-A Step 1 – Create VLAN 220, add port members, enable RIP, and enable DHCP relay

```
ERS8310-A:5# config vlan 220 create byport 1
ERS8310-A:5# config vlan 220 ports add 1/1-1/25
ERS8310-A:5# config vlan 220 name Voice
ERS8310-A:5# config vlan 220 ip create 10.84.85.1/24
ERS8310-A:5# config vlan 220 ip dhcp-relay mode dhcp
ERS8310-A:5# config vlan 220 ip dhcp-relay enable
ERS8310-A:5# config vlan 220 ip rip enable
```

6.2.1.5 Create Core VLAN 83

ERS8300-A Step 1 – Create VLAN 83, add port member, and enable RIP

```
ERS8310-A:5# config vlan 1 port remove 5/5
ERS8310-A:5# config vlan 83 create byport 1
ERS8310-A:5# config vlan 83 name Trunk
ERS8310-A:5# config vlan 83 ports add 5/5
ERS8310-A:5# config vlan 83 ip create 10.83.83.2/30
ERS8310-A:5# config vlan 83 ip rip enable
```

6.2.1.6 Configure access port membes to untag the default VLAN

ERS8300-A Step 1 – Configure port 1/1 to 1/25 for untag default VLAN and set the default VLAN to 61

```
ERS8310-A:5# config ethernet 1/1-1/25 untag-port-default-vlan enable
ERS8310-A:5# config ethernet 1/1-1/25 default-vlan-id 61
```

6.2.1.7 Enable RIP Globally

ERS8300-A Step 1 – Enable RIP

```
ERS8310-A:5# config ip rip enable
```

6.2.1.8 Enable DHCP relay agenets

ERS8300-A Step 1 – Enable relay agent for both data VLAN 61 and voice VLAN 220

```
ERS8310-A:5# config ip dhcp-relay create-fwd-path agent 10.84.84.1
server 10.10.10.20 mode dhcp state enable
ERS8310-A:5# config ip dhcp-relay create-fwd-path agent 10.84.85.1
server 10.10.10.20 mode dhcp state enable
```

6.2.1.9 Configure access port member PoE setting to high

ERS8300-A Step 1 – Enable relay agent for both data VLAN 61 and voice VLAN 220

```
ERS8310-A:5# config poe port 1/1-1/25 power-priority high
ERS8310-A:5# config poe port 1/1-1/25 type telephone
```

By default, the power priority level is set to low. It is recommended to change this value to either high or critical depending on which ports you wish to come up first after a switch power cycle. Also, by default, the power limit is set to 16W per port. You can change this value from 3 to 16 watts using the command config poe port <slot/port> power-limit [3..16].

6.2.2 Via NNCLI

Please perform the following step for ERS5520A:

6.2.2.1 Go to configuration mode.

ERS8300-A Step 1 - Enter configuration mode

```
ERS8310-A:5>enable
Password: nortel (nortel is the default password)
ERS8310-A:5#configure terminal
```

6.2.2.2 Enable VLAN tagging on access port members

ERS8300-A Step 1 – Enable VLAN tagging on ports 1/1 to 1/25

```
ERS8310-A:5(config)#interface fastEthernet 1/1-1/25
ERS8310-A:5(config-if)#encapsulation dot1q
ERS8310-A:5(config-if)#exit
```

6.2.2.3 Create Data VLAN 61

ERS8300-A Step 1 – Remove port members from the default VLAN 1 and create VLAN 61, add port members, enable RIP, and enable DHCP relay

```
ERS8310-A:5(config)#vlan members remove 1 1/1-1/25
ERS8310-A:5(config)#vlan create 61 type name Data port 1
ERS8310-A:5(config)#vlan members add 61 1/1-1/25
ERS8310-A:5(config)#interface vlan 61
ERS8310-A:5(config-if)#ip address 10.84.84.1 255.255.255.0
ERS8310-A:5(config-if)#ip dhcp-relay mode dhcp
ERS8310-A:5(config-if)#ip dhcp-relay
ERS8310-A:5(config-if)#no ip rip supply enable
ERS8310-A:5(config-if)#no ip rip listen enable
ERS8310-A:5(config-if)#exit
```

6.2.2.4 Enable Spanning Tree Faststart on access port

ERS8300-A Step 1 – Enable STP Faststart on ports 1/1 to 1/25 and disable STP on port 5/5

```
ERS8310-A:5(config)#interface fastEthernet 1/1-1/25
ERS8310-A:5(config-if)#spanning-tree stp 1 faststart
ERS8310-A:5(config-if)#exit
ERS8310-A:5(config)#interface gigabitEthernet 5/5
ERS8310-A:5(config-if)#no spanning-tree stp 1
ERS8310-A:5(config-if)#exit
```

6.2.2.5 Create Voice VLAN 220

ERS8300-A Step 1 – Create VLAN 220, add port members, enable RIP, and enable DHCP relay

```
ERS8310-A:5(config)# vlan create 220 name Voice type port 1
ERS8310-A:5(config)#vlan members add 220 1/1-1/25
ERS8310-A:5(config)#interface vlan 220
ERS8310-A:5(config-if)#ip address 10.84.85.1 255.255.255.0
ERS8310-A:5(config-if)#ip dhcp-relay mode dhcp
ERS8310-A:5(config-if)#ip dhcp-relay
ERS8310-A:5(config-if)#no ip rip supply enable
ERS8310-A:5(config-if)#no ip rip listen enable
ERS8310-A:5(config-if)#exit
```

6.2.2.6 Create Core VLAN 83

ERS8300-A Step 1 – Create VLAN 83, add port member, and enable RIP

```
ERS8310-A:5(config)#vlan members remove 1 1/1-1/25
ERS8310-A:5(config)#vlan create 83 type name Trunk port 1
ERS8310-A:5(config)#vlan members add 83 5/5
```

```
ERS8310-A:5(config)#interface vlan 83
ERS8310-A:5(config-if)#ip address 10.83.83.2 255.255.255.252
ERS8310-A:5(config-if)#exit
```

6.2.2.7 Configure access port membes to untag the default VLAN

ERS8300-A Step 1 – Configure port 1/1 to 1/25 for untag default VLAN and set the default VLAN to 61

```
ERS8310-A:5(config)#vlan ports 1/1-1/25 tagging untagpvidonly
ERS8310-A:5(config)#interface fastEthernet 1/1-1/25
ERS8310-A:5(config-if)#default-vlan-id 61
ERS8310-A:5(config-if)#exit
```

6.2.2.8 Enable RIP globally and on each interface

ERS8300-A Step 1 – Enable RIP globally and add RIP interfaces

```
ERS8310-A:5(config)#ip routing
ERS8310-A:5(config)#router rip enable
ERS8310-A:5(config)#router rip
ERS8310-A:5(config-router)#networks 10.84.84.1
ERS8310-A:5(config-router)#networks 10.84.85.1
ERS8310-A:5(config-router)#networks 10.83.83.1
ERS8310-A:5(config-router)#exit
```

6.2.2.9 Enable DHCP relay agenets

ERS8300-A Step 1 – Enable relay agent for both data VLAN 61 and voice VLAN 220

```
ERS8310-A:5(config)#ip dhcp-relay fwd-path 10.84.84.1 10.10.10.20 mode dhcp
state enable
ERS8310-A:5(config)#ip dhcp-relay fwd-path 10.84.85.1 10.10.10.20 mode dhcp
state enable
```

6.2.2.10 Configure access port member PoE setting to high

ERS8300-A Step 1 – Enable relay agent for both data VLAN 61 and voice VLAN 220

```
ERS8310-A:5(config)#interface fastEthernet 1/1-1/25
ERS8310-A:5(config-if)#poe priority high
ERS8310-A:5(config-if)#exit
```

By default, the power priority level is set to low. It is recommended to change this value to either high or critical depending on which ports you wish to come up first after a switch power cycle. Also, by default, the power limit is set to 16W per port. You can

change this value from 3 to 16 watts using the command poe limit <3-16> under the interface level.

6.2.3 Verify Operations

6.2.3.1 Using PPCLI

Step 1 – Verify operations by using the following commands:

```
ERS8310-A:5# show ip interface
ERS8310-A:5# show ip route info
ERS8310-A:5# show vlan info basic
ERS8310-A:5# show vlan info port
ERS8310-A:5# show port info vlans
ERS8310-A:5# show port info interface
ERS8310-A:5# show ip dhcp-relay fwd-path
ERS8310-A:5# show ip rip info
ERS8310-A:5# show ip rip interface
ERS8310-A:5# show poe port <info|power-measurement|stats> <port #>
ERS8310-A:5# show poe card info
ERS8310-A:5# show poe sys info
```

6.2.3.2 Using NNCLI

Step 1 – Verify operations by using the following commands:

```
ERS8310-A:5# show ip interface
ERS8310-A:5# show ip route
ERS8310-A:5# show vlan basic
ERS8310-A:5# show vlan members
ERS8310-A:5# show vlan
ERS8310-A:5# show ip dhcp-relay fwd-path
ERS8310-A:5# show ip dhcp-relay interface
ERS8310-A:5# show ip rip
ERS8310-A:5# show ip rip interface
ERS8310-A:5# show poe main-status
ERS8310-A:5# show poe port-status
ERS8310-A:5# show poe power-measurement
ERS8310-A:5# show poe sys-status
```

7. IP Phone Set Detection

IP Phone detection can be accomblished using 802.1ab, ADAC (Auto Dectection Auto Configuration) or a combination of 802.1ab and ADAC. WIth 802.1ab, you must configure QoS whereas with ADAC, QoS is automatically applied.

7.1 802.1AB Support on Nortel Products

Table 26: LLDP Support on Nortel Switches

Switch	802.1AB core (mandatory TLVs)	ORGANIZATIONAL TLVs (802.1 and 802.3)	LLDP-MED TLVs	Proprietary and/or any other TLVs
Nortel ES 325/425	v3.6	-	-	None
Nortel ES 470	v3.7	-	-	None
Nortel ERS 25xx	V4.1	-	-	None
Nortel ERS 45xx	V 5.1	V 5.1	-	None
Nortel ERS 55xx	v 5.0[1]	v 5.0[12]	v 5.0[1]	None
Nortel ERS 8300	v 2.3.1	v 3.0[1,3]	(future)	None

[1] Supported on a port configured with both a untagged data VLAN and tagged voice VLAN
[2] The ERS55xx can send two LLDP VLAN Name packets, one for a Data VLAN and another for a Voice VLAN. To do so, you must name the Data VLAN as “data” and the Voice VLAN as “voice”. The VLAN name is not case-sensitive. The LLDP VLAN Name packet will contain the VLAN name and VLAN ID.

[3] The ERS8300 only sends one LLDP VLAN Name packet. If a Voice VLAN is either not configured or not named “voice”, the ERS8300 will send one LLDP VLAN Name packet providing you name a VLAN as “data”. The LLDP VLAN Name packet will contain the name “data” and the VLAN ID. Otherwise, if you name a VLAN as “voice”, the ERS8300 will only send one LLDP VLAN Name packet which will contain the name “voice” and the VLAN ID.

7.2 ADAC Support on Nortel Products

Table 27: ADAC Support on Nortel Switches

Model	Software Release	ADAC					
		Detection		LLDP-MED	Voice VLAN Tagging		
		MAC	LLDP		Untag only	Tag only	Untag default VLAN and tag Voice VLAN
ES470	3.6	√			√	√	
	3.7	√			√	√	√
ERS2500	4.1	√[1]	√[2]		√	√	√
ERS4500	5.1	√[1]	√[2]		√	√	√
ERS5500	5.0	√[1]			√	√	√
	5.1	√[1]	√	√	√	√	√

[1]Requires filter unregistered frames to be disabled
[2]LLDP is only used to detect an IP Phone set and cannot provision the voice VLAN

The ERS4500 and ERS2500 only use ADAC LLDP for detection of an IP Phone. The Voice VLAN must either be configured manually on the IP Phone or provisioned using auto-VLAN configuration via DHCP. With the ERS5500, you can also enable LLDP-MED to provision the Voice VLAN by supplying the IP Phone with the Voice VLAN id.

7.3 802.1AB

Overview

IEEE 802.1AB LLDP is a Layer 2 neighbor discovery protocol. It defines a standard method for Ethernet network devices such as switches, routers and IP Phones to advertise information about themselves to other nodes on the network and store the information they discover.

LLDP was formally ratified as IEEE standard 802.1AB-2005 in May 2005.

LLDP defines

- a set of common advertisement messages,
- a protocol for transmitting the advertisements and
- a method for storing the information contained in received advertisements.

The LLDP lets network management systems accurately discover and model physical network topologies. As LLDP devices transmit and receive advertisements, the devices will store information they discover about their neighbours. Details such as device configuration, device capabilities and device identification can be advertised using this protocol.

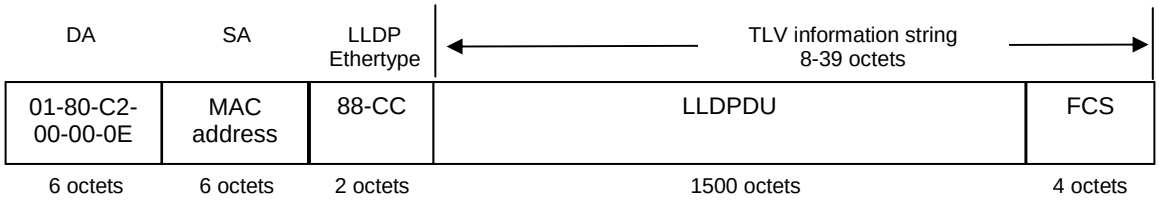
LLDP can be used as a useful management tool – particularly for heterogeneous networks – by providing accurate network mapping, inventory data and network troubleshooting information. LLDP enables Ethernet network devices to inform each other about their configurations. A mis-configuration can be easily detected and with suitable configuration management can be rectified.

Presently today, IP Phones do not have any SNMP or SONMP agent. Providing LLDP support in the phone, allows the phones to exchange information between the phone and the L2/L3 data switch to which it is attached. This allows the phone and the switch to exchange capabilities and for a network administrator to have a more complete view of the network infrastructure. LLDP exchange between the IP Phone and the data switch allows for the following:

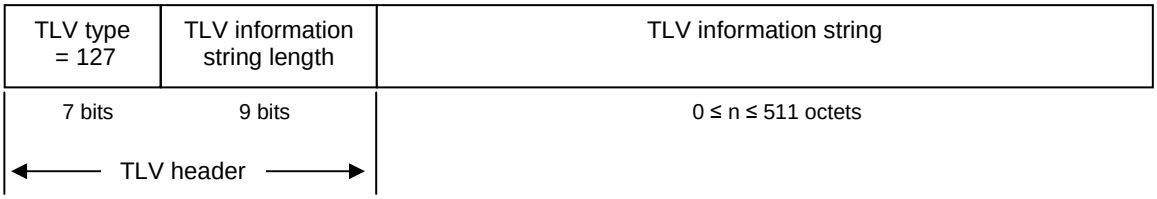
- VLAN assignment
- QoS assignment
- Duplex mismatch errors
- Topology Recognition
- Inventory Management
- Basis for e911 location services – Nortel working group
- Proprietary TLV – 802.1AB is flexible enough to define additional TLVs

Protocol Behaviour

Figure 8: IEEE 802.3 LLDP frame format



LLDPDU



LLDPPDUs are transmitted with a multicast destination address specially identified for LLDPDU. The LLDP-Multicast address is 01-80-C2-00-00-0E. An LLDPDU is identified based on the Ethertype (Hexadecimal 88-CC) value carried in the MAC header. The neighbouring devices do not acknowledge LLDP information received from a device.

LLDP information is transmitted periodically and stored for a finite period. IEEE has defined a recommended transmission rate of 30 seconds, but the transmission rate is adjustable. LLDP devices, after receiving an LLDP message from a neighbouring network device, will store the LLDP information in an Management Information Base (MIB). LLDP information is stored in the MIB and is valid for a period of time defined by the LLDP Time to Live (TTL).

An LLDP agent can operate in any of the following three modes:

1. Transmit-only mode: The agent can only transmit the information about the capabilities and the current status of the local system.
2. Receive-only mode: The agent can only receive information about the capabilities and the current status of the remote systems.
3. Transmit and receive mode: The agent can transmit the local system capabilities and status information and receive remote system's capabilities and status information.

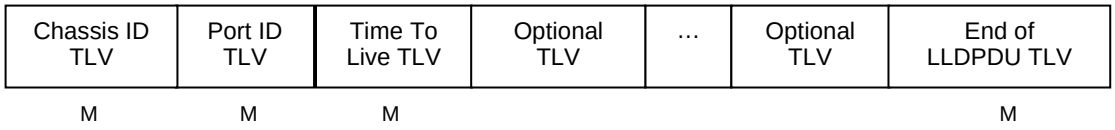
The TIA extensions require a device claiming conformity with this protocol to implement both transmit and receive mode.

Table 28: TLV Type Values

TLV Type	TLV Sub Type	TLV Name	Usage in LLPDU
0		End of LLDPDU	Mandatory
1		Chassis ID	Mandatory
2		Port ID	Mandatory
3		Time to Live	Mandatory
4		Port Description	Mandatory
5		System Name	Optional
6		System Description	Optional
7		System Capabilities	Optional
8		Management Address	Optional
9-126		Reserved for future utilization	NA
127		Organizational specific TLVx	Optional

Mandatory TLVs

Figure 9: LLDPDU Frame Format



The following mandatory TLVs shall be included at the beginning of each LLDPDU and shall be in the following order

1. Chassis ID TLV - Identifies the 802 LAN device's chassis,
2. Port ID TLV - Identifies the port from which the LLDPDU is transmitted,
3. Time-to-Live TLV - Indicates how long the received data is valid,
4. End-of-LLDPDU TLV - Indicates the end of TLVs in the LLDPDU and shall be the last TLV in the LLDPDU

Optional TLVs as selected by network management may be inserted in any order.

Optional TLVs

The optional TLVs provide various details about the LLDP agent advertising them. The LLDP agent can advertise one or more of these TLVs in addition to the mandatory TLVs. The optional TLVs defined as part of LLDP are grouped into two sets: Basic Management and Organizationally Specific extensions. Currently the latter set includes three subsets: IEEE 802.1 extensions, IEEE 802.3 extensions, and TIA Media Endpoint Discovery extensions.

Basic Management TLVs

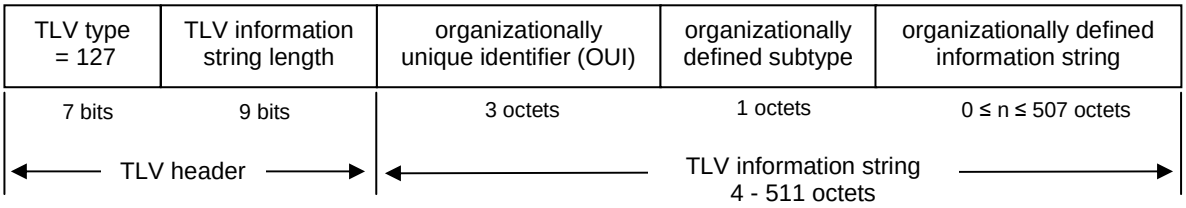
This set includes the following five TLVs:

1. **Port description TLV**:
   Provides a description of the port in an alpha-numeric format.
2. **System name TLV**:
   Provides the system's assigned name in an alpha-numeric format.
3. **System description TLV**:
   Provides a description of the network entity in an alpha-numeric format.
4. **System capabilities TLV**:
   Indicates the primary function(s) of the device such as Repeater, Bridge, WLAN AP, Router, or Telephone.

5. **Management address TLV**:
   Indicates the addresses of the local LLDP agent. Other remote managers can use this address to obtain information related to the local device.

IEEE Organization Specific TLV

Figure 10: Organizationally Specific TLV Format



This TLV category is provided to allow different organizations, such as IEEE 802.1, IEEE 802.3, IETF, as well as individual software and equipment vendors, to define TLVs that advertise information to remote entities attached to the same media.

Table 29: Organizational TLV

	OUI	TLV SubType	TLV Name	Usage in LLDPDU
802.1	00-80-C2	1	Port VLAN ID	Mandatory
	00-80-C2	2	Port & Protocol VLAN ID	Mandatory
	00-80-C2	3	VLAN Name	Mandatory
	00-80-C2	4	Protocol Identity	Mandatory
	00-80-C2	0, 5-255	Reserved	-
802.3	00-12-0F	1	MAC/PHY configuration/status	Mandatory
	00-12-0F	2	Power via MDI	Mandatory
	00-12-0F	3	Link Aggregation	Mandatory
	00-12-0F	4	Maximum Frame Size	Mandatory
	00-12-0F	0, 5-255	Reserved	-

IEEE 802.1 Organizational Specific TLV Set

This group includes the following four TLVs:

1. **Port VLANID TLV**:
   The PVID that will be associated with an untagged or priority tagged data frame received on the VLAN port.
2. **PPVLAN ID TLV**:
   The PPVID that will be associated with an untagged or priority tagged data frame received on the VLAN port.
3. **VLAN name TLV**:
   The assigned name of any VLAN at the device. The number of VLAN name TLVs in an LLDPDU corresponds to the number of VLANs enabled at the port.
4. **Protocol identity TLV**:
   The set of protocols that are accessible at the device's port.

IEEE 802.3 Organizational Specific TLV Set

This set includes the following four TLVs:

1. **MAC/PHY configuration/status TLV**:
   Duplex and bit rate capability and the current duplex and bit rate settings of the sending device. It also indicates whether the current settings are due to auto-negotiation or due to manual configuration.
2. **Power via media dependent interface (MDI) TLV**:
   The power support capabilities of the LAN device.
3. **Link aggregation TLV**:
   Indicates whether the link (associated with the port on which the LLDPDU is transmitted) can be aggregated
4. **Maximum frame size TLV**: The maximum frame size capability of the devices MAC and PHY implementation.

TIA LLDP-MED Extensions

Figure 11: LLDP-MED TLV Format

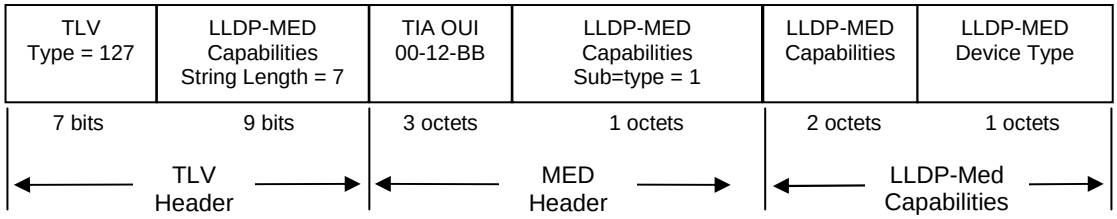


Table 30: LLDP MED TLV

OUI	TLV SubType	TLV Name	NCD	ED I	ED II	ED III
00-12-BB	1	LLDP-MED Capabilities	M	M	M	M
	2	Network Policy	C	O	M	M
	3	Location Identification	C			O
	4	Extended Powe-via-MDI	C	C	C	C
	5	Inventory – Hardware Revision	Optional TLV Set Recommended when device does not support SNMP			
	6	Inventory – Firmware Revision				
	7	Inventory – Software Revision				
	8	Inventory – Serial Number				
	9	Inventory – Manufacturer Name				
	10	Inventory – Model Name				
	11	Inventory – Asset ID				
	12-255	Reserved				

The Telecommunications Industry Association (TIA) has developed an extension to LLDP for VoIP networks. VoIP-related extensions to LLDP, known as LLDP - Media Endpoint Discovery (LLDP-MED) enables media devices to transmit and receive media related information.

In addition to expanding the LLDP TLVs, LLDP-MED requires certain optional LLDP TLVs to be transmitted as mandatory information by media endpoints. Currently the TIA has defined the following TLVs:

1. **Capabilities Discovery TLV**:
   Indicates which MED capabilities are supported,
2. **Network Policy Discovery TLV**:
   Advertises the VLAN configuration and QoS attributes,
3. **Location Identification Discovery TLV**:
   Advertises location information,
4. **Extended Power-via MDI Discovery TLV**:
   Advertises power requirements,
5. **Inventory Management Discovery TLVs**:
   Provide HW/firmware/SW revision, serial number, manufacturer/model name, and asset ID.

Nortel IP Phones

Support for media encryption and IEEE 802.1AB Link Layer Discovery Protocol (LLPD) support on the Nortel IP Phones are available via a firmware upgrade. Media encryption and LLDP support are delivered in firmware version 0604DAD for the Phase II IP Phone 2001, Phase II IP Phone 2002, and Phase II IP Phone 2004. These new features are delivered in firmware version 0621C3A for the IP Phone 2007. In addition, these new features are delivered in firmware version 0624C23 and 0625C23 for the IP Phone 1120E and 1140E respectively.

Table 31: LLDP Support on Nortel IP Phones

Model	Support	Stream
IP Phone 1110	Yes	
IP Phone 1120E	Yes	
IP Phone 1140E	Yes	
IP Phone 1150E	Yes	
IP Phone 2001	Yes	DAx
IP Phone 1210	Yes	
IP Phone 1220	Yes	
IP Phone 1230	Yes	
IP Phone 2002 Phase 1	No	
IP Phone 2002 Phase 2	Yes	DAx
IP Phone 2004 Phase 0	No	
IP Phone 2004 Phase 1	No	
IP Phone 2004 Phase 2	Yes	DAx
IP Phone 2007	Yes	
IP Audioconference Phone 2033	No	
IP Softphone 2050	No	
IP Softphone 2050v2	No	
IP Mobile Voice Client 2050	No	
WLAN Handset 2210	No	
WLAN Handset 2211	No	
WLAN Handset 2212	No	
WLAN Handset 6120	No	
WLAN Handset 6140	No	

7.3.1 LLDP Configuration on Nortel IP Phone Sets and Switches

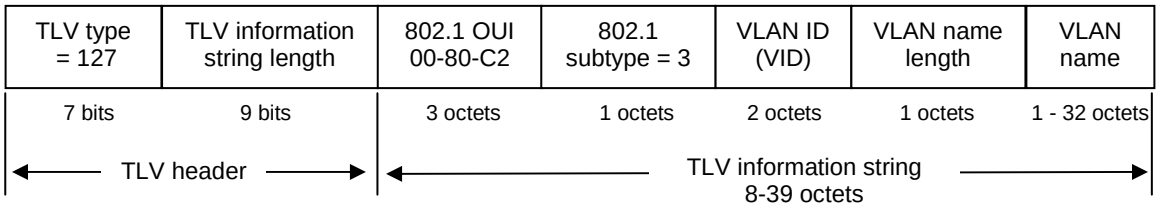
LLDP, if available, is enabled by default on certain Nortel IP Phone sets as shown in table 29.

The IP Phone sets can be set up for ether LLDP Vlan Name or LLDP-MED Network Policy but not both.

With LLDP enabled, the boot time of the IP Phone will be slightly increased. With LLDP enabled, the message “Waiting for Cfg Data …” will appear on the screen during boot time as the phone tries to exchange LLDP information with the network infrastructure. If the network device to which the phone is attached does not support LLDP, the LLDP exchanges from the phone will eventually time-out and the message “No LLDPDUs Received” will briefly appear, and then the boot sequence will continue. If LLDP is not used, it is advised to disable LLDP to reduce the boot time.

7.3.2 LLDP VLAN Name

Figure 12: Organizational TLV SubType 3 TLV Frame Format



7.3.2.1 LLDP VLAN Name – Nortel IP Phone Configuration

When the switch and IP Phone is configured to support VLAN Name, the voice VLAN on the IP Phone is configured based on the LLDP VLAN name TLVs received from the switch. In this mode, both the Voice and Data VLANs can be configured on the IP Phone via LLDP VLAN Name TLVs.

The IP Phone settings must still either be configured statically or dynamically using DHCP in regards to IP address and S1 and S2 settings.

The Nortel IP phone set requires that the switch name the voice VLAN as “voice” and the data VLAN as “data”. The name is not case sensitive.

Nortel IP Phone Step 1 – To enable LLDP VLAN Name on Nortel IP Phone sets, the following items must be enabled

```
LLDP Enable? [1=Y, 0=N]: 1
LLCP MED? 0-No, 1-Yes: 0
LLDP VLAN? 0-No, 1-Yes: 1
```

7.3.2.2 LLDP VLAN configuration on the ERS55xx

7.3.2.2.1 LLDP Interface level configuration

ERS5520-PWR Step 1 – To enable LLDP on an ERS55xx switch, please enter the following commands assuming that ports 3 to 11 are used for both voice and data using data VLAN 262 and voice VLAN 280

```
ERS5520(config)#interface fastEthernet 3-11
ERS5520(config-if)#lldp tx-tlv local-mgmt-addr local-mgmt-addr port-desc sys-cap sys-desc sys-name
ERS5520(config-if)#lldp status txAndRx config-notification
ERS5520(config-if)#lldp tx-tlv dot1 vlan-name
```

By default, the Nortel IP Phone set only uses the LLDP VLAN dot1 tx-tlv VLAN Name where the LLDP VLAN Name packet contains the VLAN name and VLAN ID. The Nortel IP Phone set requires the Voice VLAN to be named “voice” and the data VLAN to be

named “data”. The name is not case-sensitive. To set the LLDP tx-tlv dot1 VLAN name, the ERS5520 by default will send the VLAN name assigned to the actual VLAN. Hence, we rename both VLAN’s.

```
ERS5520(config)#vlan name 262 data
ERS5520(config)#vlan name 280 voice
```

7.3.2.3 Verifying Operations

The following commands are used to verify the organizational TLV for both the local (switch) and remote (IP Phone 2004) devices assuming we have an IP Phone 2004 phone set connected to port 4.

7.3.2.3.1 Verify local TLV

Step 1 – Verify the local (switch) TLV by using the following command:

```
ERS5520i#show lldp port 4 local-sys-data dot1 dot3
```

Result:

```
--------------------------------------------------------------------------------
                      lldp local-sys-data chassis
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
        ChassisId: MAC address        00:13:65:a3:b8:00
        SysName:   ERS5520i
        SysCap:    rB / rB            (Supported/Enabled)
        SysDescr:
Ethernet Routing Switch 5520-24T-PWR  HW:02       FW:5.0.0.2   SW:v5.0.0.011

        Dot1 protocols: STP,EAP,LLDP
--------------------------------------------------------------------------------
                      lldp local-sys-data port
--------------------------------------------------------------------------------
Port:  4
 PVID: 262   PPVID List: 262,280
             VLAN Name List: 262,280            ProtocolId List: ALL

 Dot3-MAC/PHY Auto-neg: supported/enabled       OperMAUtype:  100BaseTXFD
 PSE MDI power:         supported/enabled       Port class:   PSE
 PSE power pair:        signal/not controllable Power class:  0
 LinkAggr: not aggregatable/not aggregated      AggrPortID:   0
                                                MaxFrameSize: 9216
 PMD auto-neg:          10Base(T, TFD), 100Base(TX, TXFD), (FdxS)Pause,
                        1000Base(TFD)
--------------------------------------------------------------------------------
Sys capability: O-Other; R-Repeater; B-Bridge; W-WLAN accesspoint; r-Router;
T-Telephone; D-DOCSIS cable device; S-Station only.
```

Core TLV

802.1

802.3

7.3.2.3.2 Verify Remote TLV

Step 1 – Verify the remote (IP phone) TLV by using the following command:

```
ERS5520i(config)#show lldp port 4 neighbor dot1 dot3
```

Result:

```
-------------------------------------------------------------------------------
                            lldp neighbor
-------------------------------------------------------------------------------
Port: 4     Index: 157                Time: 4 days, 22:56:16
        ChassisId: Network address    ipV4  47.133.58.224
        PortId:    MAC address        00:0a:e4:09:72:e7
        SysCap:    TB / TB            (Supported/Enabled)
        PortDesc:  Nortel IP Phone
        SysDescr:  Nortel IP Telephone 2004, Firmware:C604DB1


 PVID: 0                              PPVID Supported: not supported(0)
 VLAN Name List: 280                  PPVID Enabled: none

 Dot3-MAC/PHY Auto-neg: supported/enabled       OperMAUtype:  100BaseTXFD
 PSE MDI power:         not supported/disabled  Port class:   PD
 PSE power pair:        signal/not controllable Power class:  1
 LinkAggr: not aggregatable/not aggregated      AggrPortID:   0
                                                MaxFrameSize: 1522
 PMD auto-neg:          (FdxS, FdxB)Pause, 1000Base(XFD, T)
-------------------------------------------------------------------------------
Sys capability: O-Other; R-Repeater; B-Bridge; W-WLAN accesspoint; r-Router;
T-Telephone; D-DOCSIS cable device; S-Station only.
```

Core TLC

802.1

802.3

7.3.2.4 LLDP VLAN configuration on the ERS8300

7.3.2.4.1 LLDP Interface level configuration

ERS8300 Step 1 – To enable LLDP on an ERS8300 switch, please enter the following commands assuming that ports 31 is used for both voice and data using data VLAN 61 and voice VLAN 220

```
ERS8300:5# config ethernet 1/33 default-vlan-id 61
ERS8300:5# config ethernet 1/33 lldp tx-tlv local-mgmt-addr-tx enable
ERS8300:5# config ethernet 1/33 lldp tx-tlv sys-name enable
ERS8300:5# config ethernet 1/33 lldp tx-tlv sys-desc enable
ERS8300:5# config ethernet 1/33 lldp tx-tlv sys-cap enable
ERS8300:5# config ethernet 1/33 lldp tx-tlv port-desc enable
ERS8300:5# config ethernet 1/33 lldp tx-tlv dot1 vlan-name enable
```

By default, the Nortel IP Phone set only uses the LLDP VLAN dot1 tx-tlv VLAN Name where the LLDP VLAN Name packet contains the VLAN name and VLAN ID. The Nortel IP Phone set requires the Voice VLAN to be named “voice” and the data VLAN to be named “data”. The name is not case-sensitive; however, on the ERS8300 you must either use the name “voice” or “VOICE”. Also, as noted in section 7.1.1, the ERS8300 only sends one LLDP VLAN Name packet. To set the LLDP tx-tlv dot1 VLAN name, the ERS8300 by default will send the VLAN name assigned to the actual VLAN. Hence, we rename both VLAN’s.

- ERS8300:5# ***config vlan 61 name data***
- ERS8300:5# ***config vlan 220 name voice***

7.3.2.5 Verifying Operations

The following commands are used to verify the organizational TLV for both the local (switch) and remote (IP Phone 2004) devices assuming we have an IP Phone 2004 phone set connected to port 4.

7.3.2.5.1 Verify neighbor TLV

Step 1 – Verify the local (switch) core TLV by using the following command:

```
ERS8300B:5# show lldp neighbor 1/33
```

Result:

```
================================================================================
                                    LLDP NEIGHBOR
================================================================================

PORT  INDEX CHASSIS  CHASSIS           PORT       PORT
NUM         SUBTYPE  ID                SUBTYPE    ID

PORT DESC                SYS NAME                  SYS DESC
--------------------------------------------------------------------------------

1/33  22    NetworkAddr  10.103.59.201 MAC        00:13:65:fe:f1:cb

Nortel IP Phone                                     Nortel IP Telephone 1120E, F
irmware:0624C22

================================================================================
                                    lldp Remote-sys-data Sys Capabilitities
================================================================================
Repeater Bridge   WLAN       Router   Telephone  DOCICS   Station  Other
                  Access Pt                      Cable    Only
                            (Supported/Enabled)

--------------------------------------------------------------------------------
No/No     Yes/Yes     No/No     No/No     Yes/Yes     No/No     No/No     No/No
```

Core TLV

Step 2 – Verify the neighor 802.1 TLV by using the following command:

```
ERS8300B:5# show lldp neighbor-dot1
```

Result:

```
        ================================================================================
                                          LLDP NEIGHBOR (Dot1)
        ================================================================================
        PORT  INDEX CHASSIS  CHASSIS           PORT       PORT
        NUM         SUBTYPE  ID                SUBTYPE    ID
        --------------------------------------------------------------------------------
        PVID  PPVID           PPVID           VlanName
              Supported List  Enabled List    List
        --------------------------------------------------------------------------------


        1/33  11    NetworkAddr  10.103.59.200 MAC        00:0a:e4:09:72:e7
        0     0               0               220
```

Step 3– Verify the neighor 802.3 TLV by using the following command:

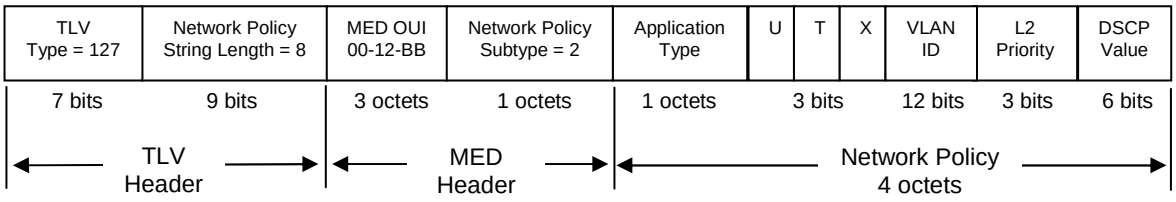
```
ERS8300B:5# show lldp neighbor-dot3
```

Result:

```
================================================================================

                                      LLDP NEIGHBOR (Dot3)
================================================================================
--------------------------------------------------------------------------------
PORT  INDEX CHASSIS  CHASSIS           PORT       PORT
NUM         SUBTYPE  ID                SUBTYPE    ID
--------------------------------------------------------------------------------

1/33  11    NetworkAddr  10.103.59.200 MAC        00:0a:e4:09:72:e7

Dot3-MAC/PHY Autoneg           : Supported/Enabled
OperMAUtype                    : 100BaseTXFD
PMD auto-neg                   : 1000-half
PSE MDI power                  :
Port Class                     :
PSE pair control               : Signal
Power Class                    : Class 1

Link Aggregation               : Supported
Link Aggregation Port ID       : 0
MaxFrameSize                   : 1522
```

7.3.3 LLDP-MED (Media Endpoint Devices) Network Policy

Figure 13: LLDP-MED Network Policy TLV SubType 2 Frame Format



7.3.3.1 LLDP-MED Nortel IP Phone Configuration

When the IP Phone is configured to support LLDP-MED, and the switch is configured to support the Network Policy TLV, the Voice VLAN, 802.1p, and DSCP values are configured based on the data received form the switch in the Network Policy TLV.

LLDP-MED is supported only for the voice VLAN and not the data VLAN.

The IP Phone must still either be configured statically or dynamically using DHCP in regards to IP address and S1 and S2 setting.

Nortel IP Phone Step 1 – To enable LLDP-MED on Nortel IP Phone sets, the following items must be enabled

```
LLDP Enable? [1=Y, 0=N]: 1
LLCP MED? 0-No, 1-Yes: 1
```

7.3.3.2 LLDP-MED configuration on the ERS55xx

In order to support LLDP-MED Network Policy TLV, ADAC must be used in addition to enabling at minimum LLDP-MED Capabilities TLV and LLDP-MED Network Policy TLV.

Assuming the ERS55xx is configured as a Layer 2 switch with a trunked uplink port 1 and access ports 3 to 11 for IP phones where we wish to tag the ADAC voice VLAN and untag the data VLAN, enter the following:

7.3.3.2.1 ERS5500 ADAC Configuration

Please note that by default, ADAC detection by MAC and LLDP is enabled. The configuration below allow only for ADAC detection by LLDP by disabling ADAC detection by MAC using interface command *no adac detection port <port list> mac*.

ERS5520-PWR Step 1 – Enable ADAC

```
(config)#adac voice-vlan 280
(config)#adac uplink-port 1
(config)#adac op-mode tagged-frames
(config)#adac enable
(config)#interface FastEthernet ALL
```

```
(config-if)#no adac detection port 3-11 mac
(config-if)#adac tagged-frames-tagging untag-pvid-only
(config-if)#adac port 3-11 enable
(config-if)#exit
```

7.3.3.2.2 LLDP-MED Configuration

. After ADAC has been configured, enable LLDP-MED by entering the following commands

ERS5520-PWR Step 1 – Enable ADAC and also set PoE priority level to high

```
(config)#interface fastEthernet 3-11
(config-if)#poe poe-priority high
(config-if)#lldp status txAndRx
(config-if)#lldp tx-tlv local-mgmt-addr port-desc sys-cap sys-desc sys-name
(config-if)#lldp tx-tlv med extendedPSE med-capabilities network-policy
(config-if)#exit
```

We will also add LLDP-MED extendedPSE so that we can compare PoE settings between the IP Phone set and the ERS55xx.

7.3.3.3 Verifying Operations

Assuming an IP Phone 2004 IP Phone set is connected to port 4.

7.3.3.3.1 Verify LLDP-MED

Step 1 – Verify LLDP-MED operation by using the following command:

```
ERS5520i# show lldp port 4 neighbor med
```

Result:

```
-------------------------------------------------------------------------------
                            lldp neighbor
-------------------------------------------------------------------------------
Port: 4     Index: 4                  Time: 0 days, 00:01:43
        ChassisId: Network address    ipV4  47.133.58.220
        PortId:    MAC address        00:0a:e4:09:72:e7
        SysCap:    TB / TB            (Supported/Enabled)
        PortDesc:  Nortel IP Phone
        SysDescr:  Nortel IP Telephone 2004, Firmware:C604DB1


 MED-Capabilities: CNSD / CNDI        (Supported/Current)
 MED-Device type:  Endpoint Class 3
 MED-Application Type: Voice                    VLAN ID: 280
 L2 Priority: 6         DSCP Value: 46          Tagged Vlan, Policy defined
 Med-Power Type: PD Device            Power Source: Unknown
 Power Priority: High                 Power Value:    5.4 Watt
-------------------------------------------------------------------------------
Sys capability: O-Other; R-Repeater; B-Bridge; W-WLAN accesspoint; r-Router;
T-Telephone; D-DOCSIS cable device; S-Station only.
Med Capabilities-C: N-Network Policy; L-Location Identification; I-Inventory;
S-Extended Power via MDI - PSE; D-Extended Power via MDI - PD.
```

Core TLC

MED

7.3.3.3.2 Verify ADAC Dection

Step 1 – Verify ADAC detection by using the following command assuming IP Phones are connected to ports 4 and 5:

```
ERS5520i#show adac interface 3-11
```

Result:

```
             Auto       Oper       Auto
Port  Type   Detection  State      Configuration  T-F PVID   T-F Tagging
----  ----   ---------  --------   -------------  ---------  ---------------
3     T      Enabled    Enabled    Not Applied    No Change  Untag PVID Only
4     T      Enabled    Enabled    Applied        No Change  Untag PVID Only
5     T      Enabled    Enabled    Applied        No Change  Untag PVID Only
6     T      Enabled    Enabled    Not Applied    No Change  Untag PVID Only
7     T      Enabled    Enabled    Not Applied    No Change  Untag PVID Only
8     T      Enabled    Enabled    Not Applied    No Change  Untag PVID Only
9     T      Enabled    Enabled    Not Applied    No Change  Untag PVID Only
10    T      Enabled    Enabled    Not Applied    No Change  Untag PVID Only
11    T      Enabled    Enabled    Not Applied    No Change  Untag PVID Only
```

Step 2 – Verify ADAC detection mechanism enabled by issing the following command:

```
ERS5520i#show adac detection interface 3-11
```

Result:

```
       MAC        LLDP
Port   Detection  Detection
----   ---------  ---------
3      Disabled   Enabled
4      Disabled   Enabled
5      Disabled   Enabled
6      Disabled   Enabled
7      Disabled   Enabled
8      Disabled   Enabled
9      Disabled   Enabled
10     Disabled   Enabled
11     Disabled   Enabled
```

7.3.3.4 LLDP-MED configuration on the ERS8300

In order to support LLDP-MED Network Policy TLV, ADAC must be enabled on an interface level in addition to enabling at minimum LLDP-MED Capabilities TLV and LLDP-MED Network Policy TLV.

Assuming the ERS8300 is configured as a Layer 2 switch with access ports 1/1 to 1/5 for IP phones, enter the following:

7.3.3.4.1 Enable ADAC at interface level

ERS8300-1 Step 1 – Enable ADAC on port members 1/1 to 1/5

PPCLI

```
ERS8300-2:5# config ethernet 1/1-1/5 adac enable
```

NNCLI

```
ERS8310-1:5(config)#interface fastEthernet 1/1-1/5
ERS8310-1:5(config-if)#adac port 3-11 enable
ERS8310-1:5(config-if)#exit
```

7.3.3.4.2 Enable LLDP-MED

ERS8300-1 Step 1 – Enable LLDP VLAN name on port 1/1 to 1/5

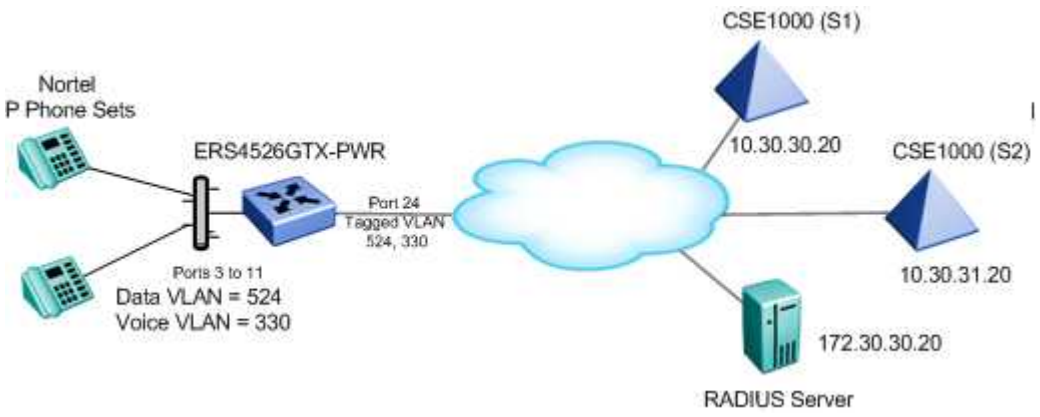
PPCLI

```
ERS8300-2:5# config ethernet 1/1-1/5 lldp tx-tlv local-mgmt-addr-tx enable
ERS8300-2:5# config ethernet 1/1-1/5 lldp tx-tlv sys-name enable
ERS8300-2:5# config ethernet 1/1-1/5 lldp tx-tlv sys-desc enable
ERS8300-2:5# config ethernet 1/1-1/5 lldp tx-tlv sys-cap enable
ERS8300-2:5# config ethernet 1/1-1/5 lldp tx-tlv port-desc enable
ERS8300-2:5# config ethernet 1/1-1/5 lldp tx-tlv med network-policy enable
ERS8300-2:5# config ethernet 1/1-1/5 lldp tx-tlv med extendedPSE enable
ERS8300-2:5# config ethernet 1/1-1/5 lldp tx-tlv med capabilities enable
```

NNCLI

```
ERS8310-1:5(config)#interface fastEthernet 3-11
ERS8310-1:5(config-if)#lldp tx-tlv local-mgmt-addr
ERS8310-1:5(config-if)#lldp tx-tlv sys-name sys-desc sys-cap
ERS8310-1:5(config-if)#lldp tx-tlv port-desc
ERS8310-1:5(config-if)#lldp status txAndRx
ERS8310-1:5(config-if)#lldp tx-tlv med capabilities extendedPSE
ERS8310-1:5(config-if)#lldp tx-tlv med network-policy
ERS8310-1:5(config-if)#exit
```

7.3.4 LLDP Configuration Example – LLDP VLAN Name using ERS4500 and Nortel IP Phone Sets



For this configuration example, we will configure the following

- ERS4526GTX-PWR
  - Enable data VLAN 524 and voice VLAN 330 with access port members 3 to 11 and uplink tagged port meber 24
  - Enable ports 3 to 11 to allow untagged data VLAN (PVID = 524) and tagged voice VLAN (PVID = 330)
  - Enable LLDP VLAN on ports 3 to 11
  - Set the PoE priority level to high on ports 3 to 11 for the IP Phone sets
- Setup the IP phone sets for LLDP VLAN Name and enable it to dynamically get it's IP address and S1/S2 information via DHCP

NOTE: Not included in this configuration example is the setup of the next-hop router for the ERS4526GTX-PWR. It will have to be setup for IP routing with DHCP relay for both the voice and data VLANs.

7.3.4.1 ERS4526GTX-PWR Configuration

7.3.4.1.1 Go to configuration mode.

ERS4526GTX-PWR-1 Step 1 - Enter configuration mode

```
4526GTX-1>enable
4526GTX-1#configure terminal
```

7.3.4.1.2 Create VLANs

ERS4526GTX-PWR-1 Step 1 – Remove port members from the default VLAN, create data VLAN 524, and add port members

```
4526GTX-1(config)#vlan members remove 1 ALL
4526GTX-1(config)#vlan create 524 name data type port
4526GTX-1(config)# vlan ports 24 tagging tagall
```

```
4526GTX-1(config)# vlan ports 3-11 tagging untagpvidOnly
4526GTX-1(config)#vlan members add 524 3-11,24
4526GTX-1(config)#vlan ports 3-11 pvid 524
```

ERS4526GTX-PWR-1 Step 2 – Add the voice VLAN, create voice VLAN 330, and add port members

```
4526GTX-1(config)#vlan create 330 name voice type port
4526GTX-1(config)#vlan members add 330 3-11,24
```

7.3.4.1.3 Enable LLDP VLAN Name

ERS4526GTX-PWR-1 Step 1 – Enable LLDP VLAN name on port 3 to 11

```
4526GTX-1(config)#interface fastEthernet 3-11
4526GTX-1(config-if)#lldp status txAndRx config-notification
4526GTX-1(config-if)#lldp tx-tlv local-mgmt-addr port-desc sys-cap sys-desc
sys-name
4526GTX-1(config-if)# lldp tx-tlv dot1 vlan-name 330
4526GTX-1(config-if)#exit
```

7.3.4.1.4 Configure PoE levels

ERS4526GTX-PWR-1 Step 1 – Set PoE Power level high on all VoIP ports

```
4526GTX-1(config)#interface fastEthernet 3-11
4526GTX-1 (config-if)#poe poe-priority high
4526GTX-1 (config-if)#exit
```

7.3.4.1.5 Add QoS

Please see section 4.4.2 and 4.4.3.

7.3.4.1.6 Set Management VLAN

ERS4526GTX-PWR-1 Step 1 – Configure the data VLAN 524 as the management VLAN and set the management IP address

```
4526GTX-1(config)#vlan mgmt 524
4526GTX-1(config)#ip address switch 10.5.2.5 netmask 255.255.255.0 default-
gateway 10.5.2.1
```

7.3.4.1.7 Enable IP Anti Spoofing

ERS4526GTX-PWR-1 Step 1 – Enable IP DHCP Snooping for data VLAN 524 and Voice VLAN 330

```
4526GTX-1(config)#ip dhcp-snooping vlan 524
4526GTX-1(config)#ip dhcp-snooping vlan 330
4526GTX-1(config)#ip dhcp-snooping enable
```

ERS4526GTX-PWR-1 Step 2 – Enable IP Arp Inspection for data VLAN 524 and Voice VLAN 330

```
4526GTX-1(config)#ip arp-inspection vlan 524
4526GTX-1(config)#ip arp-inspection vlan 330
```

ERS4526GTX-PWR-1 Step 3 – Enable core port 24 as a trusted port

```
4526GTX-1(config)#interface fastEthernet 24
4526GTX-1(config-if)#ip dhcp-snooping trusted
4526GTX-1(config-if)#ip arp-inspection trusted
4526GTX-1(config-if)#exit
```

7.3.4.1.8 Enable SNMP Management

ERS4526GTX-PWR-1 Step 1 – If you wish, enable SNMP management by entering the following command

```
4526GTX-1(config)#snmp-server enable
```

7.3.4.2 Verify operations

7.3.4.2.1 Verify VLAN Operations

Step 1 – Verify VLAN port membership, default PVID, and tagging:

```
4526GTX-1#show vlan interface info 3-11
```

Result:

```
                Filter     Filter
               Untagged Unregistered
Unit/Port       Frames     Frames    PVID PRI    Tagging    Name
--------- -------- ------------ ---- --- ------------ ----------------
3         No       Yes          524  0   UntagPvidOnly Unit 1, Port 3
4         No       Yes          524  0   UntagPvidOnly Unit 1, Port 4
5         No       Yes          524  0   UntagPvidOnly Unit 1, Port 5
6         No       Yes          524  0   UntagPvidOnly Unit 1, Port 6
7         No       Yes          524  0   UntagPvidOnly Unit 1, Port 7
8         No       Yes          524  0   UntagPvidOnly Unit 1, Port 8
9         No       Yes          524  0   UntagPvidOnly Unit 1, Port 9
10        No       Yes          524  0   UntagPvidOnly Unit 1, Port 10
11        No       Yes          524  0   UntagPvidOnly Unit 1, Port 11
```

Step 2 – Verify VLAN membership:

```
4526GTX-1#show vlan interface vids 3-11
```

Result:

```
Unit/Port VLAN VLAN Name          VLAN VLAN Name          VLAN VLAN Name
--------- ---- ----------------  ---- ----------------  ---- ----------------
3         330  voice             524  data
--------- ---- ----------------  ---- ----------------  ---- ----------------
4         330  voice             524  data
--------- ---- ----------------  ---- ----------------  ---- ----------------
5         330  voice             524  data
--------- ---- ----------------  ---- ----------------  ---- ----------------
```

```
6         330  voice             524  data
--------- ---- ----------------  ---- ----------------  ---- ----------------
7         330  voice             524  data
--------- ---- ----------------  ---- ----------------  ---- ----------------
8         330  voice             524  data
--------- ---- ----------------  ---- ----------------  ---- ----------------
9         330  voice             524  data
--------- ---- ----------------  ---- ----------------  ---- ----------------
10        330  voice             524  data
--------- ---- ----------------  ---- ----------------  ---- ----------------
11        330  voice             524  data
--------- ---- ----------------  ---- ----------------  ---- ----------------
```

On the ERS4526GTX-PWR verify the following information:

Option	Verify
Tagging:	Verify that ports 3 to 11 are set for ***UntagPvidOnly*** with a default PVID of ***524***
VLAN	Verify that for ports 3 to 11 that they are members of data VLAN ***524*** and voice VLAN ***330***.

7.3.4.2.2 Verify LLDP Configuration

The following command is used to view the LLDP dot1 configuration on the access ports.

Step 1 – Verify LLDP neighbor details by using the following command:

```
4526GTX-1# show lldp port 3-11 tx-tlv dot1
```

Result:

```
--------------------------------------------------------------------------------
                            lldp port dot1 tlvs
--------------------------------------------------------------------------------
Dot1 protocols: STP,EAP,LLDP
--------------------------------------------------------------------------------
Port PortVlanId VlanNameList     PortProtocolVlanId       ProtocolIdentity
--------------------------------------------------------------------------------
3    true       330,524          none                    LLDP
4    true       330,524          none                    LLDP
5    true       330,524          524                     LLDP
6    true       330,524          524                     LLDP
7    true       330,524          none                    LLDP
8    true       330,524          none                    LLDP
9    true       330,524          none                    LLDP
10   true       330,524          none                    LLDP
11   true       330,524          none                    LLDP
--------------------------------------------------------------------------------
```

On the ERS4526GTX-PWR verify the following information:

Option	Verify
PortVlanId:	Verify the PortVlanId setting is set to ***true***.
VlanNameList	Verify that for ports 3 to 11 that they are members of data VLAN ***524*** and voice VLAN ***330***.
PortProtocolVlanId:	By default will be ***none***. However, if you have enabled the dot1 port-protocol-vlan-id parameter (lldp tx-tlv dot1 port-protocol-vlan-id), then by

	default, both VLAN 330 and 524 will be displayed unless you manually add the VLAN. .
ProtocolIdentity:	***LLDP*** should be displayed here.

7.3.4.2.3 Verify LLDP VLAN Name Operations

The following command is used to retrieve LLDP neighbor information from the IP phone set assuming we have a Nortel i2002 IP Phone set connected to port 5 on the ERS4526GTX-PWR.

Step 1 – Verify LLDP neighbor details by using the following command:

```
4526GTX-1#show lldp port 1/5 neighbor dot1
```

Result:

```
-------------------------------------------------------------------------------
                            lldp neighbor
-------------------------------------------------------------------------------
Port: 1/5   Index: 31                Time: 17 days, 01:23:50
        ChassisId: Network address   ipV4  10.1.22.23
        PortId:    MAC address       00:0a:e4:6f:96:4f
        SysCap:    TB / TB           (Supported/Enabled)
        PortDesc:  Nortel IP Phone
        SysDescr:  Nortel IP Telephone 2002, Firmware:0604DAX


 PVID: 0                             PPVID Supported: not supported(0)
 VLAN Name List: 330                 PPVID Enabled: none
-------------------------------------------------------------------------------
Sys capability: O-Other; R-Repeater; B-Bridge; W-WLAN accesspoint; r-Router;
T-Telephone; D-DOCSIS cable device; S-Station only.
```

On the ERS4526GTX-PWR verify the following information:

Option	Verify
ChassissId:	Displays the IP address of the PD device
PortId:	Displays the MAC address of the PD device
PortDesc:	Verify that ***Nortel IP Phone*** is displayed.
SysDescr:	Displays as the Nortel IP phone model, for this example, ***Nortel IP Phone 2002*** should be displayed. Also, the Nortel IP Phone firware should be displayed.
VLAN ID:	Displays as ***330***, the Voice VLAN ID.
Power Priority:	Displays as ***High***, the PoE priority level. If not, check the port level PoE setting.
Power Value:	Displays the PoE power consumed by the PD device.

7.3.4.3 IP Phone Setup

Nortel IP Phone Set configuration

```
LLDP Enable? [0-N, 1-Y]: 1
VOICE VLAN?[0-N, 1-Y]: 1
VLAN Cfg?0-Auto, 1-Man: 0
LLDP MED? [0-N, 1-Y]: 0
LLDP VLAN? [0-N, 1-Y]: 1
GARP Ignore? (0-No, 1-Yes): 1
```

7.4 Auto Detection and Auto Configuration (ADAC) of Nortel IP Phones

Overview

ADAC can be used to automatically discover an IP Phone set either via MAC addresses or LLDP. In addition, via the ERS55xx switch only, ADAC can be used with 802.1AB LLDP-MED to inform an IP Phone with the Voice VLAN ID and QoS values. This section will cover ADAC using MAC address to discover IP Phone sets. Please see section 7.3 regarding 802.1AB.

If ADAC detection by MAC address is used, it works by checking the MAC address of the IP phone against a MAC address range pre-configured on the switch. Please note that the pre-configured range may not cover all the various IP phone sets available. However, the ADAC MAC range can be configured allowing one to add new MAC address ranges. This will allow one to add MAC address ranges for any Nortel IP phone set not supported by ADAC in addition to supporting 3rd party IP Phone sets.

When a new MAC address is learned or removed on a switch, ADAC receives an event notification and checks if the MAC address falls within the known range. Upon receiving a MAC notification event, ADAC checks if the port is enabled for ADAC. If the port is enabled for ADAC and the MAC addresses detected on the port is within the ADAC MAC address range, then the port is changed to AutoDetect active and a counter is increased. ADAC will configure the port to mark traffic as Premium Service. This will result in data from the IP Phone set to be marked with DSCP 0x2E and if tagged, setting the 802.1p value to 6. In addition, ADAC will also detect Call Server and Uplink ports and apply ADAC QoS.

If ADAC detection by LLDP is used, it works by checking if LLDP packets are send by the IP Phone set. The operation is similar to MAC detection except the Nortel switch uses LLDP instead of MAC address to detect an IP Phone set.

ADAC Operating Modes

ADAC can also be configured to automatically assign a port to a voice VLAN. The voice VLAN is an independent VLAN leaning (IVL) port-based VLAN that can be applied to either tagged or untagged ports with the following modes of operation:

- Untagged Basic Mode
    - No VLAN auto configuration will be applied
    - ADAC Call Server or Uplink Port is not used
    - The customer can create and configure the VLAN independently
    - The IP Phone must be configured to send untagged frames
    - QoS configuration is applied
    - Auto-Configuration is applied only when a Nortel IP Phone is detected on a port
- Untagged Advanced Mode

- Voice VLAN is created
- Call server port (if any)
  - Membership = add to Voice-VLAN
  - Tagging = UntaggedAll
  - PVID = Voice-VLAN
- Uplink port (if any):
  - Membership = add to Voice-VLAN
  - Tagging = UntaggedAll
  - PVID = no change
- Telephony port
  - Membership = remove from all other VLANs and add to Voice VLAN
  - Tagging = UntaggedAll
  - PVID = Voice-VLAN
- Port and PVID are assigned to Voice VLAN when phone is detected.
- The IP Phone must be configured to send untagged frames
- QoS configuration is applied
- Auto-Configuration is applied only when a Nortel IP Phone is detected on a port
- When ADAC is disabled, the port is placed back into the previously configured VLAN

- Tagged Frames
  - IP Phone are pre-configured to send *tagged* traffic
  - Voice VLAN is configured
  - Telephony port:
    - Membership = add to Voice-VLAN
    - Tagging = UntaggedPVIDOnly
    - PVID = unchanged or changed to DefaultVLAN (1) if equals Voice-VLAN
  - Call Server port (if any):
    - Membership = add to Voice-VLAN
    - Tagging = UntaggedAll
    - PVID = Voice-VLAN
  - Uplink port (if any):
    - Membership = add to Voice-VLAN
    - Tagging = TaggedAll
    - PVID = no change
- Tagged mode
  - Voice traffic is tagged from the IP phone must be configured with the VLAN ID of the Voice VLAN
  - QoS configuration is applied
  - Auto-Configuration is applied only when a Nortel IP Phone is detected on a port

Initial User Settings

When configuring ADAC, you must set the ADAC operation mode using one of the three operation modes mentioned above according to if the IP Phones are configured to send tagged or untagged frames. If you select either Untagged Advanced or Tagged mode, you must also supply the voice VLAN ID and at least one of the following:

- Call Server port, if it is connected directly to the switch
- Uplink port, if used
    - If you select Uplink port, this will enable tagging on the specified uplink port with a VLAN ID of the voice VLAN.

QoS Settings

Overall, ADAC QoS configuration will be applied to:

- traffic coming from the IP Phones
- traffic coming from the Call Server port
- traffic coming from the Uplink port

ADAC Port Restrictions

The following applies to the Call Server, Uplink, and Telephony ports:

The Call Server port must not be:

- part of a trunk (MLT, LAG)
- a Monitor Port in port mirroring
- a Telephony port
- the Uplink port

The Uplink port must not be:

- a Monitor Port in port mirroring
- a Telephony port
- the Call Server port

The Telephony port must not be:

- part of a trunk (MLT, LAG)
- a Monitor Port in port mirroring
- an IGMP static router port
- the Call Server port
- the Uplink port

It is recommended to use software release 5.1 for the Ethernet Routing Switch 5500 and software release 3.7 for the Ethernet Switch 470. Both of these software releases allows configuration at a port level for either an untagged voice VLAN or a tagged voice VLAN with or without an untagged data VLAN.

In software release 3.6 for the Ethernet Switch 470-PWR with ADAC operating mode of Tagged, ADAC will configure the phone set port for *tagPvidOnly*. Hence, the IP Phone set cannot be configured in Auto Configuration mode. The reason being that the initial

DHCP request from the Nortel IP Phone set will be forwarded untagged and the ADAC enabled port is set for tagging only.

In software release 5.0 for the Ethernet Routing Switch 5500, to support Auto Configuration on a Nortel IP Phone, an ADAC port must be configured as *untagPvidOnly* with a default PVID belonging to the data VLAN even though ADAC is configured with operation mode of Tagged. This will allow support for an IP Phone with Auto Configuration and a data device on the same port. The data device will be put in an untagged data VLAN and the IP Phone will be put into a different tagged voice VLAN.

For ADAC MAC Detection to work, you must disable unregistered frames on the ERS2500, ERS4500, and ERS5500 series. In regards to the ES470, it does not matter is unregistered frames is enabled or disabled.

Nortel IP Phone Set MAC Address Ranges

Please note that the information provided below is correct at the time of publishing the document. The information will be updated with each up-issue of this document.

As address ranges can change from the factory over time, it is recommended to verify that new sets received still fall within the range published below, and check with your Nortel representative for any updates.

IP Phone 2000 Series

- IP Phone 2004 (Phase 0) used the OUI MAC scheme/range: 00:60:38:xx:xx:xx
- IP Phone 2002/2004 (Phase 1) used the OUI MAC schema/ranges: 00:60:38:xx:xx:xx & 00:0A:E4:xx:xx:xx
- IP Phone 2001/2002/2004/2007 (Phase 2) used/use the OUI MAC schema/ranges: 00:0A:E4:xx:xx:xx , 00:14:0D:xx:xx:xx , 00:16:CA:xx:xx:xx , 00:17:65:xx:xx:xx , 00:18:B0:xx:xx:xx and 00:19:69:xx:xx:xx
- IP Audio Conferencing Phone 2033 use the OUI MAC scheme/range: 00:04:F2:xx:xx:xx

IP Phone 1100 Series

- IP Phone 1110/1120E/1140E use the OUI MAC schema/ranges: 00:13:65:xx:xx:xx , 00:16:CA:xx:xx:xx and 00:17:65:xx:xx:xx
- IP Phone 1150E use the OUI MAC scheme/range: 00:15:9B:xx:xx:xx

IP Phone 1200 Series

- IP Phone 1210/1220/1230 use the OUI MAC scheme/range: 00:19:E1:xx:xx:xx

WLAN Handset 2200 / 6100 Series

- WLAN Handset Phone 2210/2211/2212/6120/6140 use the OUI MAC scheme/range: 00:90:7A:xx:xx:xx

7.4.1 ADAC Configuration

ADAC can be configured by either using NNCLI (PPCLI or NNCLI on ERS8300) or by using Java Device Manager (JDM).

7.4.1.1 ADAC Global Settings

Via the privileged configuration terminal mode, the following command is used to enable ADAC:

Use the following command to view the various ADAC options:

```
470-48T(config)#adac ?

       Parameters:
         call-server-port  Set call server port
         enable            Enable ADAC
         op-mode           Set ADAC operation mode
         traps             Enable ADAC notifications
         uplink-port       Set uplink port
         voice-vlan        Set Voice-VLAN
       Sub-Commands/Groups:

         mac-range-table  Add new supported MAC address range
```

Use the following command to disable ADAC:

```
470-48T(config)#no adac enable
```

The ES470 requires software release 3.7 to get the ADAC mac-range-table

Where:

Item	Description
call-server-port	Sets Call Server port.
enable	Enables ADAC on the switch.
op-mode	Sets the ADAC operation mode to one of the following: • untagged-frames-basic: IP Phones send untagged frames and the Voice VLAN is not created • untagged-frames-advanced: IP Phones send untagged frames and the Voice VLAN is created • tagged-frames: IP Phones send tagged frames
traps	Enables ADAC trap notifications.
uplink-port	Sets the Uplink port.
voice-vlan	Sets the Voice VLAN ID. The assigned VLAN ID must not previously exist.
mac-range-table	Sets a new MAC address range used by ADAC to auto detect IP Phone sets. NOTE: this option is only available for the ERS5500 series.

Please note that the ADAC mac-range-table in not available in software release 3.6 for the Ethernet Switch 470.

7.4.1.2 ADAC Interface settings

Please note the settings shown are only available in software release 5.1 for the Ethernet Routing Switch 5500 and Ethernet Routing Switch 4500, software release 4.1 for the Ethernet Routing Switch 2500, and software release 3.7 for the Ethernet Switch 470. The Ethernet Routing Switch 5500, 4500, and 2500 also has the option to detect an IP Phone based on either MAC address or LLDP.

ERS5500, ERS4500, or ERS2500: Use the following command to view the various ADAC options:

```
5520(config)#interface fastEthernet all

5520(config-if)#adac ?

 Parameters:
    enable                  Enable auto-detection on ports
    port                    Port number(s) for which to change settings
    tagged-frames-pvid      Set the PVID to be configured for telephony ports in
                            Tagged Frames operating mode
    tagged-frames-tagging   Set the tagging to be configured for telephony ports
                            in Tagged Frames operating mode
  Sub-Commands/Groups:
    detection   Enable detection mechanisms on ports
```

ES470: Use the following command to view the various ADAC detection options:

```
470-24T-PWR(config)#interface fastEthernet all

470-24T-PWR(config-if)#adac ?

 Parameters:
    enable                  Enable auto-detection on ports
    port                    Port number(s) for which to change settings
    tagged-frames-pvid      Set the PVID to be configured for telephony ports in
                            Tagged Frames operating mode
    tagged-frames-tagging   Set the tagging to be configured for telephony ports
                            in Tagged Frames operating mode
```

ERS5500, ERS4500, or ERS2500: Use the following command to view the various ADAC detection options:

```
5520g(config)#interface fastEthernet all

5520g(config-if)# adac detection ?

 Parameters:
    lldp   Enable 802.1ab-based detection on ports
    mac    Enable MAC-based detection on ports
    port   Port number(s) for which to change settings
```

Where:

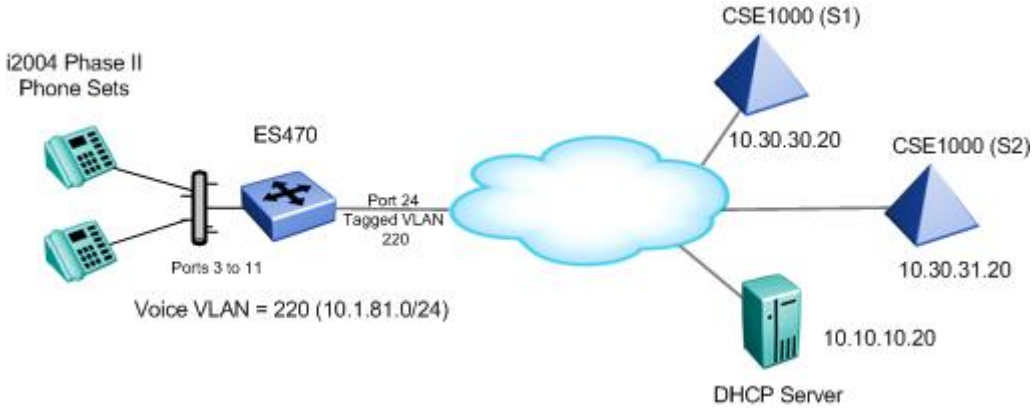
Item	Description
enable	Enables ADAC on the port or ports listed.
port <*portlist*>	Ports to which to apply the ADAC

	configuration.
tagged-frames-pvid <1-4094> | no-change	Sets Tagged-Frames PVID on the port or ports listed. Use no-change to keep the current setting.
tagged-frames-tagging tagAll | tagPvidOnly | untagPvidOnly | no-change	Sets Tagged-Frames Tagging to • tagAll • tagPvidOnly • untagPvidOnly Use no-change to keep the current setting.
ADAC Dectection variable	Specifies the ADAC detection method for etiher MAC or LLDP. The default setting is MAC.

7.4.2 ADAC Configuration Example: MAC Detection using ES470

For this configuration example, we will configure the following:

- Configure the Ethernet Switch 470-PWR for ADAC using VLAN 220 for the Voice VLAN
- Configure port 24 on the Ethernet Switch 470-PWR as the ADAC uplink port
- Setup the IP Phone 2004 Phone Sets for partial DHCP



7.4.2.1 Ethernet Switch 470-PWR Configuration

7.4.2.1.1 Go to configuration mode.

ES470-PWR Step 1 - Enter configuration mode
470-48T-PWR>***enable***
470-48T-PWR#***configure terminal***

7.4.2.1.2 Configure ADAC

ES470-48T-PWR Step 1 – Add ADAC voice VLAN
470-48T-PWR(config)#***adac voice-vlan 220***
ES470-48T-PWR Step 2 – Set ADAC operation mode to tagged-frames
470-48T-PWR(config)#***adac op-mode tagged-frames***
ES470-48T-PWR Step 3 – Add the ADAC uplink port
470-48T-PWR(config)#***adac uplink-port 24***
ES470-48T-PWR Step 4 – Enable ADAC
470-48T-PWR(config)#***adac enable***

Please note the following:

- VLAN 220 must not exist prior to configuring ADAC.
- The command *adac uplink-port 24* will automatically enable VLAN tagging on port 24 and add this port as a member of VLAN 220.

- ADAC up to BOSS 3.6.2 and BOSS 4.2 only detects IP Phone 200x Phase II phone sets and with a port configured for tagged-frames, set the port for *TagPvidOnly*. As noted above, BOSS 3.7 and BOSS 5.0 will supports both tagging and no tagging on the same port in addition to allow the user to configure a new IP Phone set MAC range.

7.4.2.1.3 Enable ADAC at interface level

ES470-48T-PWR Step 1 – Enable ADAC on port members 3 to 11

```
470-48T-PWR(config)#interface fastEthernet all
470-48T-PWR(config-if)#adac port 3-11 tagged-frames-tagging tag-all tagged-frames-pvid 220
470-48T-PWR(config-if)# adac port 3-11 enable
470-48T-PWR(config-if)#exit
```

7.4.2.1.4 Remove port members from default VLAN

ES470-48T-PWR Step 1 – Enable ADAC on port members 3 to 11

```
470-48T-PWR(config)# vlan members remove 1 ALL
```

7.4.2.2 IP Phone 2004 Phase II Setup

i2004 Step 1 – IP Phone 2004 Phase II Phone Set configuration

```
DHCP? (0-No, 1-Yes): 0
DHCP: 0-Full, 1-Partial: 1
S1 IP: 10.30.30.20
S1 PORT: 5000
S1 ACTION: 1
S1 RETRY COUNT: 1
S2 IP: 10.30.31.20
S2 PORT: 5000
S2 ACTION: 1
S2 RETRY COUNT: 1
Voice VLAN? 0-No, 1-Yes: 1
VLAN Cfg? 0-Auto, 1-Man: 1
Voice VLAN ID: 220
VLANFILTER? 0-No, 1-Yes: 1
PC Port? 1-ON, 0-OFF: 1
GARP Ignore? 0-N, 1-Y: 1
```

NOTE: The setting for S1 and S2 Port, Action and Retry count shown above are the default settings.

7.4.2.3 Verify Operation

7.4.2.3.1 VLAN Information

Step 1 – Verify the VLAN configuration for all access and trunk port members prior to connecting an IP phone to any port member

```
470-48T-PWR#show vlan interface info 3-11,24
```

Result:

```
             Filter     Filter
           Untagged Unregistered
Port  Frames     Frames     PVID PRI    Tagging    Name
---- -------- ---------- ---- --- ------------- ----------------
3    No     No       No          1    0   UntagAll      Port 3
4    No     No       No          1    0   UntagAll      Port 4
5    No     No       No          1    0   UntagAll      Port 5
6    No     No       No          1    0   UntagAll      Port 6
7    No     No       No          1    0   UntagAll      Port 7
8    No     No       No          1    0   UntagAll      Port 8
9    No     No       No          1    0   UntagAll      Port 9
10   No     No       No          1    0   UntagAll      Port 10
11   No     No       No          1    0   UntagAll      Port 11
24   No     No       No          220  0   TagAll        Port 24
```

Step 2 – Verify the VLAN configuration for all access port members after connecting an IP phone to a port member. For example, assuming we have attached an i2004 IP phone to port 5

```
470-48T-PWR#show vlan interface info 3-11
```

Result:

```
             Filter     Filter
           Untagged Unregistered
Port  Frames     Frames     PVID PRI    Tagging    Name
---- -------- ---------- ---- --- ------------- ----------------
3    No     No       No          1    0   UntagAll      Port 3
4    No     No       No          1    0   UntagAll      Port 4
5    No     No       No          220  0   TagAll        Port 5
6    No     No       No          1    0   UntagAll      Port 6
7    No     No       No          1    0   UntagAll      Port 7
8    No     No       No          1    0   UntagAll      Port 8
9    No     No       No          1    0   UntagAll      Port 9
10   No     No       No          1    0   UntagAll      Port 10
11   No     No       No          1    0   UntagAll      Port 11
```

Step 3 – Verify the VLAN PVIDs for all access port members after connecting an IP phone to a port member. For example, assuming we have attached an i2004 IP phone to port 5

```
470-48T-PWR#show vlan interface vids 12-18
```

Result:

```
Port VLAN VLAN Name          VLAN VLAN Name          VLAN VLAN Name
---- ---- ----------------  ---- ----------------  ---- ----------------
3
---- ---- ----------------  ---- ----------------  ---- ----------------
4
---- ---- ----------------  ---- ----------------  ---- ----------------
5    220  Voice_VLAN
---- ---- ----------------  ---- ----------------  ---- ----------------
```

```
       6
       ---- ---- ----------------  ---- ----------------  ---- ----------------
       7
       ---- ---- ----------------  ---- ----------------  ---- ----------------
       8
       ---- ---- ----------------  ---- ----------------  ---- ----------------
       9
       ---- ---- ----------------  ---- ----------------  ---- ----------------
       10
       ---- ---- ----------------  ---- ----------------  ---- ----------------
       11
       ---- ---- ----------------  ---- ----------------  ---- ----------------
```

On the ES470, verify the following information:

Option	Verify
PVID	Verify that the default PVID on port member 3 to 11 is ***1***
Tagging	Verify that ports 3 to 11 are configured as ***UntagAll*** when no IP Phones have been detected by ADAC and set to ***TagAll*** only when an IP Phone has successfully been detected by ADAC
VLAN and VLAN Name	Verify that port 5 is member of VLANs ***220*** as an IP Phone has been detected by ADAC.

7.4.2.3.2 Verify ADAC Global Information

Step 1 – Verify ADAC Global Settings

```
470-48T-PWR#show adac
```

Result:

```
            ADAC Global Configuration
       ----------------------------------------
       ADAC Admin State:  Enabled
       ADAC Oper State:  Enabled
       Operating Mode:  Tagged Frames
       Traps Control Status:  Enabled
       Voice-VLAN ID:  220
       Call Server Port:  None
       Uplink Port:  24
```

On the ERS470, verify the following information:

Option	Verify
ADAC Admin State: ADAC Oper State:	Verify that the ADAC administrative and operation state is ***Enabled***
Operating Mode	Verify the ADAC operating mode is set for ***Tagged Frames***
Traps Control Status:	Verify the ADAC traps is set for ***Enabled***
Voice-VLAN ID:	Verify the ADAC voice VLAN is set for ***220***

Uplink Port:	Verrify the ADAC uplink port is configured for port ***24***

7.4.2.3.3 Verify ADAC at interace level

Assuming ADAC has detected an i2004 on port 5.

Step 2 – Verify ADAC at interface level

```
470-1#show adac interface 3-11
```

Result:

```
                  Auto          Auto              Tagged-Frames
       Port  Type  Detection   Configuration    PVID         Tagging
       ----  ----  ---------   -------------    ---------    ---------------
       3      T     Enabled    Not Applied     220          Tag All
       4      T     Enabled    Not Applied     220          Tag All
       5      T     Enabled    Applied         220          Tag All
       6      T     Enabled    Not Applied     220          Tag All
       7      T     Enabled    Not Applied     220          Tag All
       8      T     Enabled    Not Applied     220          Tag All
       9      T     Enabled    Not Applied     220          Tag All
       10     T     Enabled    Not Applied     220          Tag All
       11     T     Enabled    Not Applied     220          Tag All
```

On the ES470, verify the following information:

Option	Verify
Type	Verify that the ADAC type is set for ***T*** indicating the port is configured for ADAC type of tagged port
Auto Detection	Verify the ADAC detection is set to ***Enabled*** for port 3 to 11
Auto Configuration	In our example, port 5 should indicate ***Applied*** while ports 3, 4, and 6 to 11 should indicate ***Not Applied*** as only port 5 has an IP Phone set detected by ADAC
PVID	Verify the PVID is configured as ***220***
Tagging	Verify the port members 3 to 11 are set to ***Tag All***

7.4.2.3.4 To view the ADAC filters

Step 1 – To view the ADAC L2 filter, use the following command:

```
470-48T-PWR#show qos l2-filters
```

Result:

```
Id  VLAN  VLAN Tag Ether     802.1p      DSCP  Protocol   Dest IP     Src IP
                   Type      Priority                      L4 Port     L4 Port
                                                          Min / Max   Min / Max

__ ______ ________ ______ _____________ ______ ________ ___________ _________
1  220    Tagged   0x800  Ignore         Ignore Ignore   Ignore      Ignore
                                                         Ignore      Ignore
```

Step 2 – To view the ADAC L3 filter, use the following command:

```
470-48T-PWR#show qos ip-filters
```

Result:

```
Id    Destination       Source        DSCP  Protocol  Dest     Src
      Addr / Mask     Addr / Mask                   L4 Port L4 Port

___ _______________ _______________ ______ ________ _______ _______
1   Ignore          Ignore          Ignore Ignore   Ignore  Ignore
    Ignore          Ignore
```

Step 3 – To view the ADAC policy, use the following command:

```
470-48T-PWR#show qos policies
```

Result:

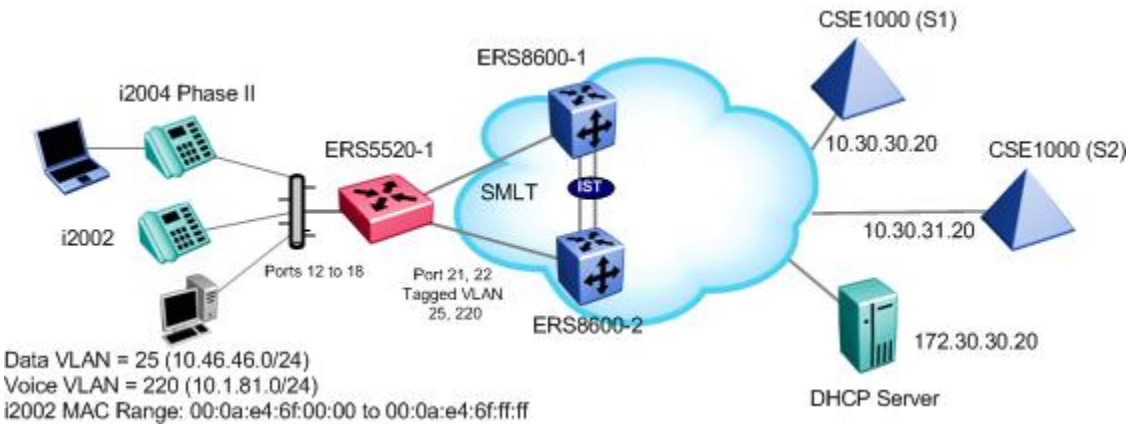
```
Id        Name         State      Filter Set     Fltr        Role          Order
                                                 Type     Combination

___ _________________ _________ _______________ ____ ____________________ _____
1   ADACPolicy2       Enabled   ADACFilterGrp2  L2   ADACIfGroup2         32767
2   ADACPolicy1       Enabled   ADACFilterGrp1  IP   ADACIfGroup1         1

Id      Meter       In-Profile    Out-of-Profile     Shaper     Shaper  User
                      Action          Action                    Group   Group
                                                                        Session

___ _____________ _____________ _____________ _____________ ______ _______
1                 Premium_Servic                              0      0
2                 Premium_Servic                              0      0
```

7.4.3 ADAC Configuration – MAC Dectection using ERS5500 and Adding a new MAC address range

For this configuration example, we will configure the following assuming that Ethernet Routing Switch 5520 had been loaded with software release 5.1:

- We wish to support both VoIP and Data on the same port so that either application can be used
  - We will configure ADAC at the port level for *tagged-frames* and with *untag-pvid-only* to allow for untagged data traffic and tagged VoIP traffic.
- Configure the Ethernet Routing Switch 5520 for ADAC using VLAN 220 for the Voice VLAN
- Configure the Ethernet Routing Switch 5520 with data VLAN 25 on the same access ports used by ADAC
- Configure MLT port 21 and 22 on the Ethernet Switch 5520 as the ADAC uplink ports
- Setup Ethernet Routing Switch 5520 to support a MAC address range belonging the IP Phone 2002 phone sets.
- Setup the Nortel IP Phone Sets for full DHCP an manually provision the voice VLAN to 220

Please note that in software release 5.0, at a port level, you have to configure the port as untagPvidOnly, set the default PVID to the data VLAN and add the Data and Voice VLAN as port members. In software release 5.1, you enter the ADAC tagging mode via the interface level and select if MAC address or LLDP is used to recognize the IP phone.



Since ERS5520-1 is being used as an SMLT access switch, the recommended SMLT options of Spanning Tree Fast Start, BPDU filtering, and rate limiting should be enabled on all access port members. In addition, the MLT trunks member should have the 'discard untagged frames' option enabled.

7.4.3.1 Ethernet Switch 5520 Configuration

7.4.3.1.1 Go to configuration mode.

ERS5520-PWR Step 1 - Enter configuration mode
5520-1>***enable***

```
5520-1#configure terminal
```

7.4.3.1.2 Create MLT

ERS5520-PWR Step 1 – Create MLT 1 with port members 21 and 22 and disable Spanning Tree

```
5520-1(config)# mlt 1 enable member 21,22 learning disable
```

7.4.3.1.3 Configure ADAC

ERS5520-PWR Step 1 – Add ADAC voice VLAN with operation mode of tagged frame, enable ADAC traps, and add ADAC uplink port 21

```
5520-1(config)#adac voice-vlan 220
5520-1(config)#adac op-mode tagged-frames
5520-1(config)#adac uplink-port 21
5520-1(config)#adac traps enable
5520-1(config)#adac enable
```

Please note the following:

- VLAN 220 must not exist prior to configuring ADAC.
- The command *adac uplink-port 21* will automatically enable VLAN tagging on port 21 and 22 and add these ports as a member of VLAN 220 and MLT 1.

7.4.3.1.4 Remove port members from default VLAN 1

ERS5520-PWR Step 1 – Remove all port member from default VLAN

```
5520-1(config)#vlan members remove 1 ALL
```

7.4.3.1.5 Add the data VLAN

ERS5520-PWR Step 1 – Create the data VLAN 25, name it 'data', and add port members

```
5520-1(config)#vlan create 25 name data type port
5520-1(config)#vlan members add 25 12-18,21,22
```

7.4.3.1.6 Enable ADAC at interface level

ERS5520-PWR Step 1 – Enable ADAC on port members 12 to 18 and enable ADAC tagged frames with the opion to untag the default PVID. By default, ADAC MAC detection is already enabled, hence it is not nessessary to enable ADAC MAC detection.

```
5520-1(config)#interface fastEthernet all
5520-1(config-if)#adac port 12-18 tagged-frames-tagging untag-pvid-only
5520-1(config-if)#adac port 12-18 enable
5520-1(config-if)#exit
```

7.4.3.1.7 Add ADAC MAC address range

ERS5520-PWR Step 1 – Add to ADAC the IP Phone set MAC address range for the Nortel 2002 phone set used in this example

```
5520-1(config)#adac mac-range-table low-end 00:0a:e4:6f:00:00 high-end
00:0a:e4:6f:ff:ff
```

7.4.3.1.8 Spanning Tree Fast Start and BPDU filtering

ERS5520-PWR Step 1 – Enable STP Fast Start and BPDU filtering on all access port members

```
5520-1(config)#interface fastEthernet 12-18
5520-1(config-if)#spanning-tree learning fast
5520-1(config-if)#spanning-tree bpdu-filtering timeout 0
5520-1(config-if)#spanning-tree bpdu-filtering enable
5520-1(config-if)#exit
```

7.4.3.1.9 Enable Rate Limiting

ERS5520-PWR Step 1 – Enable Rate Limiting to 10% of total traffic for both broadcast and multicast traffic

```
5520-1(config)#interface fastEthernet all
5520-1(config-if)#rate-limit port 12-18 both 10
5520-1(config-if)#exit
```

7.4.3.1.10 Disable unregistered frames on ADAC port members

ERS5520-1: Step 1 – Enable Discard Untagged Frames on MLT trunks members

```
5520-1(config)#vlan ports 12-18 filter-unregistered-frames disable
```

7.4.3.1.11 Discard Untagged Frames

ERS5520-1: Step 1 – Enable Discard Untagged Frames on MLT trunks members

```
5520-1(config)#vlan ports 21,22 filter-untagged-frame enable
```

7.4.3.1.12 Configure PoE levels

ERS5520-1 Step 1 – Set PoE Power level high on all VoIP ports

```
5520-1(config)#interface fastEthernet 12-18
5520-1(config-if)#poe poe-priority high
5520-1(config-if)#exit
```

7.4.3.1.13 Enable IP Spoofing

ERS5520-1: Step 1 – Enable IP DHCP Snooping for data VLAN 10and Voice VLAN 220

```
5520-1(config)#ip dhcp-snooping vlan 10
5520-1(config)#ip dhcp-snooping vlan 220
5520-1(config)#ip dhcp-snooping enable
```

ERS5520-1: Step 2 – Enable IP Arp Inspection for data VLAN 524 and Voice VLAN 330

```
5520-1(config)#ip arp-inspection vlan 10
5520-1(config)#ip arp-inspection vlan 220
```

ERS5520-1: Step 3 – Enable core ports 21 and 22 as a trusted ports

```
5520-1(config)#interface fastEthernet 21,22
5520-1(config-if)#ip dhcp-snooping trusted
5520-1(config-if)#ip arp-inspection trusted
5520-1(config-if)#exit
```

ERS5520-1: Step 4 – Enable IP Source Guard on ports 12 to 18

```
5520-1(config)#interface fastEthernet 12-18
5520-1(config-if)#ip verify source
5520-1(config-if)#exit
```

7.4.3.2 IP Phone

7.4.3.2.1 i2002 and i2004 Setup

i2004 Step 1 – IP Phone 200x Phone Set configuration assuming we will use the DHCP server to provide the IP Phone 200x phone set with the call server information, it should be configured as follows.

```
DHCP? (0-No, 1-Yes): 1
DHCP: 0-Full, 1-Partial: 0
VOICE VLAN? 0-NO, 1-YES: 1
VLAN Cfg? 0 - AUTO, 1 - MAN: 1
VLAN: 220
VLANFILTER? 0-NO, 1-YES: 1
DATA VLAN? 0-NO, 1-YES: 0
GARP Ignore? 0-N, 1-Y: 1
```

7.4.3.3 Verify configuration

7.4.3.3.1 VLAN Information

Step 1 – Verify the VLAN configuration for all access and trunk port members prior to connecting

an IP phone to any port member

```
5520-1#show vlan interface info 12-18,21-22
```

Result:

```
        Filter     Filter
      Untagged Unregistered
Port   Frames     Frames    PVID PRI    Tagging    Name
---- -------- ------------ ---- --- ------------- ----------------
12    No       No           25   0   UntagAll      Port 12
13    No       No           25   0   UntagAll      Port 13
14    No       No           25   0   UntagAll      Port 14
15    No       No           25   0   UntagAll      Port 15
16    No       No           25   0   UntagAll      Port 16
17    No       No           25   0   UntagAll      Port 17
18    No       No           25   0   UntagAll      Port 18
21    Yes      Yes          1    0   TagAll        Port 21
22    Yes      Yes          1    0   TagAll        Port 22
```

Step 2 – Verify the VLAN configuration for all access port members after connecting an IP phone to a port member. For example, assuming we have attached an i2004 IP phone to port 12 and an i2002 to port 13.

```
5520-1# show vlan interface info 12-18
```

Result:

```
        Filter     Filter
      Untagged Unregistered
Port   Frames     Frames    PVID PRI    Tagging    Name
---- -------- ------------ ---- --- ------------- ----------------
12    No       Yes          25   0   UntagPvidOnly Port 12
13    No       Yes          25   0   UntagPvidOnly Port 13
14    No       Yes          25   0   UntagAll      Port 14
15    No       Yes          25   0   UntagAll      Port 15
16    No       Yes          25   0   UntagAll      Port 16
17    No       Yes          25   0   UntagAll      Port 17
18    No       Yes          25   0   UntagAll      Port 18
21    No       Yes          1    0   TagAll        Port 21
22    No       Yes          1    0   TagAll        Port 22
```

Step 3 – Verify the VLAN PVIDs for all access port members after connecting an IP phone to a port member. For example, assuming we have attached an i2004 IP phone to port 12 and an i2002 to port 13.

```
5520-1# show vlan interface vids 12-18
```

Result:

```
Port VLAN VLAN Name         VLAN VLAN Name         VLAN VLAN Name
---- ---- ---------------- ---- ---------------- ---- ----------------
12   25   data             220  Voice_VLAN
---- ---- ---------------- ---- ---------------- ---- ----------------
13   25   data             220  Voice_VLAN
---- ---- ---------------- ---- ---------------- ---- ----------------
14   25   data
---- ---- ---------------- ---- ---------------- ---- ----------------
15   25   data
---- ---- ---------------- ---- ---------------- ---- ----------------
16   25   data
```

```
---- ---- ----------------  ---- ----------------  ---- ----------------
17   25   data
---- ---- ----------------  ---- ----------------  ---- ----------------
18   25   data
---- ---- ----------------  ---- ----------------  ---- ----------------
```

On the ERS5520, verify the following information:

Option	Verify
PVID	Verify that the default PVID on port member 12 to 18 is ***25***
Tagging	Verify that ports 12 to 18 are configured as ***UntagAll*** when no IP Phones have been detected by ADAC and set to ***UntagPvidOnly*** only when an IP Phone has successfully been detected by ADAC
Filter Untagged Frames	Verify that ports 12 to 18 are configured as ***No*** and port members 21 and 22 are configured as ***Yes***
Filter Unregistered Frames	Verify that ports 12 to 18 are configured as ***No*** and port members 21 and 22 are configured as ***Yes***
VLAN and VLAN Name	Verify that ports 12 to 18 are membes of VLANs ***25*** and and only members of VLAN ***220*** when an IP Phone has been detected by ADAC.

7.4.3.3.2 Verify ADAC Global Information

Step 1 – Verify ADAC Global Settings

```
5520-1#show adac
```

Result:

```
          ADAC Global Configuration
---------------------------------------
ADAC Admin State:  Enabled
ADAC Oper State:  Enabled
Operating Mode:  Tagged Frames
Traps Control Status:  Enabled
Voice-VLAN ID:  220
Call Server Port:  None
Uplink Port:  21
```

On the ERS5520, verify the following information:

Option	Verify
ADAC Admin State: ADAC Oper State:	Verify that the ADAC administrative and operation state is ***Enabled***
Operating Mode	Verify the ADAC operating mode is set for ***Tagged Frames***
Traps Control Status:	Verify the ADAC traps is set for ***Enabled***
Voice-VLAN ID:	Verify the ADAC voice VLAN is set for ***220***

Uplink Port:	Verrify the ADAC uplink port is configured for port ***21***

7.4.3.3.3 Verify ADAC at interace level

Assuming ADAC has detected an i2004 on port 12 and an i2002 port 13.

Step 2 – Verify ADAC at interface level

```
5520-1#show adac interface 12-18
```

Result:

```
                Auto       Oper       Auto
Port  Type  Detection  State      Configuration  T-F PVID   T-F Tagging
----  ----  ---------  --------   -------------  ---------  --------------
12    T     Enabled    Enabled    Applied        No Change  Untag PVID Only
13    T     Enabled    Enabled    Applied        No Change  Untag PVID Only
14    T     Enabled    Enabled    Not Applied    No Change  Untag PVID Only
15    T     Enabled    Enabled    Not Applied    No Change  Untag PVID Only
16    T     Enabled    Enabled    Not Applied    No Change  Untag PVID Only
17    T     Enabled    Enabled    Not Applied    No Change  Untag PVID Only
18    T     Enabled    Enabled    Not Applied    No Change  Untag PVID Only
```

The filter unregistered frames must be disabled for ADAC to work. If you connect an IP phone set to a port and the auto configuration state is *Not Applied*, either the MAC address is not part of the ADAC MAC table or filter unregistered frames is enabled.

On the ERS5520, verify the following information:

Option	Verify
Type	Verify that the ADAC type is set for ***T*** indicating the port is configured for ADAC type of tagged port
Auto Detection	Verify the ADAC detection is set to ***Enabled*** for port 12 to 18
Oper State:	Verify the ADAC operation state is set to ***Enabled*** for port 12 to 18
Auto Configuration	In our example, ports 12 and 13 should indicate ***Applied*** while ports 14 to 18 should indicate ***Not Applied*** as only ports 12 and 13 have IP Phone sets detected by ADAC
T-F PVID	Verify the tagged frames ***No Change*** which indicates do not change the default PVID
T-F Tagging	Verify the port members 12 to 18 are set to ***Untag PVID only***

7.4.3.3.4 Verify ADAC MAC Address table

Step 3 – Verify ADAC MAC address range

```
5520-1# show adac mac-range-table
```

Result:

```
          Lowest MAC Address          Highest MAC Address
      ------------------------    ------------------------
         00-0A-E4-01-10-20           00-0A-E4-01-23-A7
         00-0A-E4-01-70-EC           00-0A-E4-01-84-73
         00-0A-E4-01-A1-C8           00-0A-E4-01-AD-7F
         00-0A-E4-01-DA-4E           00-0A-E4-01-ED-D5
         00-0A-E4-02-1E-D4           00-0A-E4-02-32-5B
         00-0A-E4-02-5D-22           00-0A-E4-02-70-A9
         00-0A-E4-02-D8-AE           00-0A-E4-02-FF-BD
         00-0A-E4-03-87-E4           00-0A-E4-03-89-0F
         00-0A-E4-03-90-E0           00-0A-E4-03-B7-EF
         00-0A-E4-04-1A-56           00-0A-E4-04-41-65
         00-0A-E4-04-80-E8           00-0A-E4-04-A7-F7
         00-0A-E4-04-D2-FC           00-0A-E4-05-48-2B
         00-0A-E4-05-B7-DF           00-0A-E4-06-05-FE
         00-0A-E4-06-55-EC           00-0A-E4-07-19-3B
         00-0A-E4-08-0A-02           00-0A-E4-08-7F-31
         00-0A-E4-08-B2-89           00-0A-E4-09-75-D8
         00-0A-E4-09-BB-9D           00-0A-E4-09-CF-24
         00-0A-E4-09-FC-2B           00-0A-E4-0A-71-5A
         00-0A-E4-0A-9D-DA           00-0A-E4-0B-61-29
         00-0A-E4-0B-BB-FC           00-0A-E4-0B-BC-0F
         00-0A-E4-0B-D9-BE           00-0A-E4-0C-9D-0D
         00-0A-E4-6F-00-00           00-0A-E4-6F-FF-FF
         00-13-65-FE-F3-2C           00-13-65-FF-ED-2B
         00-15-9B-FE-A4-66           00-15-9B-FF-24-B5
         00-16-CA-00-00-00           00-16-CA-01-FF-FF
         00-16-CA-F2-74-20           00-16-CA-F4-BE-0F
         00-17-65-F6-94-C0           00-17-65-F7-38-CF
         00-17-65-FD-00-00           00-17-65-FF-FF-FF
         00-18-B0-33-90-00           00-18-B0-35-DF-FF
         00-19-69-83-25-40           00-19-69-85-5F-FF

      Total Ranges: 30
```

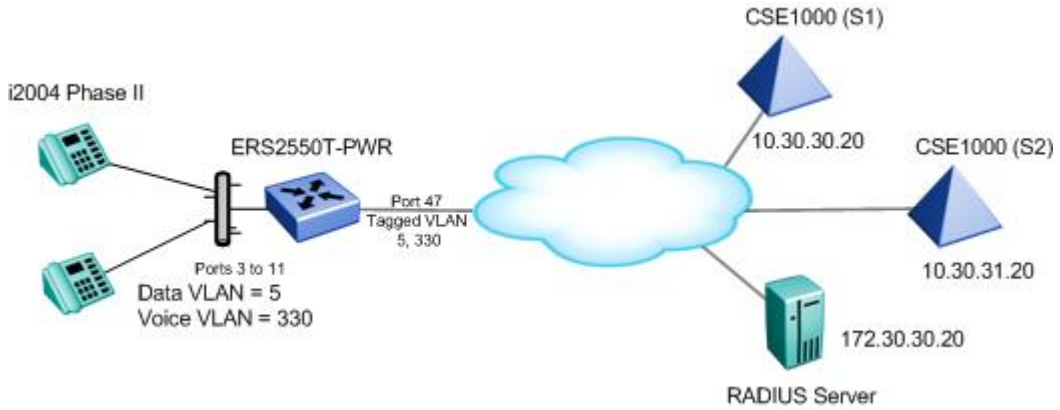
On the ERS5520, verify the following information:

Option	Verify
Lowest MAC Address Highest MAC Address	Verify the ADAC MAC address range you added for the i2002 phone set from ***00-0A-E4-6F-00-00*** to ***00-0A-E4-6F-FF-FF***

7.4.4 ADAC Configuration Example – LLDP Detection using ERS2500

For this configuration example, we will configure the following:

- Configure the Ethernet Routing Switch 2550T-PWR for ADAC using LLDP detection with VLAN 330 for the Voice VLAN
- Configure data VLAN 5
- Configure port 47 on the Ethernet Routing Switch 2550T-PWR as the ADAC uplink port
- Setup the IP Phone 2004 Phone Sets with VLAN 330 and use DHCP to set S1 and S2 configuration



Please note that the ERS2500 ADAC LLDP detection is only used to detect an IP Phone via LLDP. On ports where you wish to support both voice and data, as in this example, you must manually provision the voice VLAN on IP Phone set.

7.4.4.1 Ethernet Routing Switch 2550T-PWR Configuration

7.4.4.1.1 Go to configuration mode.

ERS2550T-PWR Step 1 - Enter configuration mode

```
2550T-PWR>enable
2550T-PWR#configure terminal
```

7.4.4.1.2 Remove port members from default VLAN 1

ERS2550T-PWR Step 1 – Remove all port member from default VLAN

```
2550T-PWR(config)#vlan members remove 1 ALL
```

7.4.4.1.3 Configure ADAC

ERS2550T-48T-PWR Step 1 – Configure ADAC globally using VLAN 330 with tagged mode and uplink port 47

```
2550T-PWR(config)#adac voice-vlan 330
2550T-PWR(config)#adac op-mode tagged-frames
2550T-PWR(config)#adac uplink-port 47
2550T-PWR(config)#adac enable
```

Please note the following:

- VLAN 330 must not exist prior to configuring ADAC.
- The command *adac uplink-port 47* will automatically enable VLAN tagging on port 47 and add this port as a member of VLAN 330.

7.4.4.1.4 Add the data VLAN

ERS2550T-PWR Step 1 – Create the data VLAN 5, name it 'data', and add port members

```
2550T-PWR(config)#vlan create 5 name data type port
2550T-PWR(config)#vlan members add 5 3-11,47
```

7.4.4.1.5 Enable ADAC at interface level

ERS2550T-48T-PWR Step 1 – Disable ADAC MAC detection and set tagged mode to untag-pvid-only. By default, ADAC LLDP detection is already enabled

```
2550T-PWR(config)#interface fastEthernet 3-11
2550T-PWR(config-if)# adac tagged-frames-tagging untag-pvid-only
2550T-PWR(config-if)#adac enable
2550T-PWR(config-if)#exit
```

7.4.4.1.6 Configure PoE levels

ERS2550T-48T-PWR – Set PoE Power level high on all VoIP ports

```
2550T-PWR(config)#interface fastEthernet 3-11
2550T-PWR(config-if)#poe poe-priority high
2550T-PWR(config-if)#exit
```

7.4.4.1.7

7.4.4.1.8 Enable LLDP on ports 3-11

ERS2550T-48T-PWR Step 1 – Enable ADAC on port members 3 to 11

```
2550T-PWR(config)#interface fastEthernet 3-11
2550T-PWR(config-if)#lldp status txandRx config-notification
2550T-PWR(config-if)#lldp tx-tlv local-mgmt-addr port-desc sys-cap sys-desc
sys-name
2550T-PWR(config-if)#exit
```

7.4.4.2 i2004 Setup

i2004 Step 1 – IP Phone 2004 Phase II Phone Set configuration assuming we will use the DHCP server to provide the IP Phone 2004 phone set with the call server information, it should be configured as follows.

```
LLDP Enable? [1=Y, 0=N]: 1
DHCP? [0-No, 1-Yes]: 1
DHCP: 0-Full, 1-Partial: 0
VOICE VLAN? [0-No, 1-Y]: 1
VLAN Cfg? 0-Auto, 1-Man: 1
VOICE VLAN ID: 330
GARP Ignore? [0-No, 1-Yes]: 1
```

7.4.4.3 Verify ADAC LLDP Dectection

7.4.4.3.1 ADAC Global Information

Step 1 – Verify ADAC Global Settings
2550T-PWR#***show adac***
Result:

```
            ADAC Global Configuration
      ---------------------------------------
      ADAC Admin State:  Enabled
      ADAC Oper State:  Enabled
      Operating Mode:  Tagged Frames
      Traps Control Status:  Enabled
      Voice-VLAN ID:  330
      Call Server Port:  None
      Uplink Port:  47
```

On the ERS2550T-PWR, verify the following information:

Option	Verify
ADAC Admin State: ADAC Oper State:	Verify that the ADAC administrative and operation state is ***Enabled***
Operating Mode	Verify the ADAC operating mode is set for ***Tagged Frames***
Traps Control Status:	Verify the ADAC traps is set for ***Enabled***
Voice-VLAN ID:	Verify the ADAC voice VLAN is set for ***330***
Uplink Port:	Verrify the ADAC uplink port is configured for port ***47***

7.4.4.3.2 Verify ADAC at interace level

Assuming ADAC has detected an i2004 on port 5.

Step 2 – Verify ADAC at interface level
2550T-PWR#***show adac interface 3-11***
Result:

```
                Auto        Oper       Auto
Port  Type  Detection   State      Configuration  T-F PVID   T-F Tagging
----  ----  ---------   --------   -------------  ---------  ---------------
3     T     Enabled     Enabled    Not Applied    No Change  Untag PVID Only
4     T     Enabled     Enabled    Not Applied    No Change  Untag PVID Only
5     T     Enabled     Enabled    Applied        No Change  Untag PVID Only
6     T     Enabled     Enabled    Not Applied    No Change  Untag PVID Only
7     T     Enabled     Enabled    Not Applied    No Change  Untag PVID Only
8     T     Enabled     Enabled    Not Applied    No Change  Untag PVID Only
9     T     Enabled     Enabled    Not Applied    No Change  Untag PVID Only
10    T     Enabled     Enabled    Not Applied    No Change  Untag PVID Only
11    T     Enabled     Enabled    Not Applied    No Change  Untag PVID Only
```

On the ERS2550T-PWR, verify the following information:

Option	Verify
Type	Verify that the ADAC type is set for ***T*** indicating the port is configured for ADAC type of tagged port
Auto Detection	Verify the ADAC detection is set to ***Enabled*** for port 3 to 11
Oper State:	Verify the ADAC operation state is set to ***Enabled*** for port 3 to 11
Auto Configuration	In our example, port 5 should indicate ***Applied*** while ports 3 to 4 and 6 to 11 should indicate ***Not Applied*** as only port 5 has an IP Phone set detected by ADAC
T-F PVID	Verify the tagged frames ***No Change*** which indicates do not change the default PVID
T-F Tagging	Verify the port members 3 to 11 are set to ***Untag PVID only***

7.4.4.3.3 Verify LLDP at interace level

Assuming ADAC has detected an i2004 on port 5.

Step 2 – Verify LLDP at interface level

```
2550T-PWR# show lldp port 5 neighbor detail
```

Result:

```
-------------------------------------------------------------------------------
                            lldp neighbor
-------------------------------------------------------------------------------
Port: 5     Index: 14                 Time: 7 days, 02:08:45
        ChassisId: Network address    ipV4  10.60.30.33
        PortId:    MAC address        00:0a:e4:09:72:e7
        SysCap:    TB / TB            (Supported/Enabled)
        PortDesc:  Nortel IP Phone
        SysDescr:  Nortel IP Telephone 2004, Firmware:C604DB1

-------------------------------------------------------------------------------
Sys capability: O-Other; R-Repeater; B-Bridge; W-WLAN accesspoint; r-Router;
T-Telephone; D-DOCSIS cable device; S-Station only.
```

On the ERS2550T-PWR, verify the following information:

Option	Verify

ipV4	Verify that the IP Phone set has an IP address belongs to the VLAN 330 subnet.
MAC Address	This field indicates the MAC address of the IP Phone set.
PortDesc:	Verify the LLDP PortDesc is ***Nortel IP Phone*** for port 5
SysDescr	Verify the LLDP SysDescr is ***Nortel IP Telephone 2004*** for port 5. The firmware displayed will vary depending on the firmware loaded on the IP Phone.

7.4.4.3.4 Verify VLAN information

Assuming ADAC has detected an i2004 on port 5.

Step 2 – Verify VLAN at interface level

```
2550T-PWR#show vlan interface vids 3-11
```

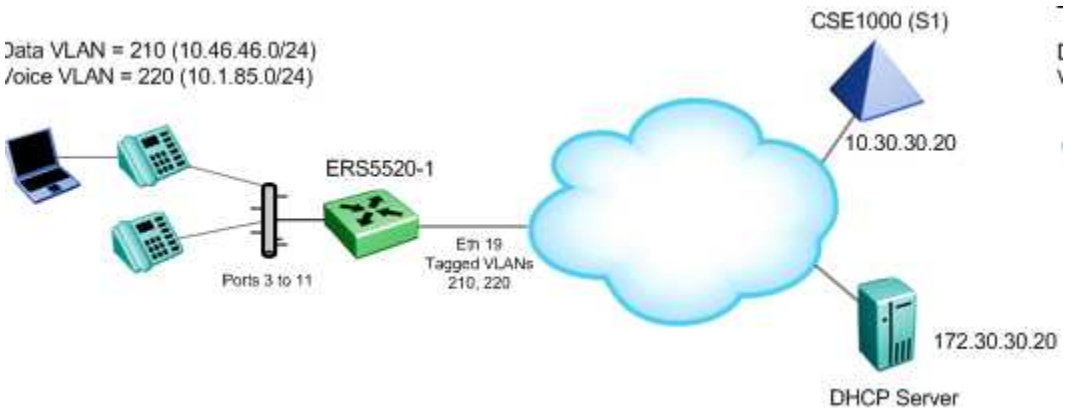
Result:

```
Port VLAN VLAN Name         VLAN VLAN Name         VLAN VLAN Name
---- ---- ----------------  ---- ----------------  ---- ----------------
3    5    data
---- ---- ----------------  ---- ----------------  ---- ----------------
4    5    data
---- ---- ----------------  ---- ----------------  ---- ----------------
5    5    data              330  Voice_VLAN
---- ---- ----------------  ---- ----------------  ---- ----------------
6    5    data
---- ---- ----------------  ---- ----------------  ---- ----------------
7    5    data
---- ---- ----------------  ---- ----------------  ---- ----------------
8    5    data
---- ---- ----------------  ---- ----------------  ---- ----------------
9    5    data
---- ---- ----------------  ---- ----------------  ---- ----------------
10   5    data
---- ---- ----------------  ---- ----------------  ---- ----------------
11   5    data
---- ---- ----------------  ---- ----------------  ---- ----------------
```

On the ERS2550T-PWR, verify the following information:

Option	**Verify**
VLAN and VLAN Name	Verify that that port 5 upon detecting an IP Phone is a member of both the data VLAN ***5*** and ADAC voice VLAN ***330***.

7.4.5 ADAC Configuration Example – LLDP-MED using ERS5500 and Nortel IP Phone Sets



For this configuration example, we will configure the following

- Configure the ERS5520 as a Layer 2 switch
- ERS5520-1
  - Enable ADAC with voice VLAN 220 and uplink port 19
  - Enable ADAC detection for LLDP only and disable ADAC MAC detection
  - Enable ports 3 to 11 to allow untagged data VLAN (PVID = 210) and tagged voice VLAN (PVID = 220)
  - Enable LLDP-MED on ports 3 to 11
  - Set the PoE priority level to high on ports 3 to 11 for the IP Phone sets
- Setup the IP phone sets for LLDP-MED and enable it to dynamically get it's IP address and S1 information via DHCP

NOTE: Not included in this configuration example is the setup of the next-hop router for the ERS5520. It will have to be setup for IP routing with DHCP reply for both the voice and data VLANs.

7.4.5.1 ERS5520 Configuration

7.4.5.1.1 Go to configuration mode.

ERS5520-1 Step 1 - Enter configuration mode
5520-1>***enable*** 5520-1#***configure terminal***

7.4.5.1.2 Create VLAN 210

ERS5520-1 Step 1 – Remove port members from the default VLAN, create data VLAN 210, and add port members
5520-1(config)#***vlan members remove 1 ALL*** 5520-1(config)#***vlan create 210 name data type port***

7.4.5.1.3 Enable ADAC Globally

ERS5520-1 Step 1 – Enable ADAC using VLAN 220, set the operation mode to tagged-frames, and add the uplink port 19

```
5520-1(config)#adac voice-vlan 220
5520-1(config)#adac op-mode tagged-frames
5520-1(config)#adac uplink-port 19
5520-1(config)#adac enable
```

7.4.5.1.4 Set access port member to untag the default data VLAN 210

ERS5520-1 Step 1 – Add port members the data VLAN 210

```
5520-1(config)#vlan members add 210 3-11,19
```

7.4.5.1.5 Enable ADAC at interface level

ERS5520-1 Step 1 – Enable ADAC on port members 3 to 11, set the ADAC detection to LLDP only, and enable the ADAC tag mode to tagged frames and untag the default VLAN

```
5520-1(config)#interface fastEthernet 3-11
5520-1(config-if)#adac detection lldp
5520-1(config-if)#no adac detection mac
5520-1(config-if)#adac tagged-frames-tagging untag-pvid-only
5520-1(config-if)#adac enable
5520-1(config-if)#exit
```

Note that by default, ADAC detection for MAC and LLDP is enabled. Hence, the command *adac detection lldp* is not required and only used in this example to show that there is a command to enable or disable the detection type.

7.4.5.1.6 Enable LLDP-MED

ERS5520-1 Step 1 – Enable LLDP VLAN name on port 3 to 11

```
5520-1(config)#interface fastEthernet 3-11
5520-1(config-if)#lldp tx-tlv local-mgmt-addr port-desc sys-cap sys-desc sys-name
5520-1(config-if)#lldp status txAndRx config-notification
5520-1(config-if)#lldp tx-tlv med extendedPSE med-capabilities network-policy
5520-1(config-if)#exit
```

7.4.5.1.7 Configure PoE levels

ERS5520-1 Step 1 – Set PoE Power level high on all VoIP ports

```
5520-1(config)#interface fastEthernet 3-11
5520-1 (config-if)#poe poe-priority high
5520-1 (config-if)#exit
```

7.4.5.1.8 Set Management VLAN

ERS5520-1 Step 1 – Configure the data VLAN 210 as the management VLAN and set the management IP address

```
5520-1(config)#vlan mgmt 210
5520-1(config)#ip address switch 10.46.46.2 netmask 255.255.255.0 default-gateway 10.46.46.1
```

7.4.5.1.9 Enable SNMP Management

ERS5520-1 Step 1 – If you wish, enable SNMP management by entering the following command

```
5520-1(config)#snmp-server enable
```

7.4.5.1.10 Enable IP Spoofing

ERS5520-1: Step 1 – Enable IP DHCP Snooping for data VLAN 10and Voice VLAN 220

```
5520-1(config)#ip dhcp-snooping vlan 10
5520-1(config)#ip dhcp-snooping vlan 220
5520-1(config)#ip dhcp-snooping enable
```

ERS5520-1: Step 2 – Enable IP Arp Inspection for data VLAN 524 and Voice VLAN 330

```
5520-1(config)#ip arp-inspection vlan 10
5520-1(config)#ip arp-inspection vlan 220
```

ERS5520-1: Step 3 – Enable core ports 21 and 22 as a trusted ports

```
5520-1(config)#interface fastEthernet 21,22
5520-1(config-if)#ip dhcp-snooping trusted
5520-1(config-if)#ip arp-inspection trusted
5520-1(config-if)#exit
```

ERS5520-1: Step 4 – Enable IP Source Guard on ports 12 to 18

```
5520-1(config)#interface fastEthernet 12-18
5520-1(config-if)#ip verify source
5520-1(config-if)#exit
```

7.4.5.1.11

7.4.5.2 Phone Setup

The Nortel IP phone set should be setup as follows.

Nortel IP Phone Step 1 – The IP phone set should be setup as follows

```
EAP Enable? [1=Y, 0=N]: 0
LLDP Enable? [1=Y, 0=N]: 1 ←
DHCP? [0-No, 1-Yes]: 1
DHCP: 0-Full, 1-Partial: 0
Voice VLAN? [0-N, 1-Y]: 1
VLAN Cfg? 0- Auto, 1-Man: 0
LLDP MED? 0-No, 1-Yes: 1 ←
GARP Ignore? [0-No, 1-Yes]: 1
```

7.4.5.3 Verify operations

7.4.5.3.1 Verify LLDP-MED Operations

The following command is used to retrieve LLDP neighbor information from the IP Phone 2004 phone set assuming we have an IP Phone set connected to port 4 on the ERS5520

Step 1 – Verify LLDP neighbor details by using the following command:

```
5520-1# show lldp port 4 neighbor detail
```

Result:

```
--------------------------------------------------------------------------------
                              lldp neighbor
--------------------------------------------------------------------------------
Port: 4     Index: 4                  Time: 0 days, 00:01:43
        ChassisId: Network address    ipV4  47.133.58.220
        PortId:    MAC address        00:0a:e4:09:72:e7
        SysCap:    TB / TB            (Supported/Enabled)
        PortDesc:  Nortel IP Phone
        SysDescr:  Nortel IP Telephone 2004, Firmware:C604DB1


 PVID: 0                              PPVID Supported: not supported(0)
 VLAN Name List: 220                  PPVID Enabled: none

 Dot3-MAC/PHY Auto-neg: supported/enabled       OperMAUtype:  100BaseTXFD
 PSE MDI power:         not supported/disabled  Port class:   PD
 PSE power pair:        signal/not controllable Power class:  1
 LinkAggr: not aggregatable/not aggregated      AggrPortID:   0
                                                MaxFrameSize: 1522
 PMD auto-neg:          (FdxS, FdxB)Pause, 1000Base(XFD, T)

 MED-Capabilities: CNSD / CNDI        (Supported/Current)
 MED-Device type:  Endpoint Class 3
 MED-Application Type: Voice                    VLAN ID: 220
 L2 Priority: 6         DSCP Value: 46          Tagged Vlan, Policy defined
 Med-Power Type: PD Device            Power Source: Unknown
 Power Priority: High                 Power Value:    5.4 Watt
 HWRev:                               FWRev: C604DB1
 SWRev:                               SerialNumber:
 ManufName: Nortel-01                 ModelName: IP Phone 2004
 AssetID:
```

```
--------------------------------------------------------------------------------
Sys capability: O-Other; R-Repeater; B-Bridge; W-WLAN accesspoint; r-Router;
T-Telephone; D-DOCSIS cable device; S-Station only.
Med Capabilities-C: N-Network Policy; L-Location Identification; I-Inventory;
S-Extended Power via MDI - PSE; D-Extended Power via MDI - PD.
```

Step 2 – Verify LLDP-MED operations by using the following command:

```
5520-1# show lldp port 4 neighbor med
```

Result:

```
--------------------------------------------------------------------------------
                              lldp neighbor
--------------------------------------------------------------------------------
Port: 4     Index: 4                  Time: 0 days, 00:01:43
        ChassisId: Network address    ipV4  47.133.58.220
        PortId:    MAC address        00:0a:e4:09:72:e7
        SysCap:    TB / TB            (Supported/Enabled)
        PortDesc:  Nortel IP Phone
        SysDescr:  Nortel IP Telephone 2004, Firmware:C604DB1


 MED-Capabilities: CNSD / CNDI        (Supported/Current)
 MED-Device type:  Endpoint Class 3
 MED-Application Type: Voice                    VLAN ID: 220
 L2 Priority: 6         DSCP Value: 46          Tagged Vlan, Policy defined
 Med-Power Type: PD Device            Power Source: Unknown
 Power Priority: High                 Power Value:    5.4 Watt
--------------------------------------------------------------------------------
Sys capability: O-Other; R-Repeater; B-Bridge; W-WLAN accesspoint; r-Router;
T-Telephone; D-DOCSIS cable device; S-Station only.
Med Capabilities-C: N-Network Policy; L-Location Identification; I-Inventory;
S-Extended Power via MDI - PSE; D-Extended Power via MDI - PD.
```

On the ERS5500 verify the following information:

Option	Verify
ChassissId:	Displays the IP address of the PD device
PortId:	Displays the MAC address of the PD device
PortDesc:	Verify that ***Nortel IP Phone*** is displayed.
SysDescr:	Displays as the Nortel IP phone model, for this example, ***Nortel IP Phone 2004*** should be displayed. Also, the Nortel IP Phone firware should be displayed.
L2 Priority:	Displays as ***6*** indicating the 802.1p value for a CoS class of Premium.
DSCP Value:	Displays as decimal ***46*** indicating the DSCP value for a CoS class of Premium.
VLAN ID:	Displays as ***220***, the Voice VLAN ID.
Power Priority:	Displays as ***High***, the PoE priority level. If not, check the port level PoE setting.
Power Value:	Displays the PoE power consumed by the PD device.

7.4.5.3.2 Verify ADAC Operations

The following command is used to view ADAC detection. Assuming we have IP Phones connected to ports 3 and 5, the results should be as follows

Step 1 – Verify LLDP neighbor details by using the following command:

```
5520-1#show adac interface 3-11
```

Result:

```
                Auto       Oper       Auto
Port  Type  Detection  State      Configuration  T-F PVID   T-F Tagging
----  ----  ---------  --------   -------------  ---------  ---------------
3     T     Enabled    Enabled    Applied        No Change  Untag PVID Only
4     T     Enabled    Enabled    Not Applied    No Change  Untag PVID Only
5     T     Enabled    Enabled    Applied        No Change  Untag PVID Only
6     T     Enabled    Enabled    Not Applied    No Change  Untag PVID Only
7     T     Enabled    Enabled    Not Applied    No Change  Untag PVID Only
8     T     Enabled    Enabled    Not Applied    No Change  Untag PVID Only
9     T     Enabled    Enabled    Not Applied    No Change  Untag PVID Only
10    T     Enabled    Enabled    Not Applied    No Change  Untag PVID Only
11    T     Enabled    Enabled    Not Applied    No Change  Untag PVID Only
```

On the ERS5520, verify the following information:

Option	Verify
Type	Verify that the ADAC type is set for ***T*** indicating the port is configured for ADAC type of tagged port
Auto Detection	Verify the ADAC detection is set to ***Enabled*** for ports 3 to 11
Oper State:	Verify the ADAC operation state is set to ***Enabled*** for port 3 to 11
Auto Configuration	In our example, ports 3 and 5 should indicate ***Applied*** while ports 4 and 6 to 11 should indicate ***Not Applied*** as only ports 3 and 5 have IP Phone sets detected by ADAC
T-F PVID	Verify the tagged frames ***No Change*** which indicates do not change the default PVID
T-F Tagging	Verify the port members 12 to 18 are set to ***Untag PVID only***

7.4.5.3.3 Verify ADAC Detection

The following command is used to view ADAC detection configuration.

Step 1 – Verify LLDP neighbor details by using the following command:

```
5520-1# show adac detection interface 3-11
```

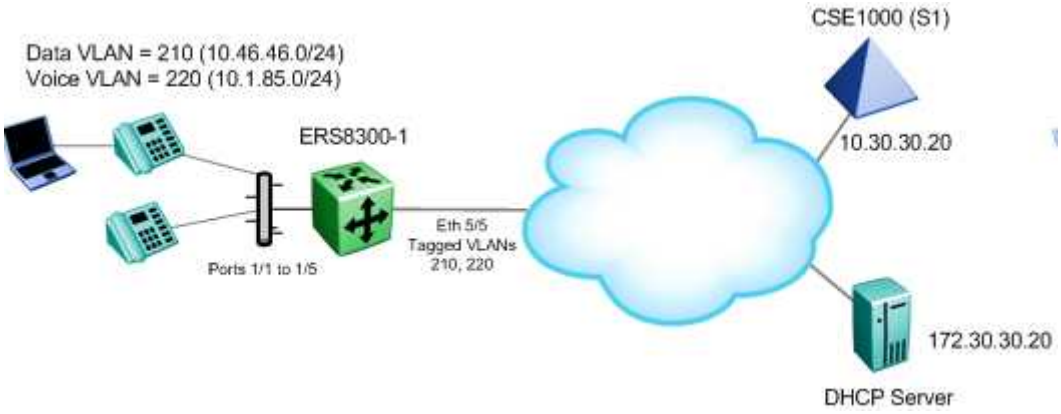
Result:

```
            MAC         LLDP
      Port  Detection   Detection
      ----  ---------   ---------
      3     Disabled    Enabled
      4     Disabled    Enabled
      5     Disabled    Enabled
      6     Disabled    Enabled
      7     Disabled    Enabled
      8     Disabled    Enabled
      9     Disabled    Enabled
      10    Disabled    Enabled
      11    Disabled    Enabled
```

On the ERS5520, verify the following information:

Option	Verify
MAC Dectection	For this example, we disabled ADAC MAC detection, hence the value should be ***Disabled***
LLDP Detection	For this example, we enabled ADAC LLDP detection, hence the value should be ***Enabled***

7.4.6 Configuration Example – LLDP-MED using ERS8300, and IP Phone 2004 IP Phone Sets



For this configuration example, we will configure the following

- Configure ERS8300 as a Layer 2 switch
- ERS8300-1
  - Enable ADAC with voice VLAN 220 and uplink port 5/5
  - Enable ports 1/1 to 1/5 as untagPvidOnly to allow untagged data VLAN (PVID = 210) and tagged voice VLAN (PVID = 220)
  - Enable LLDP-MED on ports 1/1 to 1/5
  - Set the PoE priority level to high on ports 1/1 to 1/5 for the IP Phone sets
- Setup the IP phone sets for LLDP-MED and enable it to dynamically get it's IP address and S1 information via DHCP

NOTE: Not including in this configuration example is the setup of the next-hop router for the ERS8300. It will have to be setup for IP routing with DHCP reply for both the voice and data VLANs.

7.4.6.1 ERS8300 Configuration

7.4.6.1.1 Go to configuration mode.

ERS8300-1 Step 1 - Enter configuration mode

```
ERS8310-1>enable
Password: ******
ERS8310-1#configure terminal
```

7.4.6.1.2 Enable VLAN tagging on access port members

ERS8300-1 Step 1 – Enable VLAN tagging on ports 1/1 to 1/5

```
ERS8310-1:5(config)#interface fastEthernet 1/1-1/5
ERS8310-1:5(config-if)#encapsulation dot1q
ERS8310-1:5(config-if)#exit
```

7.4.6.1.3 Create Data VLAN 210

ERS8300-1 Step 1 – Remove port members from the default VLAN 1 and create VLAN 210, and add port members

```
ERS8310-1:5(config)#vlan members remove 1 1/1-1/5
ERS8310-1:5(config)#vlan create 210 type name Data port 1
ERS8310-1:5(config)#vlan members add 210 1/1-1/5
```

7.4.6.1.4 Enable Spanning Tree Faststart on access port

ERS8300-1 Step 1 – Enable STP Faststart on ports 1/1 to 1/5

```
ERS8310-1:5(config)#interface fastEthernet 1/1-1/5
ERS8310-1:5(config-if)#spanning-tree stp 1 faststart
ERS8310-1:5(config-if)#exit
```

7.4.6.1.5 Create Voice VLAN 220

ERS8300-1 Step 1 – Create VLAN 220 and add port members

```
ERS8310-A:5(config)# vlan create 220 name voice type port 1
ERS8310-A:5(config)#vlan members add 220 1/1-1/5
```

You must name the voice VLAN ***"voice"*** in order to enable ADAC and also assign port membership prior to enabling ADAC on an interface. If not, you will be prompted with an error message "*Error: port x, No voice VLAN configured on this port."*

7.4.6.1.6 Configure access port membes to untag the default VLAN

ERS8300-1 Step 1 – Configure port 1/1 to 1/5 for untag default VLAN and set the default VLAN to 210

```
ERS8310-1:5(config)#vlan ports 1/1-1/5 tagging untagpvidonly
ERS8310-1:5(config)#interface fastEthernet 1/1-1/5
ERS8310-1:5(config-if)#default-vlan-id 210
ERS8310-1:5(config-if)#exit
```

7.4.6.1.7 Enable ADAC at interface level

ERS8300-1 Step 1 – Enable ADAC on port members 1/1 to 1/5

```
ERS8310-1:5(config)#interface fastEthernet 1/1-1/5
ERS8310-1:5(config-if)#adac port 3-11 enable
ERS8310-1:5(config-if)#exit
```

7.4.6.1.8 Enable LLDP-MED

ERS8300-1 Step 1 – Enable LLDP VLAN name on port 1/1 to 1/5

```
ERS8310-1:5(config)#interface fastEthernet 3-11
ERS8310-1:5(config-if)#lldp tx-tlv local-mgmt-addr
ERS8310-1:5(config-if)#lldp tx-tlv sys-name sys-desc sys-cap
ERS8310-1:5(config-if)#lldp tx-tlv port-desc
ERS8310-1:5(config-if)#lldp status txAndRx
ERS8310-1:5(config-if)#lldp tx-tlv med capabilities extendedPSE
ERS8310-1:5(config-if)#lldp tx-tlv med network-policy
ERS8310-1:5(config-if)#exit
```

7.4.6.1.9 Configure PoE levels

ERS8300-1 Step 1 – Set PoE Power level high on all VoIP ports

```
ERS8310-1:5(config)#interface fastEthernet 1/1-1/5
ERS8310-1:5(config)#poe priority high
ERS8310-1:5(config)#exit
```

7.4.6.2 Phone Setup

The IP phone set should be setup as follows.

Nortel IP Phone Step 1 – The IP phone set should be setup as follows

```
EAP Enable? [1=Y, 0=N]: 0
LLDP Enable? [1=Y, 0=N]: 1 ←
DHCP? [0-No, 1-Yes]: 1
DHCP: 0-Full, 1-Partial: 0
Voice VLAN? [0-N, 1-Y]: 1
VLAN Cfg? 0- Auto, 1-Man: 0
LLDP MED? 0-No, 1-Yes: 1 ←
GARP Ignore? [0-No, 1-Yes]: 1
PSK SRTP? [0-No, 1-Yes]: 0
```

7.4.6.3 Verify operations

7.4.6.3.1 Verify LLDP-MED Operations

The following command is used to retrieve LLDP neighbor information from the IP Phone 2004 phone set assuming we have an IP Phone set connected to port 1/1 on the ERS8300

Step 1 – Verify LLDP neighbor details by using the following command:

```
ERS8310-1:5# show lldp neighbor 1/1
```

Result:

```
================================================================================
                                    LLDP NEIGHBOR
================================================================================

PORT  INDEX CHASSIS  CHASSIS           PORT       PORT
NUM         SUBTYPE  ID                SUBTYPE    ID

PORT DESC                 SYS NAME                  SYS DESC
--------------------------------------------------------------------------------

1/1   7     NetworkAddr  47.133.58.220 MAC        00:0a:e4:09:72:e7

Nortel IP Phone                                     Nortel IP Telephone 2004, Fi
rmware:C604DB1

================================================================================
                                    lldp Remote-sys-data Sys Capabilitities
================================================================================
Repeater Bridge   WLAN       Router   Telephone  DOCICS   Station  Other
                  Access Pt                      Cable    Only
                            (Supported/Enabled)

--------------------------------------------------------------------------------
No/No    Yes/Yes     No/No     No/No    Yes/Yes     No/No     No/No     No/No


Total Neighbors : 1
```

Step 2 – Verify LLDP-MED operations by using the following command:

```
ERS8310-1:5#show lldp neighbor med  network-policy
```

Result:

```
================================================================================
                                    LLDP NEIGHBOR (MED)

================================================================================
--------------------------------------------------------------------------------
PORT  INDEX CHASSIS  CHASSIS           PORT       PORT
NUM         SUBTYPE  ID                SUBTYPE    ID
--------------------------------------------------------------------------------

1/1   7     NetworkAddr  47.133.58.220 MAC        00:0a:e4:09:72:e7

MED-Application Type           : Voice
VLAN ID                        : 220
Priority Tagged                : Yes
L2 Priority                    : 6
DSCP Value                     : 40
```

On the ERS8300 verify the following information:

Option	Verify
CHASSIS ID:	Displays the IP address of the PD device
PORT ID:	Displays the MAC address of the PD device
PORT DESC:	Verify that ***Nortel IP Phone*** is displayed.
SYS DESC:	Displays as the Nortel IP phone model, for this example, ***Nortel IP Phone 2004*** should be displayed. Also, the Nortel IP Phone firware

	should be displayed.
PORT NUM:	Displays as ***1/1*** indicating physical port number used on the ERS8300.
MED-Application Type:	Displays as ***Voice*** indicating a IP Phone is discovered.
L2 Priority:	Displays as ***6*** indicating the 802.1p value for a CoS class of Premium.
DSCP Value:	Displays as decimal ***40*** indicating the DSCP value for a CoS class of Premium.
VLAN ID:	Displays as ***220***, the Voice VLAN ID.

8. EAPoL Support

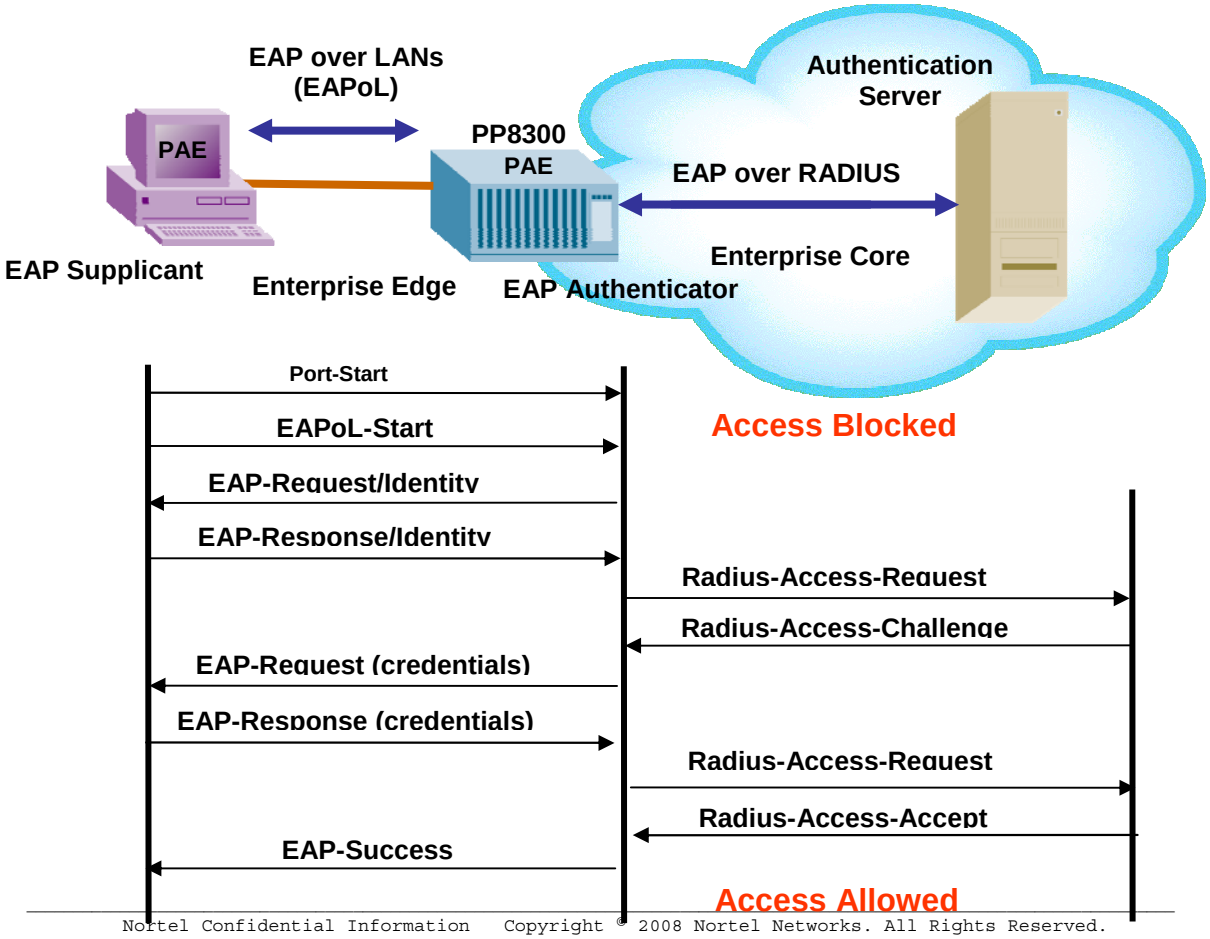
8.1 EAP Overview

Extensible Authentication Protocol over LAN is a port-based network access control protocol. EAPoL provides a method for performing authentication at the edge of the network in order to obtain network access based on the IEEE 802.1X standard.

802.1X specifies a protocol used between devices (EAP Supplicants) that desire access to the network and devices providing access to the network (EAP Authenticator). It also specifies the requirements for the protocol used between the EAP Authenticator and the Authentication server, i.e. RADIUS. The following are some of the 802.1X definitions:

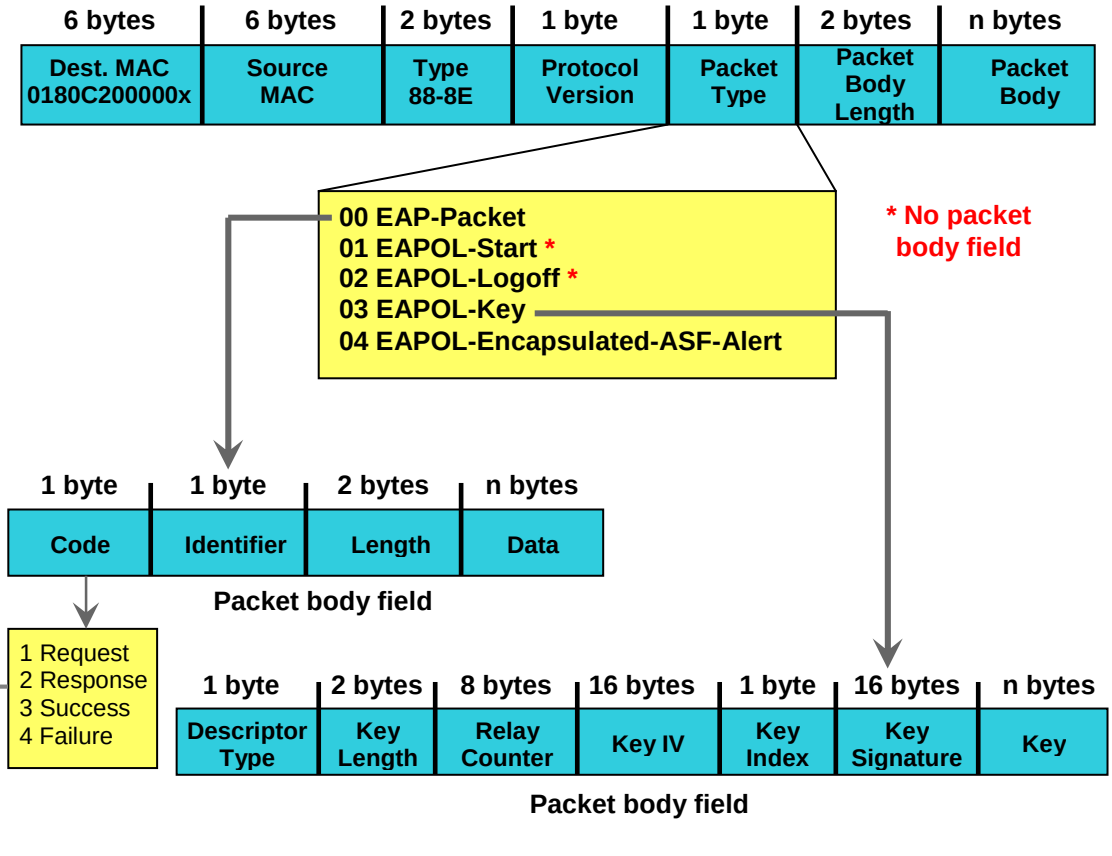
- Authenticator: The entity that requires the entity on the other end of the link to be authenticated. Authenticator passes authentication exchanges between supplicant and authentication server.
- Supplicant: The entity being authenticated by the Authenticator and desiring access to the services of the Authenticator.
- Port Access Entity (PAE): The protocol entity associated with a port. May support functionality of Authenticator, Supplicant or both.
- Authentication Server: An entity providing authentication service to the Authenticator. May be co-located with Authenticator, but most likely an external server.

Figure 14: EAP Overview



802.1x Ethernet Frame

Figure 15: EAP Frame



EAP Request and Response Code Types

- Type code 1: Identity
- Type code 2: Notification
- Type code 3: NAK
- Type code 4: MD-5 Challenge
- Type code 5: One-time password (OTP)
- Type code 6: Generic Token Card
- Type code 13: TLS

EAP and RADIUS related RFCs

- RFC2284 – PPP Extensible Authentication Protocol
- RFC2716 – PPP EAP Transport Level Security (TLS) Authentication Protocol
- RFC2865 (Obsoletes RFC2138) – RADIUS
- RFC2548 – Microsoft Vendor specific RADIUS Attributes

8.2 EAP Support on Nortel IP Phone Sets

EAP can be configured using MD5 on the IP Phone 11x0 series, the IP Phone 2007, and the IP Phone 2004 phase II phone sets.

8.3 EAP and ADAC

EAP and ADAC are support on the ERS 5500 using Release 5.0 and greater and the ES 470 using Release 3.7 and greater.

ADAC and EAP are mutually exclusive on

- The Call Server port
- The Uplink port

ADAC and EAP can both be enabled on telephony ports as follows:

- The ports must be configured to allow non-EAP MAC addresses
- Guest VLAN must not be configured on the ports

To enable ADAC on an EAP port, you must perform the following:

- On the switch, globally enable support for non-EAP MAC addresses
- On each telephony port, enable support for non-EAP MAC addresses
- On each telephony port, enable EAP Multihost
- On the telephony ports, ensure that Guest VLAN is disabled
- On the switch, enable EAP globally
- Configure and enable ADAC on the ports

When you configure ADAC and EAP, the following restrictions apply:

- If ADAC is enabled, you cannot enable or disable EAP or EAP Multihost on the port

You can enable ADAC on the port only if:

- EAP is disabled on the port OR EAP and Multihost are enabled on the port
- EAP does not change the VLAN configuration for ADAC-enabled ports. ADAC changes to the VLAN configuration take priority over EAP configurations

8.4 EAP Support on Nortel Switches

Table 25 shown below display's the various EAP features supported on the Nortel switches used for this TCG.

Table 32: EAP Support on Nortel Switches

Authentication Feature	Switch				
	Ethernet Switch 470	Ethernet Routing Switch 2500	Ethernet Routing Switch 4500	Ethernet Routing Switch 5500	Ethernet Routing Switch 8300
Local MAC Security	Yes	Yes	Yes	Yes	Yes
Non EAP (Centralized MAC) Security	Yes	Yes	Yes	Yes	Yes
*Guest VLAN	Yes	Yes	Yes	Yes	Yes
Single Host Single Authentication (SHSA) – 802.1x	Yes	Yes	Yes	Yes	Yes
Multiple Host Single Authentication (MHSA) – 802.1x	Yes	Yes	Yes	Yes	Yes
Multiple Host Multiple Authentication (MHMA) – 802.1x	Yes (3.7)	Yes	Yes	Yes	Yes
SHSA with Guest VLAN	Yes	Yes	Yes	Yes	Yes
*MHSA with Guest VLAN	Yes	Yes	Yes	Yes	Future
*MHMA with Guest VLAN	Yes	Yes	Yes	Yes	Yes
EAP with Dynamic RADIUS VLAN Assignment	Yes, with SHSA	Yes, with SHSA and MHMA	Yes, with SHSA and MHMA	Yes, with SHSA and MHMA[1]	Yes, with SHSA
Non-EAP Phone	No	No	Yes	Yes	No
Policy Support	No	No	No	Yes	No
Tagged/Untagged					
Per VLAN Egress Tagging	Yes	Yes	Yes	Yes	Yes
Tagged and untagged per port	Yes	Yes	Yes	Yes	Yes
Tagging with EAP	Yes	Yes	Yes	Yes	**Yes

* Please note that a device is only put into the Guest VLAN providing another user has not already passed EAP authentication. For example, on a switch port configured for MHMA with Guest VLAN, once an EAP supplicant has passed EAP authentication, any existing client or any new client that either fails EAP or does not support EAP will be removed from the Guest VLAN. You cannot enable Guest VLAN and non-EAP on the same port.

[1]Requires software release 5.1. Not supported for NEAP (centralized MAC authentication)

**The Ethernet Routing Switch 8300 supports tagging with 802.1x in software release 2.2.2.0. Please see software release notes. Tagging with EAP is not supported in release 2.3, but is reintroduced in release 2.3.1.

8.5 EAP Configuration on an Ethernet Switch

Please refer to the document titled *Technical Configuration Guide for EAP* that can be found by going to www.nortel.com/support and going to the documentation folder for the Ethernet Switch 470-PWR.

8.6 EAP Feature Overview on Nortel Switches

8.6.1 Single Host Single Authentication: SHSA

SHSA is the default mode of operation which supports a single EAP Supplicant on a per port basis. Hence, only one MAC address is allowed per port. If multiple MAC addresses are detected, the port will be disabled - set to an EAP Force Unauthorized state.

In SHSA mode, the switch supports dynamic VLAN assignment and setting of the port priority via the RADIUS server. Note that this feature is only supported in SHSA mode of operation.

8.6.2 Guest VLAN

By default, if EAP is enabled on a port, an EAP Supplicant is required on the end station and requires authentication against an Authentication Server. If the end station does not have an EAP Supplicant or if the EAP authentication fails, the end station can be put into a guest VLAN. Any VLAN can be assigned as the guest VLAN. The guest VLAN, for example, could allow internet access, but deny access to the corporate network. A port configured with EAP and Guest VLAN feature only allows one MAC address to be learned per port. Any traffic from a new host will be discarded.

8.6.3 Multiple Host Multiple Authentication: MHMA

MHMA allows multiple EAP Supplicants to be authenticated on the same port. Up to eight (8) end stations are allowed per port for the Ethernet Routing Switch 8300 which can be either EAP Supplicants or non-eap-mac end stations. Up to 32 stations are allowed for the Ethernet Switch 470 and the Ethernet Routing Switch 5500 currently supports up to 8 EAP clients per port. For non-eap-mac end stations, the MAC address must either be statically configured on the switch or Centralized MAC (Non-EAP MAC) must be used. If the switch senses more than the configured MHMA limit, traffic from the new host will be discarded and a trap message is sent.

NOTES: Please be aware of the following when using MHMA:

- VLAN Tagging is now supported on a port configuring with MHMA on the Ethernet Routing Switch 8300 in software release 2.2.2.0 and 3.0
- A maximum of eight (8) clients are supported on the Ethernet Routing Switch 8300 and 5500
- A maximum of 32 clients are supported on the Ethernet Switch 470-PWR

8.6.4 Enhanced MHMA Feature: Non-EAP-MAC (NEAP)

If a port is configured for MHMA, by default only multiple EAP Supplicants are allowed on this port. All traffic from non-EAP MAC addresses will be discarded. To allow non-EAP MAC (NEAP) addresses on a port, the Switch non-eap-mac (NEAP) feature must be enabled. The NEAP MAC address or addresses can be statically configured on the switch. If a NEAP MAC connects to the switch, its MAC address will be checked against the NEAP table and if present, the port will forward traffic for this particular MAC address.

As an alternative to configuring the NEAP MAC statically on the switch, the NEAP MAC can be authenticated via RADIUS. Upon detecting a NEAP MAC, the switch will first check to see if the NEAP MAC is located in the NEAP table. If not, and if the Radius authentication of non-eap clients is enabled, the switch will forward an Access-Request to the Radius server. The Access-Request will contain the non-EAP MAC address as the user name and one or any combination of IP address, MAC address, and/or port number for the password. Hence, if the password is made up of MAC address or IP address or MAC and IP address, this will allow NEAP MAC to be used on any port. For example, assuming the non-eap MAC is 00:50:8b:e1:58:e8, the non-eap source-IP is 11.1.46.5 and the port number for the client is 1/21 (stack 1, port 21), this will result in any of the following passwords:

RADIUS Password	Details
. 00508be158e8.	Just MAC included
011001046005..	Just IP included
011001046005.00508be158e8.	IP and MAC included
011001046005.00508be158e8.0121	IP, MAC, and port included.

If only MAC address is used, a period must be inserted before and after the MAC address
If only the switch IP address is used, 2 periods must be inserted after the IP address
If you plan to use unit/port number, on a standalone switch the unit number is always 00.

The number of EAP and non-EAP addresses is configurable.

EAP Guest VLAN cannot be enabled with NEAP.

8.6.4.1 Enhanced MHMA Feature: Non-EAP Nortel IP Phone client

This feature allows a Nortel IP Phone and an EAP Supplicant to co-exist on an EAP enabled port. The IP Phone is not required to use EAP and instead is authenticated by the switch using a DHCP Signature from the Nortel IP Phone while the PC, if connected on the same interface, is authenticated by EAP. At this time, support for only Nortel IP Phones sets are supported with this feature

Do not enable EAP Guest VLAN. Do not enable EAP on the IP Phone. If EAP authentication is required on the phone, do not enable this feature. Do not enable any other non-eap feature on the same port.

8.6.4.2 Unicast EAP Request in MHMA

By default, the switch periodically queries the connected MAC addresses connected to a port with EAP MHMA enabled with EAP Request Identity packets. The EAP Supplicant must reply in order to remain an authorized MAC address. This does not occur when the switch is configured for SHSA unless EAP re-authentication is enabled.

With the switch setup for unicast EAP in MHMA, the switch no longer quries the connected MAC addresses with EAP Request Identity packets. It helps in preventing repeated authentications. The EAP Supplicants must be able to initiate the EAP authentication session. In other words, the Supplicant must send EAP Start and End packets to the switch. Please note that not all EAP Supplication support this operating mode.

By default, multicast mode is selected both globally and at an interface level on all switch ports. To select unicast mode, you must enable EAP unicast mode globally and at an interface level. Any other combination, i.e. multicast in global and unicast in interface mode, will select multicast operating mode.

To enable unicast mode globally, enter the following command:

- 5520-1(config)#***eapol multihost eap-packet-mode unicast***

To enable unicast mode at an interface level, enter the following commands:

- 5520-1(config)#***interface fastEthernet all***
- 5520-1(config-if)#***eapol multihost port <port #> eap-packet-mode unicast***
- 5520-1(config-if)#***exit***

8.6.4.3 Radius Assigned VLANs in MHMA

This feature is similar in operation with the already existing Radius assigned VLANs feature available in SHSA mode. In MHMA, the switch will put move the port to the VLAN of the first authenticated client. This prevents the port from being bounced between different VLANs.

8.6.4.4 RADIUS Setup for NEAP

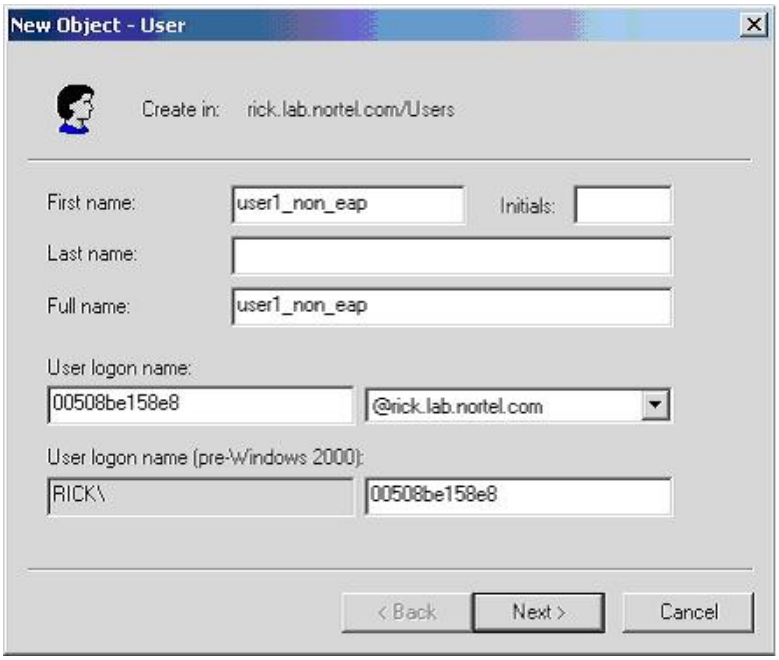
8.6.4.4.1 Microsoft IAS Server

When setting up the RADIUS server, the user name is the non-eap MAC address. The password is one of or a combination of the non-eap MAC address, source-IP address and the physical port of the non-eap MAC as a string separated by dots. For example, assuming the non-eap MAC is 00:50:8b:e1:58:e8, the non-eap source-IP is 11.1.46.5 and the port number for the client is 1/21, this will result in a user name of 00508be158e8 and password of 011001046005.00508be158e8.0121 assuming use the non-eap password format of MAC, IP and port number.

For a Microsoft IAS, the non-eap user is entered as follows:

1) Go to *Active Directory for Users and Computers*, right-click on *Users* and select *New>User*

2) Add new user using the MAC address of the PC as the *User logon name*.



3) Next, enter the Password shown above (011001046005.00508be158e8.0121) and click on *Finish* when done.

4) Next, right-click on the user you just created and select *Properties*

- In the *Dial-in* dialog box, select *Allow Access*
- In the *Member Of* dialog box, click on *Add* and add *RAS and IAS Servers*
- Finally, in the *Account* dialog box, under *Account options*, click on *Store Password using reverse encryption*

5) Enable the IAS Authentication profile for MD5-Challenge with PAP/SPAP selected.

8.6.4.4.2 FreeRADIUS Setup

In the radius server's user configuration file,

1. Add the MAC address of the Non-EAP host as the user name. (ex: "00a0c9a4d0e0")
2. Set the Auth-Type to 'local'.
3. Set the User-Password to "Net Mgmt IP of the switch" + "." + "Mac address of the Non-EAP host" + "." + "slot port through which the non-eap client will be connected". For example, assuming the management IP address of the switch is 192.168.151.165, the MAC address of the non-EAP host is 00:a0:c9:a4:d0:e0 and the slot/port is 8/5, enter "192168151165.00a0c9a4d0e0.0805"
4. Set the desired QoS value for the Non-EAP host in the 'Nortel-Dot1x-Mac-Qos' attribute. Where, "Nortel-Dot1x-Mac-Qos" is declared as a vendor-specific-attribute in "dictionary.passport" file as follows:

   ATTRIBUTE Nortel-Dot1x-Mac-Qos 2 integer Nortel

   The above declaration describes that "Nortel-Dot1x-Mac-Qos" attribute is a vendor-specific attribute (Nortel keyword does that). The identifier for this vendor-specific attribute is 2 and the type of the attribute is integer.

   Example:

"192.168.151.165" specifies the net management IP of the switch. User configuration for Non-Eap host with mac address 00:a0:c9:a4:d0:e0 connected to port 8/5 is given as:

00a0c9a4d0e0 Auth-Type := local, User-Password == "192168151165.00a0c9a4d0e0.0805"

Termination-Action = RADIUS-Request,

Tunnel-Type = VLAN,

Tunnel-Medium-Type = IEEE802,

Tunnel-Private-Group-Id = "0002",

Nortel-Dot1x-Port-Priority = 5,

Nortel-Dot1x-Mac-Qos = 3

8.6.4.4.3 Steel-Belted Radius Server

To get a non-eap client authenticated using radius server,

1. Ensure that *pprt8300* is included in *dictiona.dcm* file.
2. In the *pprt8300* file, add the following return list attribute for returning MAC QoS in the access-accept packet. The Mac-QoS attribute identifier, i.e. type1 is set to 2 and data is set to integer.

   ATTRIBUTE Mac-QoS 26 [vid=1584 type1=2 len1=+2 data=integer]R

   VALUE Mac-QoS Level0 0

   VALUE Mac-QoS Level1 1

   VALUE Mac-QoS Level2 2

   VALUE Mac-QoS Level3 3

   VALUE Mac-QoS Level4 4

   VALUE Mac-QoS Level5 5

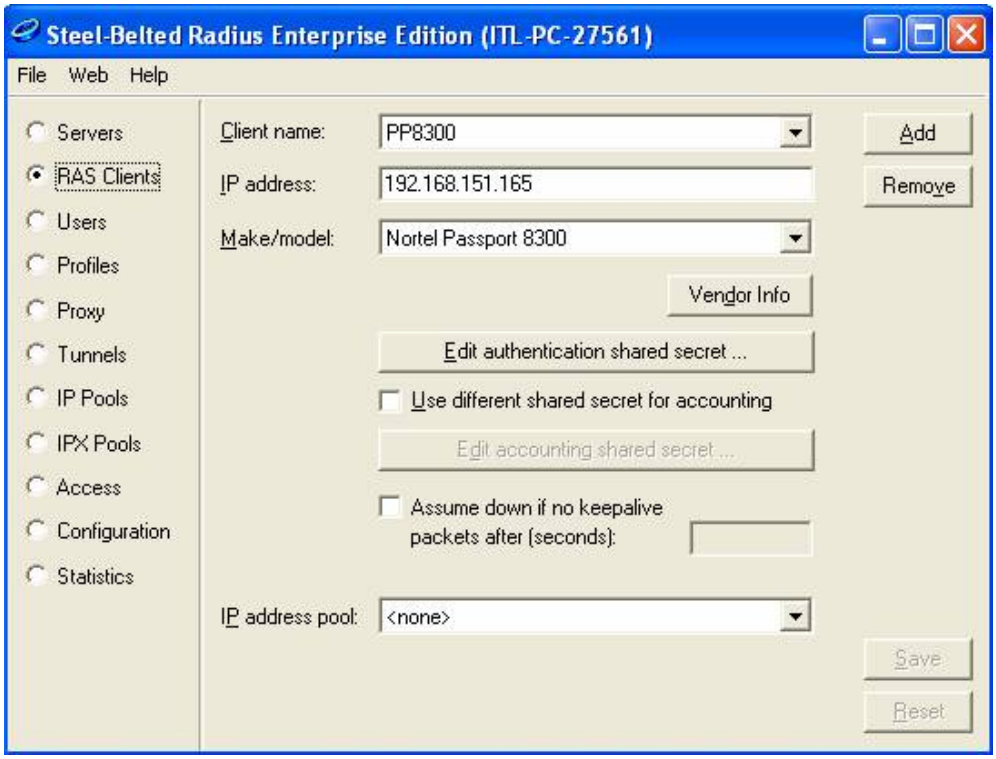
   VALUE Mac-QoS Level6 6

   VALUE Mac-QoS Level7 7
3. In *eap.ini* file, add the following lines for the Non-EAP client to get authenticated [radiusmac]

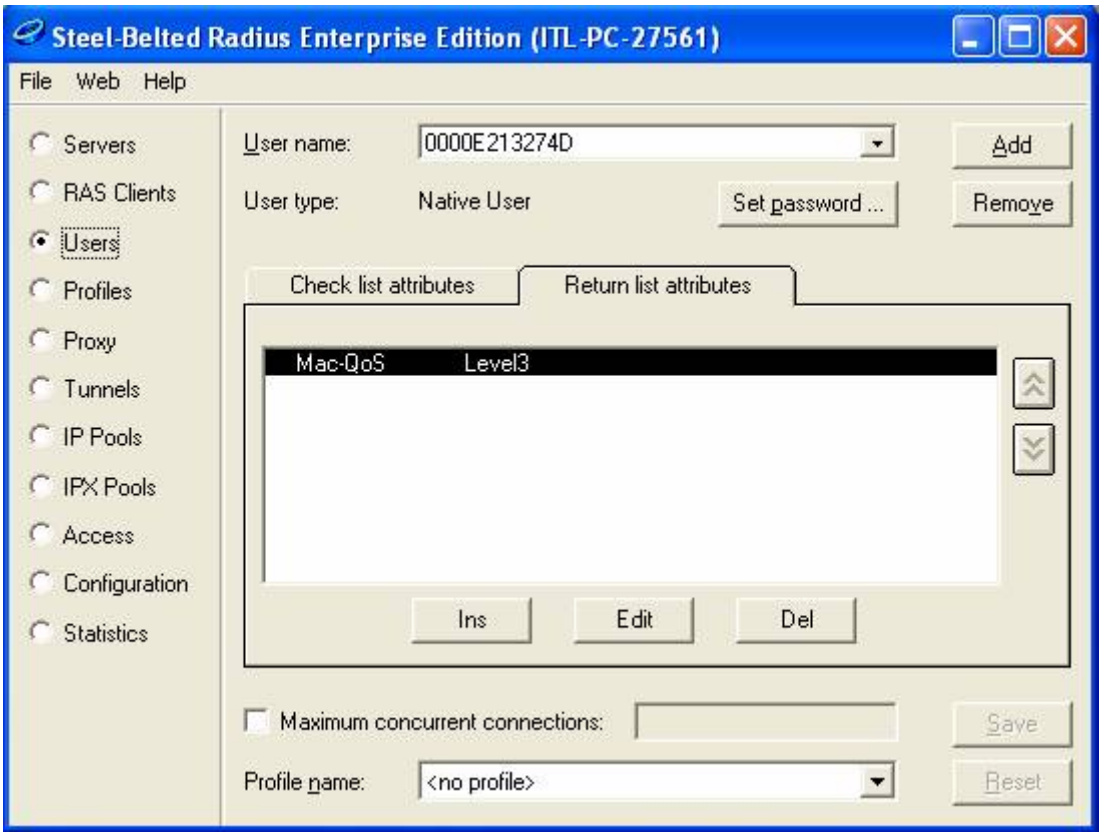
   EAP-Only = 0

   EAP-Type =

   First-Handle-Via-Auto-EAP = 0
4. Set the RAS-Clients as follows:



5. Configure the Non-EAP user with user-name, password (as specified in FreeRADIUS section) and the return list attribute, MAC-QoS.



8.6.5 EAP Dynamic VLAN Assignment

In EAP SHSA or MHMA mode, the RADIUS server can be configured with a Return-Attribute to dynamically set the VLAN and if required, the port priority.

The following applies to dynamic VLAN assignment:

- The dynamic VLAN configuration values assigned by EAPoL are not stored in the switch's NVRAM or running configuration file.
- You can override the dynamic VLAN configuration values assigned by EAPoL; however, be aware that the values you configure are not stored in NVRAM.
- When EAPoL is enabled on a port, and you configure values other than VLAN configuration values, those values are applied and stored in NVRAM.
- You cannot enable EAPoL on tagged ports or MLT ports.
- You cannot change the VLAN/STG membership of EAPoL authorized ports.

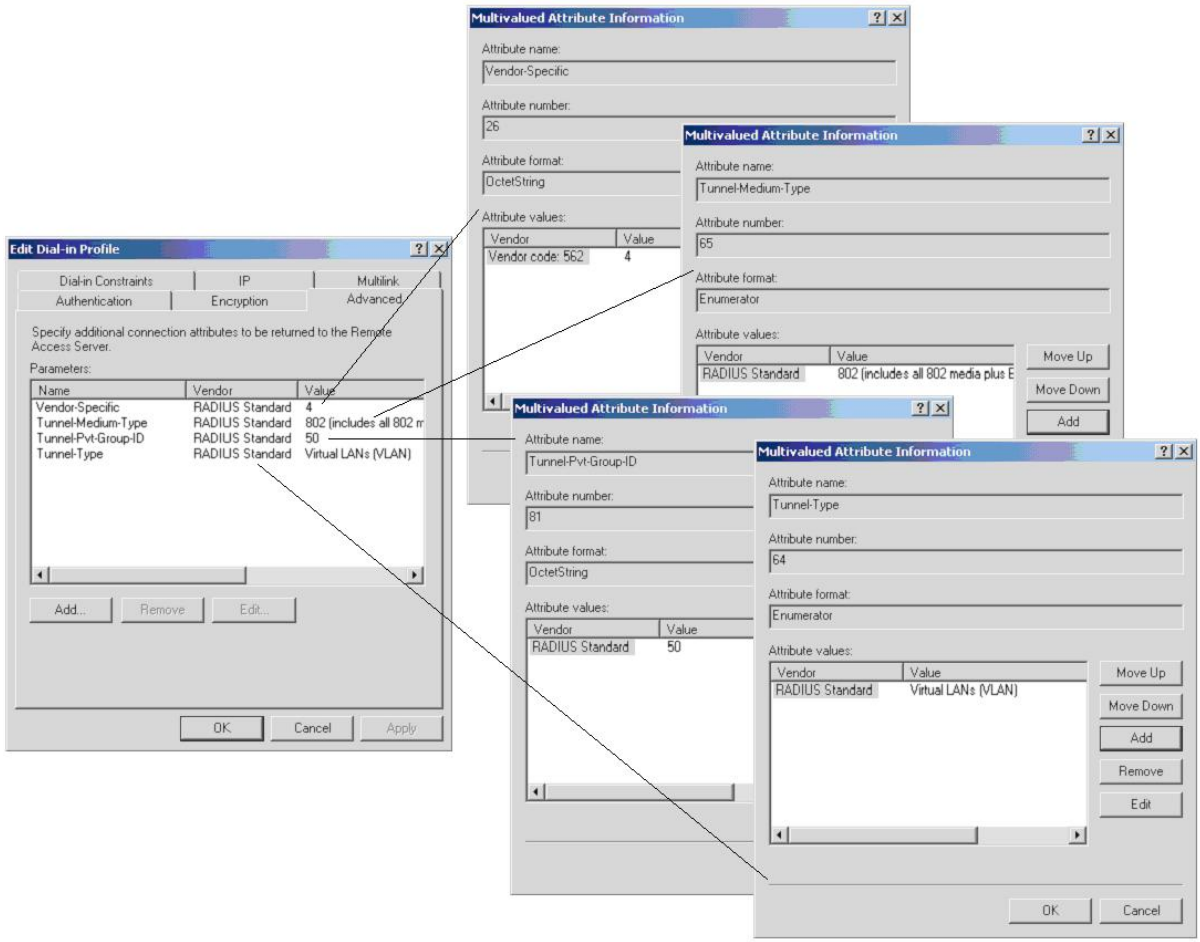
8.6.5.1 RADIUS Configuration

To set up the Authentication server, the following RADIUS 'Return-List' attributes needs to be set:

- VLAN membership attributes:
  - Tunnel-Type: value 13, Tunnel-Type-VLAN
  - Tunnel-Medium-Type: value 6, Tunnel-Medium-Type-802
  - Tunnel-Private-Group-Id: ASCII value 1 to 4094 (this value is used to identify the specified VLAN)
- Port priority (vendor-specific) attributes:
  - Vendor Id: value 562, Nortel vendor Id

8.6.5.2 IAS Server

If the Authentication server is a Microsoft IAS server, the configuration would look something like the following assuming the dynamic VLAN is 50 and the port priority is 4.

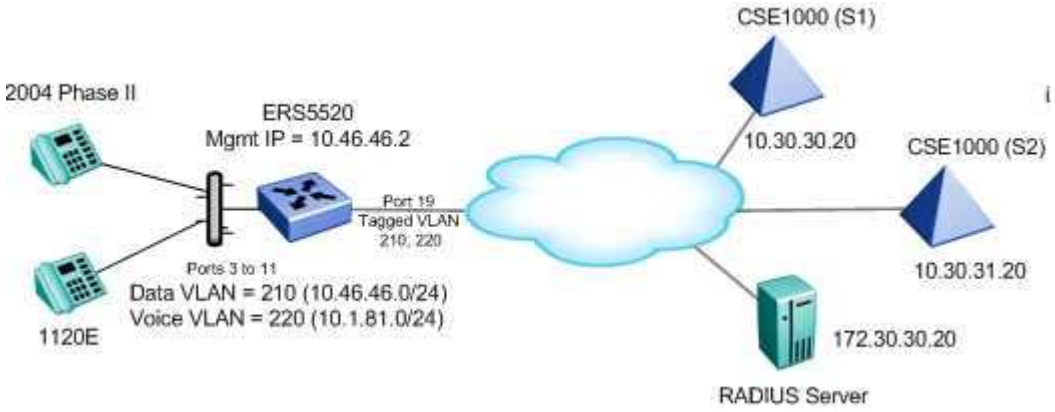


9. EAP Configuration

9.1 EAP Configuration Example - Using Ethernet Routing Switch 5520-PWR with EAP SHSA

For this configuration example, we will configure the following:

- Configure the IP Phone 2004 and IP Phone 1120E for Auto-Configuration and EAP using MD5
- Configure ports 3 to 11 with EAP Single-Host-Single-Authentication (SHSA)
- Configure the Ethernet Routing Switch 5520-PWR as a Layer 2 switch with VLAN 210 for data and VLAN 220 for voice
- Configure ports 3 to 11 as untagPvidOnly with VLAN's 210 and 220 and set the default PVID to 210 (data VLAN)
- Enable LLDP-MED on the Ethernet Routing Switch 5520-PWR and Nortel IP Phone sets



Please note that ADAC cannot be used with EAP to apply QoS for the IP phone sets. To apply QoS for the IP phones, you can either configure filters, use a user based policy (UBP) with RADIUS, or enable LLDP-MED. Please note this you cannot enable LLDP-MED on the ERS4500, hence, this application is only supported on the ERS5500. Please see configuration example 9.3 in regards to using UBP.

9.1.1 Ethernet Routing Switch 5520-PWR Configuration

9.1.1.1 Go to configuration mode.

ERS5520-1 Step 1 - Enter configuration mode

```
5520-24T-1>enable
5520-24T-1#configure terminal
```

9.1.1.2 Create VLAN's

ERS5520-1 Step 1 – Remove port members from the default VLAN, create VLAN 210 and 220

```
5520-24T-1(config)#vlan members remove 1 ALL
5520-24T-1(config)#vlan create 210 name Data type port
```

```
5520-24T-1(config)#vlan create 220 name Voice type port
```

9.1.1.3 Enable VLAN Tagging

ERS5520-1 Step 1 – Enable VLAN tagging on all appropriate ports

```
5520-24T-1(config)#vlan port 19 tagging tagall
5520-24T-1(config)#vlan port 3-11 tagging untagpvidOnly
```

9.1.1.4 Add VLAN Port members and default VLAN ID

ERS5520-1 Step 1 – Enable VLAN tagging on all appropriate ports

```
5520-24T-1(config)#vlan members add 210 3-11,19
5520-24T-1(config)#vlan members add 220 3-11,19
5520-24T-1(config)#vlan port 3-11 pvid 210
5520-24T-1(config)#vlan mgmt 210
```

9.1.1.5 Enable EAP at interface level

ERS5520-1 Step 1 – Enable EAP on ports 3 to 11

```
5520-24T-1(config)#interface fastEthernet all
5520-24T-1(config-if)#eapol port 3-11 status auto
5520-24T-1(config-if)#exit
```

9.1.1.6 Configure Management IP address on switch

ERS5520-1 Step 1 – Set the IP address of the switch

```
5520-24T-1(config)#ip address 10.46.46.2 netmask 255.255.255.0
5520-24T-1(config)#ip default-gateway 10.46.46.1
```

9.1.1.7 Configure RADIUS server

ERS5520-1 Step 1 – Add RADIUS server

```
5520-24T-1(config)#radius-server host 172.30.30.20 key
Enter key: ******
Confirm key: ******
```

9.1.1.8 Enable EAP globally

ERS5520-1 Step 1 – Enable EAP

```
5520-24T-1(config)#eapol enable
```

9.1.1.9 Enable LLDP-MED

ERS5520-1 Step 1 – Enable ADAC and also set PoE priority level to high

```
5520-24T-1(config)#interface fastEthernet all

5520-24T-1(config-if)#lldp status txandRx config-notification
5520-24T-1(config-if)#lldp tx-tlv local-mgmt-addr port-desc sys-cap sys-desc
sys-name
5520-24T-1(config-if)#lldp tx-tlv med extendedPSE med-capabilities network-
policy

5520-24T-1(config-if)#exit
```

9.1.2 IP Phone set configuration

Setup the Nortel IP phone with the following parameters where the Device ID is the MD5 user name and Password is the MD5 password configured on the RADIUS server:

Nortel i2003 Phase II Step 1

```
EAP Enable? (0-No, 1-Yes): 1
Device ID: <enter user name via keypad>
Password: <enter password via keypad>
LLDP Enable? [1=Y, 0=N]: 1
DHCP? (0-No, 1-Yes): 1
DHCP? 0-Full, 1-Partial: 0
Voice VLAN? 0-No, 1-Yes: 1
VLAN Cfg? 0-Auto, 1-Man: 0
LLDP MED? 0-No, 1-Yes: 1
VLAN FILTER? 0-No, 1-Yes: 1
PC Port? 1-On, 0-Off: 1
Data VLAN? 0-No, 1-Yes: 0
```

Nortel 1120E Step 1

```
Enable EAP: ✓
Device ID: <enter user name via keypad>
Password: <enter password via keypad>
LLDP Enable? [1=Y, 0=N]: 1
DHCP: Full
Voice VLAN? Auto
LLDP MED? 0-No, 1-Yes: 1
VLAN Filter: ✓
Data VLAN: No
```

9.1.3 Verify Operations

9.1.3.1 Verify EAP Global and Port Configuration

Assuming we have an IP phone authenticated via port 6.

Step 1 – Verify that EAP has been enabled globally and the correct port members:

```
5520-24T-1#show eapol port 3-11
```

Result:

```
EAPOL Administrative State:  Enabled
EAPOL User Based Policies:  Disabled
EAPOL User Based Policies Filter On MAC Addresses:  Disabled
     Admin          Admin Oper ReAuth ReAuth Quiet  Xmit   Supplic Server  Max
Port Status   Auth Dir   Dir  Enable Period Period Period Timeout Timeout Req
---- -------- ---- ----- ---- ------ ------ ------ ------ ------- ------- ---
3    Auto     No   Both  Both No     3600   60     30     30      30      2
4    Auto     No   Both  Both No     3600   60     30     30      30      2
5    Auto     No   Both  Both No     3600   60     30     30      30      2
6    Auto     Yes  Both  Both No     3600   60     30     30      30      2
7    Auto     No   Both  Both No     3600   60     30     30      30      2
8    Auto     No   Both  Both No     3600   60     30     30      30      2
9    Auto     No   Both  Both No     3600   60     30     30      30      2
10   Auto     No   Both  Both No     3600   60     30     30      30      2
11   Auto     No   Both  Both No     3600   60     30     30      30      2
```

On the ERS5520 verify the following information:

Option	Verify
EAPOL Administrative State	Verify that the EAPOL is ***Enabled*** globally.
Admin Status	Verify that the EAP is enabled on ports 3 to 11 by verifying that the Admin Status is set to ***Auto***.
Auth	The value will be ***Yes*** for port 6 assuming the IP phone attached to port 6 has successfully authenticated using EAP. Otherwise, the value should be ***No***.

9.1.3.2 Verify LLDP-MED Configuration

Step 1 – Verify that LLDP neighbor state for port 6:

```
5520-24T-1# show lldp port 3-11
```

Result:

```
-----------------------------------------------------
                            lldp admin port status
-----------------------------------------------------
-----------------------------------------------------
Port    AdminStatus    ConfigNotificationEnable
-----------------------------------------------------
3         txAndRx         enabled
4         txAndRx         enabled
5         txAndRx         enabled
6         txAndRx         enabled
7         txAndRx         enabled
8         txAndRx         enabled
```

```
        9          txAndRx          enabled
        10         txAndRx          enabled
        11         txAndRx          enabled
        ------------------------------------------------------
```

On the ERS5520 verify the following information:

Option	Verify
AdminStatus	The AdminSatus should be set to ***txAndRx*** for ports 3 to 11.
ConfigNotificationEnable	Verify that the ConfigNotificationEnable setting is set to ***enabled*** for ports 3 to 11.

9.1.3.3 Verify LLDP-MED Operations

Assuming we have an IP phone authenticated via port 6.

Step 1 – Verify that LLDP neighbor state for port 6:

```
5520-24T-1# show lldp port 6 neighbor detail
```

Result:

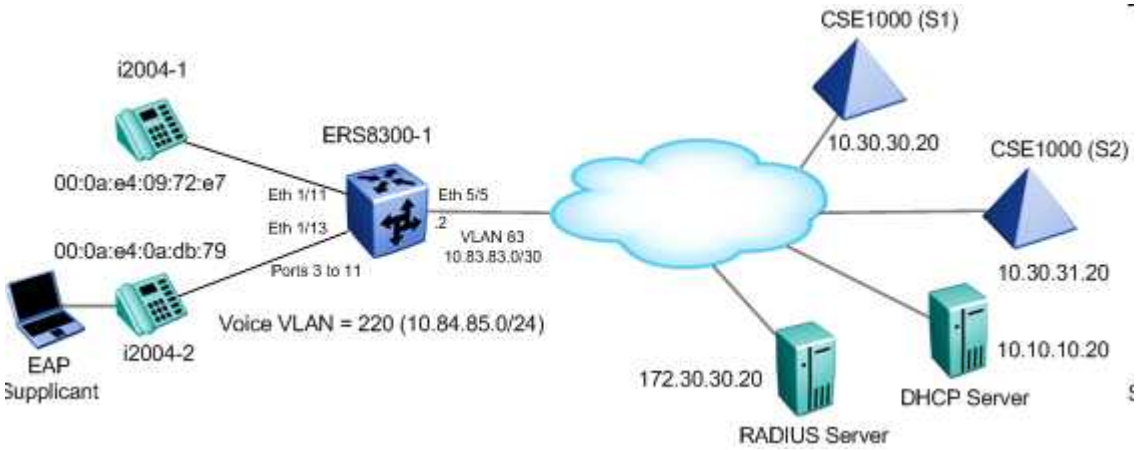
```
        --------------------------------------------------------------------------------
                                  lldp neighbor
        --------------------------------------------------------------------------------
        Port: 6     Index: 61                 Time: 5 days, 19:45:40
                ChassisId: Network address    ipV4  10.1.81.23
                PortId:    MAC address        00:0a:e4:09:72:e7
                SysCap:    TB / TB            (Supported/Enabled)
                PortDesc:  Nortel IP Phone
                SysDescr:  Nortel IP Telephone 2004, Firmware:C604DB1


         PVID: 0                              PPVID Supported: not supported(0)
         VLAN Name List: 220                  PPVID Enabled: none

         Dot3-MAC/PHY Auto-neg: supported/enabled       OperMAUtype:  100BaseTXFD
         PSE MDI power:         not supported/disabled  Port class:   PD
         PSE power pair:        signal/not controllable Power class:  1
         LinkAggr: not aggregatable/not aggregated      AggrPortID:   0
                                                        MaxFrameSize: 1522
         PMD auto-neg:          (FdxS, FdxB)Pause, 1000Base(XFD, T)

         MED-Capabilities: CNSD / CNDI        (Supported/Current)
         MED-Device type:  Endpoint Class 3
         MED-Application Type: Voice                    VLAN ID: 220
         L2 Priority: 6         DSCP Value: 40          Tagged Vlan, Policy unknown
         Med-Power Type: PD Device            Power Source: Unknown
         Power Priority: High                 Power Value:    5.4 Watt
         HWRev:                               FWRev: C604DB1
         SWRev:                               SerialNumber:
         ManufName: Nortel-01                 ModelName: IP Phone 2004
         AssetID:
        --------------------------------------------------------------------------------
        Sys capability: O-Other; R-Repeater; B-Bridge; W-WLAN accesspoint; r-Router;
        T-Telephone; D-DOCSIS cable device; S-Station only.
        Med Capabilities-C: N-Network Policy; L-Location Identification; I-Inventory;
        S-Extended Power via MDI - PSE; D-Extended Power via MDI - PD.
```

On the ERS5520 verify the following information:

Option	Verify

IpV4	Verify that the IP address giving to the IP phone set via DHCP belongs to the ***10.1.81.0/24*** network.
MAC address	The MAC address address shown here belongs to the IP phone set connected to port 6.
L2 Priority	Verify the p-bit value is set to a value of ***6*** indicating a CoS level of Premium.
DSCP Priority	Verify the DSCP value is set to a value of decimal ***40*** indicating a CoS level of Premium.
VLAN Name List VLAN ID	Verify the value is set to ***220***, the voice VLAN ID.

9.2 NEAP Configuration Example - Using Centralized MAC with the Ethernet Routing Switch 8300



The Ethernet Routing Switch 8300 can be configured to accept both EAP and non-EAP MAC (NEAP) on the same port. Up to eight hosts can be allowed on an Ethernet Routing Switch 8300 port by either statically configuring the MAC address for each host or by using the Centralized MAC feature. For this example, we wish to accomplish the following:

- Use RIP as the routing protocol and enable RIP on VLANs 83 and 220
- Enable Centralized MAC for IP Phone set #1 on port 1/11 of ERS8300A
- Enable non-eap-mac for IP Phone set #2 and add MAC address to port 1/13 on Ethernet Routing Switch 8300A
- Configure the Ethernet Routing Switch 8300 and RADIUS server with shared key set to 'nortel'

9.2.1 Ethernet Routing Switch 8300-1 Configuration

Please perform the following step for Ethernet Routing Switch 8300-1:

9.2.1.1 Spanning Tree Configuration

ERS8300-1 Step 1 – Enable STP Faststart on ports 1/1 to 1/25 and disable STP on port 5/5

```
ERS8310-1:5# config ethernet 1/1-1/25 stg 1 faststart enable
ERS8310-1:5# config ethernet 5/5 stg 1 stp disable
```

9.2.1.2 Create VLANs

ERS8300-1 Step 1 – Remove port members from the default VLAN 1 and create VLAN 220, add port members, enable RIP, and enable DHCP relay

```
ERS8310-1:5# config vlan 1 port remove 1/1-1/25,5/5
```

ERS8300-1 Step 2 – Create VLAN 220 and add port members

```
ERS8310-1:5# config vlan 220 create byport 1
ERS8310-1:5# config vlan 220 ports add 1/11,1/13
ERS8310-1:5# config vlan 220 name Voice
```

ERS8300-1 Step 3 – Create VLAN 83 and add port members

```
ERS8310-1:5# config vlan 83 create byport 1
ERS8310-1:5# config vlan 83 name Trunk
ERS8310-1:5# config vlan 83 ports add 5/5
```

9.2.1.3 Add IP address

ERS8300-1 Step 1 – Add IP configuration for VLAN 220 and enable DHCP

```
ERS8310-1:5# config vlan 220 ip create 10.84.85.1/24
ERS8310-1:5# config vlan 220 ip dhcp-relay mode dhcp
ERS8310-1:5# config vlan 220 ip dhcp-relay enable
ERS8310-1:5# config vlan 220 ip rip enable
```

ERS8300-1 Step 2 – Add IP configuration for VLAN 83

```
ERS8310-1:5# config vlan 83 ip create 10.83.83.2/30
ERS8310-1:5# config vlan 83 ip rip enable
```

9.2.1.4 Enable RIP globally

ERS8300-1 Step 1 – Enable RIP

```
ERS8310-1:5# config ip rip enable
```

9.2.1.5 Enable DHCP relay agents

ERS8300-1 Step 1 – Enable DHCP relay agent for VLAN 220

```
ERS8310-1:5# config ip dhcp-relay create-fwd-path agent 10.84.85.1 server
10.10.10.20 mode dhcp state enable
```

9.2.1.6 Configure PoE

ERS8300-1 Step 1 – Set the PoE priority on ports 1/11 to 1/13 to high

```
ERS8310-1:5# config poe port 1/11,1/13 power-priority high
ERS8310-1:5# config poe port 1/11,1/13 type telephone
```

9.2.1.7 Enable EAP at interface level

ERS8300-1 Step 1 – Configure EAP on ports 1/11 and 1/13

```
ERS8310-1:5# config ethernet 1/11,1/13 eapol admin-status auto
```

ERS8300-1 Step 2 – Enable EAP MHMA with non-EAP MAC and a limit of two MAC's on port 1/13

```
ERS8310-1:5# config ethernet 1/13 eapol multi-host enable
```

```
ERS8310-1:5# config ethernet 1/13 eapol max-multi-hosts 2
ERS8310-1:5# config ether 1/13 eapol non-eap-mac max-non-eap-clients 1
ERS8310-1:5# config ether 1/13 eapol non-eap-mac add 00:0a:e4:0a:db:79
```

ERS8300-1 Step 3 – Enable Centralized MAC on port 1/11

```
ERS8310-1:5# config ether 1/11 eapol non-eap-mac radius-mac-centralization
```

ERS8300-1 Step 4 – Enable non-EAP MAC clients on ports 1/11 and 1/13

```
ERS8310-1:5# config ethernet 1/11,1/13 eapol non-eap-mac allow-non-eap-clients enable
```

9.2.1.8 Add RADIUS server

ERS8300-1 Step 1 – Configure RADIUS server

```
ERS8310-1:5# config radius enable true
ERS8310-1:5# radius server create 172.30.30.20 secret nortel usedby eap source-ip 10.83.83.2
ERS8310-1:5# config radius sourceip-flag true
```

9.2.1.9 Enable EAP globally

ERS8300-1 Step 1 – Configure RADIUS server

```
ERS8310-1:5# config sys set eapol enable
ERS8310-1:5# config sys set eapol radius-mac-centralization enable
```

9.2.2 IP Phone Set

Setup the Nortel IP phone with the following parameters:

IP Phone 2004 #1:

```
EAP Enable? (0-No, 1-Yes): 0
DHCP? (0-No, 1-Yes): 1
DHCP? 0-Full, 1-Partial: 0
Voice VLAN? 0-No, 1-Yes: 1
PC Port? 1-On, 0-Off: 0
```

IP Phone 2004 #2:

```
EAP Enable? (0-No, 1-Yes): 0
DHCP? (0-No, 1-Yes): 1
DHCP? 0-Full, 1-Partial: 0
Voice VLAN? 0-No, 1-Yes: 1
PC Port? 1-On, 0-Off: 1
```

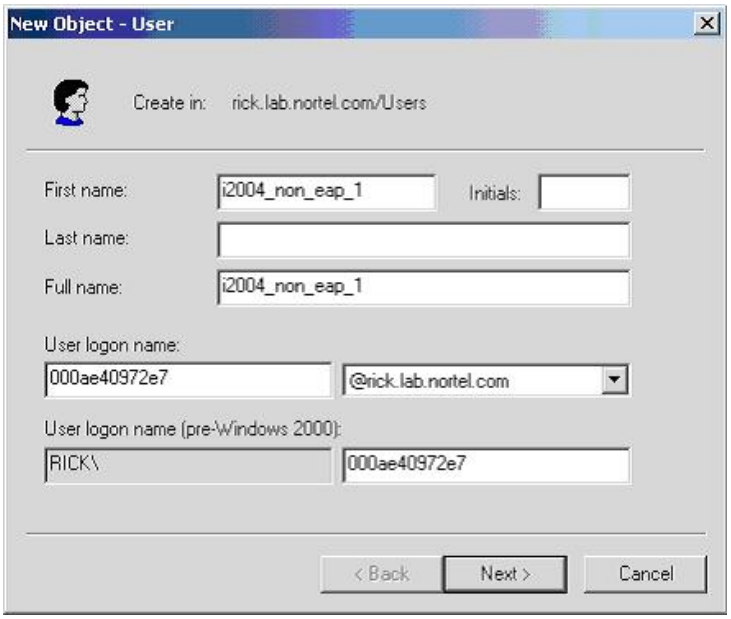
9.2.3 RADIUS Server Configuration for Centralized MAC - Windows IAS Server

When setting up the RADIUS server, the user name is the non-eap MAC address. The password is a combination of the clients MAC address, the RADIUS source-IP address configured on the Ethernet Routing Switch 8300 and slot/port number of the physical port of the non-eap MAC. The password is in the format of <decimal value of source-ip>.<MAC address of non-eap user>.<slot/port>. In our example, the non-eap MAC is 00:0a:e4:09:72:e7, the RADIUS source-ip configured on the Ethernet Routing Switch 8300 is 10.83.83.2 while the port number used is 1/11 resulting in a password of 010083083002.000ae40972e7.0111. Notice that the RADIUS address that is configured on the Ethernet Routing Switch 8300 is entered always using three digits (10.83.83.2 = 010083083002).

In this example, the RADIUS server is a Microsoft IAS server. The non-eap user is entered as follows.

1. Go to *Active Directory for Users and Computers*, right-click on *Users* and select *New>User.*

2. Add new user using the MAC address of the PC as the *User logon name*.



3. Next, enter the Password shown above (010083083002.000ae40972e7.0111) and click on *Finish* when done.

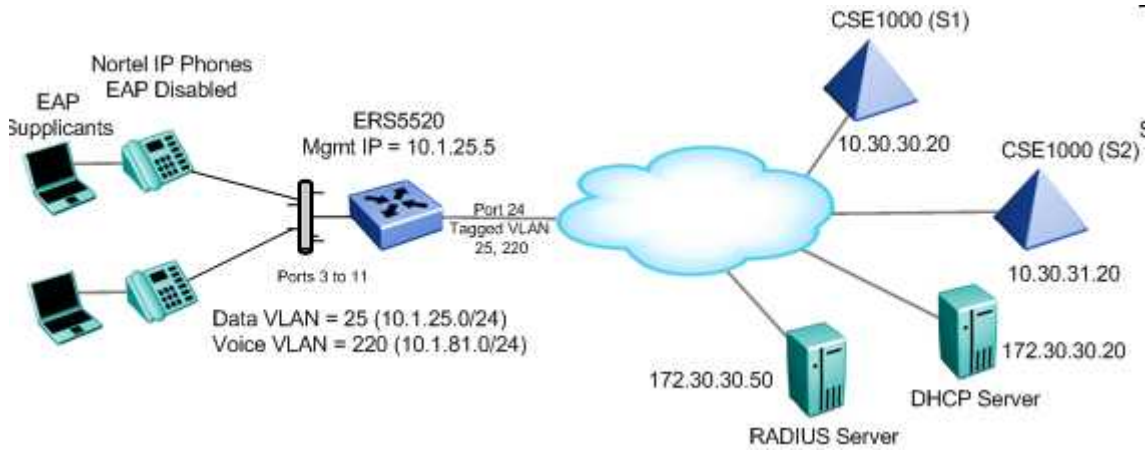
4. Next, right-click on the user you just created and select *Properties.*
   - In the *Dial-in* dialog box, select *Allow Access*
   - In the *Member Of* dialog box, click on *Add* and add *RAS and IAS Servers*
   - Finally, in the *Account* dialog box, under *Account options*, click on *Store Password using reverse encryption*

5. Enable the IAS Authentication profile for MD5-Challenge with PAP/SPAP selected.

9.2.4 DHCP Server Setup

For this example, only DHCP Option #128 has to be setup. Please see Section 3.1.4 in regards to setting up the DHCP server for DHCP Option #128. DHCP Option #191, VLAN ID, is not required as the voice VLAN in not tagged.

9.3 ERS5500 NEAP Configuration Example - Using non-MAC with User Based Policy



For this example, we will demonstate how to configure the Ethernet Routing Switch 5500 to allow for non-EAP (NEAP) authentication via RADIUS for the IP Phones. We will also demonstate using user based policies to apply QoS for the IP Phones. Hence, instead of configuring filters on the switch to apply QoS for the voice traffic, we can use a policy triggered by EAP to apply QoS to the voice VLAN.

The Ethernet Routing Switch 5500 can be configured to accept both EAP and non-EAP (NEAP) on the same port. In regards to non-EAP, the switch can be configured to accept a password format using any combination of IP address and MAC address with or without port number. By default, the password format is set for IP address, MAC address, and port number.

To apply QoS for the IP Phone sets, you can either configure the QoS filters on the switch, use ADAC, or use user based policies (UBP) and trigger the policy via RADIUS authentication. As stated above, we will use UBP for this configuration example. Once the user based policies has been configured on a switch, the RADIUS server can reference the policy by using the name given to the UBP policy. User based policies (UBP) can be used with EAP and/or NEAP.

Overall, we will configured the following

- Enable Centralized MAC for IP Phone set on port 3 of ERS5520 using the non-EAP password format of MAC address only – the will allow the IP Phone to be connected anywhere in the network
- Configure a user based policy (UBP) for non-EAP IP Phones named *voice* that will remark both the DSCP and p-bit values to a CoS value of Premuim only for tagged Voice VLAN 220
- Configure the Ethernet Routing Switch 5520 and RADIUS server with shared key set to *nortel*
- Configure the RADIUS server NEAP policy using Nortel specific option 562 with vendor-assigned attribute number 110 and set the string value to *UROLvoice*. Please see note below.

Please note that when setting up the RADIUS server policy for the NEAP group, the string always starts with *UROL*. In our example, we configured the ERS5520 with a user based policy named *voice*, hence the string value configured on the RADIUS server

must be set to *UROLvoice*.

	If you do not wish to use EAP to authenticate the phone, enable the non-eap phone feature and use ADAC to configure the QoS portion for the IP Phone. Please see the next configuration example.

	You cannot use the EAP radius-assigned VLAN option with NEAP.

9.3.1 Configuration

9.3.1.1 Go to configuration mode.

ERS5520-1 Step 1 - Enter configuration mode

```
5520-24T-1>enable
5520-24T-1#configure terminal
```

9.3.1.2 Create VLAN's

ERS5520-1 Step 1 – Remove port members from the default VLAN, create VLAN 25 and 220

```
5520-24T-1(config)#vlan members remove 1 ALL
5520-24T-1(config)#vlan create 25 name data type port
5520-24T-1(config)#vlan create 220 name voice type port
```

9.3.1.3 Enable VLAN Tagging

ERS5520-1 Step 1 – Enable VLAN tagging on all appropriate ports

```
5520-24T-1(config)#vlan port 24 tagging tagall
5520-24T-1(config)#vlan port 3-11 tagging untagpvidOnly
```

9.3.1.4 Add VLAN Port members and default VLAN ID

ERS5520-1 Step 1 – Enable VLAN tagging on all appropriate ports

```
5520-24T-1(config)#vlan members add 25 3-11,24
5520-24T-1(config)#vlan members add 220 3-11,24
5520-24T-1(config)#vlan port 3-11 pvid 25
5520-24T-1(config)#vlan mgmt 25
```

9.3.1.5 Configure Management IP address on switch

ERS5520-1 Step 1 – Set the IP address of the switch

```
5520-24T-1(config)#ip address 10.1.25.5 netmask 255.255.255.0
5520-24T-1(config)#ip default-gateway 10.1.25.1
```

9.3.1.6 Configure RADIUS server

ERS5520-1 Step 1 – Add RADIUS server using key 'nortel'

```
5520-24T-1(config)#radius-server host 172.30.30.50 key
Enter key: ******
Confirm key: ******
```

9.3.1.7 Enable EAP globally

ERS5520-1 Step 1 – Enable non-EAP (NEAP)

```
5520-24T-1(config)#eapol multihost allow-non-eap-enable
```

ERS5520-1 Step 2 – Enable multihost RADIUS authentication for NEAP

```
5520-24T-1(config)#eapol multihost radius-non-eap-enable
```

ERS5520-1 Step 3 – Remove the default NEAP password format of IpAddr.MACAddr.PortNumber

```
5520-24T-1(config)#no eapol multihost non-eap-pwd-fmt
```

ERS5520-1 Step 4 – Enable NEAP password format of MAC address only

```
5520-24T-1(config)#eapol multihost non-eap-pwd-fmt mac-addr
```

ERS5520-1 Step 5 – Enable EAP user-based Policies

```
5520-24T-1(config)#eapol user-based-policies enable
```

ERS5520-1 Step 6 – Enable EAP multihost NEAP policies

```
5520-24T-1(config)# eapol multihost non-eap-user-based-policies enable
```

ERS5520-1 Step 6 – Enable EAP globally

```
5520-24T-1(config)#eapol enable
```

9.3.1.8 Enable EAP at interface level

ERS5520-1 Step 1 – Enable EAP on port 3 with NEAP, set the maximum allowable EAPand NEAP client to 1, enable EAP multihost and enable RADIUS NEAP

```
5520-24T-1(config)#interface fastEthernet 3
5520-24T-1(config-if)#eapol status auto
5520-24T-1(config-if)#eapol multihost allow-non-eap-enable
5520-24T-1(config-if)#eapol multihost eap-mac-max 1
```

```
5520-24T-1(config-if)#eapol multihost non-eap-mac-max 1
5520-24T-1(config-if)#eapol multihost radius-non-eap-enable
5520-24T-1(config-if)#eapol multihost enable
5520-24T-1(config-if)#exit
```

9.3.1.9 Configure Policy

ERS5520-1 Step 1 – Configure a policy using the name 'voice' to filter on tagged VLAN 220 and remark DSCP and p-bit to Premium CoS. We will set the eval-order to 5 in case you wish to add additional filters in the future with a higher preference

```
5520-24T-1(config)#qos ubp classifier name voice vlan-min 220 vlan-max 220
vlan-tag tagged ethertype 0x0800 update-dscp 46 update-1p 6 eval-order 5
```

ERS5520-1 Step 2 – Set the default action to pass all other traffic

```
5520-24T-1(config)#qos ubp set name voice drop-nm-action enable
```

ERS5520-1 Step 3 – Enable ubp

```
5520-24T-1(config)#qos agent ubp high-security-local
```

9.3.2 Verify Operations

9.3.2.1 Verify EAP Global and Port Configuration

Step 1 – Verify that EAP has been enabled globally and the correct port members:

```
5520-24T-1# show eapol port 3
```

Result:

```
EAPOL Administrative State:  Enabled
EAPOL User Based Policies:  Enabled
EAPOL User Based Policies Filter On MAC Addresses:  Disabled
     Admin          Admin Oper ReAuth ReAuth Quiet  Xmit   Supplic Server  Max
Port Status   Auth Dir   Dir  Enable Period Period Period Timeout Timeout Req
---- -------- ---- ----- ---- ------ ------ ------ ------ ------- ------- ---
3    Auto     No   Both  Both No     3600   60     30     30      30      2
```

On the ERS5520 verify the following information:

Option	Verify
EAPOL Administrative State	Verify that the EAPOL is ***Enabled*** globally.
EAPOL User Based Policies	Verify that EAPOL policies is ***Enabled*** globally.
Admin Status	Verify that the EAP is enable on port 3 by verifying that the Admin Status is set to ***Auto***.
Auth	The value will be ***No*** even if the IP Phone has successfully authenticated. Only if there a Supplicant attached to the IP Phone and it

	has successfully authenticated will this value change to Yes.

9.3.2.2 Verify EAP Multihost Configuration

Step 1 – Verify that EAP multihost has been globally configurued correctly:

```
5520-24T-1#show eapol multihost
```

Result:

```
        Allow Non-EAPOL Clients:  Enabled
        Use RADIUS To Authenticate Non-EAPOL Clients:  Enabled
        Allow Non-EAPOL Clients After Single Auth (MHSA):  Disabled
        Allow Non-EAPOL VoIP Phone Clients:  Disabled
        EAPOL Request Packet Generation Mode:  Multicast
        Allow Use of RADIUS Assigned VLANs:  Disabled
        Non-EAPOL RADIUS Password Attribute Format:  .MACAddr.
        Non-EAPOL User Based Policies:  Enabled
        Non-EAPOL User Based Policies Filter On MAC Addresses:  Disabled
```

On the ERS5520 verify the following information:

Option	Verify
Allow Non-EAPOL Clients:	Verify that the non-EAPOL (NEAP) is ***Enabled*** globally.
Use RADIUS To Authenticate Non-EAPOL Clients:	Verify the use RADUIS to authenticate non-EAPOL option is ***Enabled*** globally.
Non-EAPOL RADIUS Password Attribute Format:	Verify that the non-EAP password format is set for ***.MACAddr.***.
Non-EAPOL User Based Policies:	Verifty that the non-EAPOL user based policies is ***Enabled***

9.3.2.3 Verify EAP Multihost Status

Step 1 – Assuming the IP Phone via port 3 has successfully authenticated via EAP, use the following command to view the EAP status:

```
5520-24T-1# show eapol multihost non-eap-mac status
```

Result:

```
        Port Client MAC Address State
        ---- ------------------ ------------------------------
        3    00:0A:E4:09:72:E7 Authenticated By RADIUS
```

On the ERS5520 verify the following information:

Option	Verify
Port	Verify the port number is correct, should be ***3*** for this example.

Client MAC Address	If the IP phone has successfully authenticated via NEAP, it's MAC address should be shown. For this example, the MAC ***00:0A:E4:09:72:E7*** will be displayed.
State	Verfity that ***Authenticated By RADIUS*** is displayed

9.3.2.4 Verify EAP Policy

Step 1 – Assuming the IP Phone via port 3 has successfully authenticated via EAP, use the following command to view the UBP Policy:

```
5520-24T-1# show qos ubp classifier
```

Result:

```
        Id: 1
        Name: voice
        Block:
        Eval Order: 5
        Address Type: IPv4
        Destination Addr/Mask: Ignore
        Source Addr/Mask: Ignore
        DSCP: Ignore
        IPv4 Protocol / IPv6 Next Header: Ignore
        Destination L4 Port Min: Ignore
        Destination L4 Port Max: Ignore
        Source L4 Port Min: Ignore
        Source L4 Port Max: Ignore
        IPv6 Flow Id: Ignore
        Destination MAC Addr: Ignore
        Destination MAC Mask: Ignore
        Source MAC Addr: Ignore
        Source MAC Mask: Ignore
        VLAN: 220
        VLAN Tag: Tagged
        EtherType: 0x0800
        802.1p Priority: All
        Action Drop: No
        Action Update DSCP: 0x2E
        Action Update 802.1p Priority: Priority 6
        Action Set Drop Precedence: Low Drop
        Storage Type: NonVolatile
```

On the ERS5520 verify the following information:

Option	Verify
Name:	Verify the port number is correct, should be ***voice*** for this example.
Eval Order:	Verify the port number is correct, should be ***5*** for this example.
Address Type:	Verify the Address Type is correct, should be ***IPv4*** for this example.
VLAN:	Verify VLAN is correct, should be ***220*** for this example.
EtherType:	Verify the EtherType is correct, should be ***0x0800*** represently IP for this example.
Action Update DSCP:	Verify the DSCP value is correct, should be ***0x2e*** (decimal 46) for this example.

Action Update 802.1p Priority:	Verify the p-bit value is correct, should be ***6*** for this example.

9.3.2.5 Verify EAP Policy upon the NEAP client successfully authenticating

Step 1 – Assuming the IP Phone via port 3 has successfully authenticated via EAP, use the following command to view the UBP Policy:

```
5520-24T-1# show qos ubp interface
```

Result:

```
          Id  Unit Port Filter Set Name
       _____ ____ ____ _______________
       55001 1    3    voice
```

On the ERS5520 verify the following information:

Option	Verify
Port	Verify the port number is correct, should be ***3*** for this example.
Filter Set Name	If the IP phone has successfully authenticated via NEAP, and if the RADIUS server has been configured correctly, the policy named ***voice*** will be displayed.

9.3.2.6 View EAP Policy Statistics

Step 1 – You can view the statistics by using the UBP reference and port number using the following command. Please note that the reference number for each port will be differnent.

```
5520-24T-1# show qos statistics 55001 port 3
```

Result:

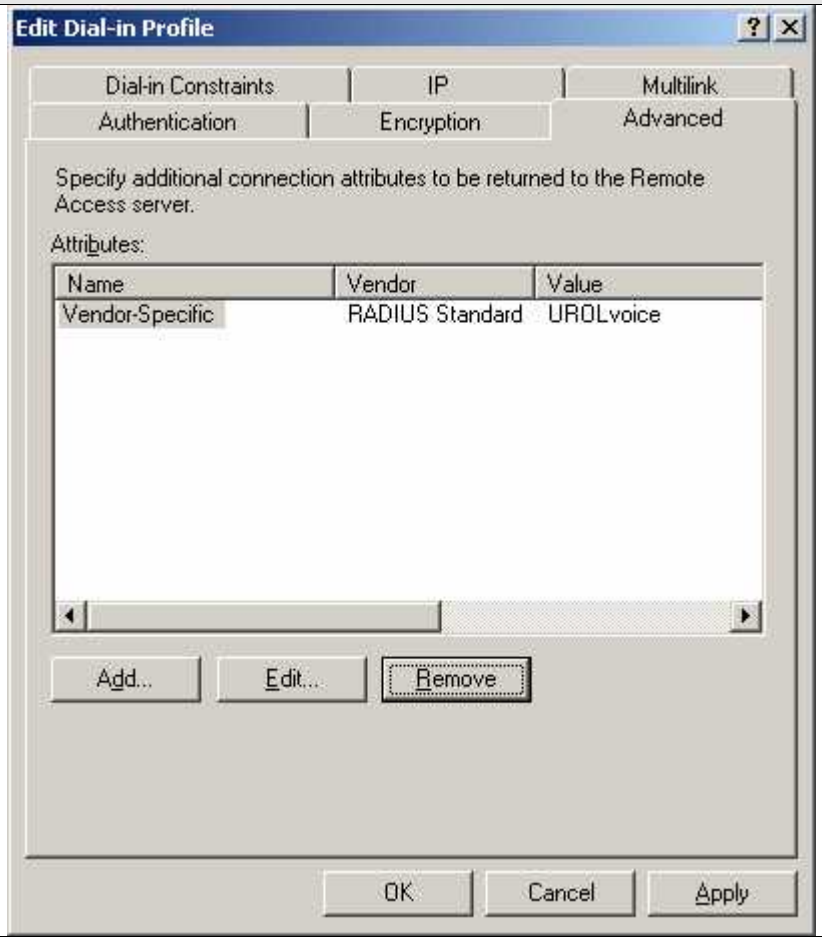
```
       Id: 55001
       Policy Name: UntrustedClfrs2

          Classifier     Unit/Port       In-Profile
             Name                          Packets
       _________________ _________ ____________________
                         1/3       22547378
```

9.3.3 RADIUS Server – Policy Setup

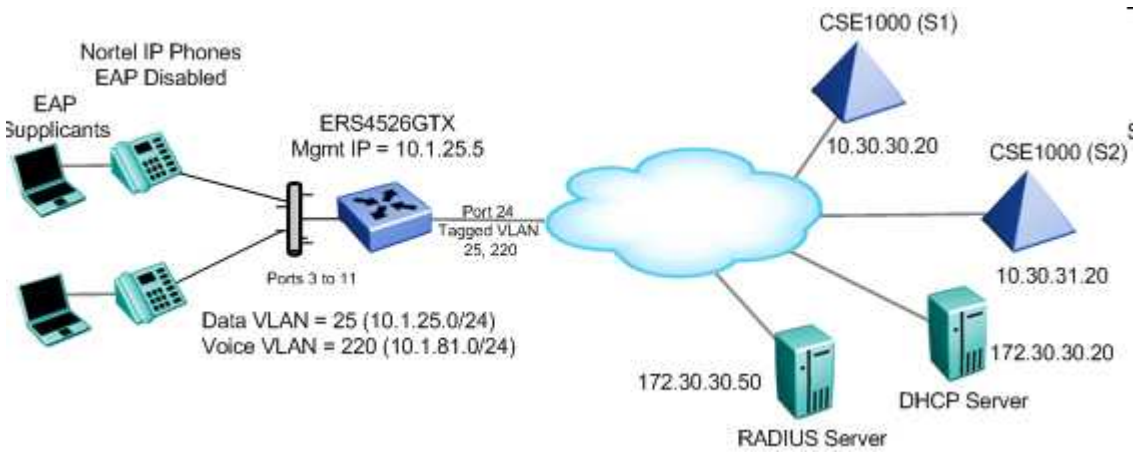
Step 1 – Assuming the RADIUS server is a Windows 2003 server, via the IAS Remote Access Policies, go to your NEAP policy Advanced settings. The Vendor-Specific attribute should be setup as follows.

- Vendor Code : Nortel ; Nortel Specific Option 562
- Vendor-assigned attribute
  - Attribute number : 110
  - Attribute formate : String
  - Attribute value : UROLvoice

Result:



9.4 Non-EAP Support for IP Phone with ADAC LLDP Detection for QoS – Using the Ethernet Routing Switch 4500



In the 5.1 software release for the ERS4500 and ERS5500, non-EAP support for Nortel IP phones was introduced. This feature allows a Nortel IP Phone and an EAP Supplicant to co-exist on an EAP enabled port. The IP Phone will not require authentication while the device attached to the IP phone will have to be authenticated via EAP.

For this configuration example, we wish to accomplish the following:

- Configure ERS4526GTX with a data VLAN 25 and voice VLAN 220
- Configure the Ethernet Routing Switch with EAP multihost using options non-EAP phone on port 3 to 11
  - This will in fact allow NEAP support for the Nortel IP Phone sets
  - Please note that DHCP must be enabled on the Nortel IP Phones for non-EAP-phone to work
- Configure ERS4526GTX and RADIUS server with shared key set to 'nortel'
- Limit the number of EAP Supplicant to only 1
- Configure ports 3 to 11 on the ERS4526GTX to untag the data VLAN 25 and use ADAC with LLDP detection for the Nortel IP Phone set
- The Nortel IP Phones will need to be setup with LLDP-MED and for DHCP

Please note the non-EAP support for IP phones is only supported on Nortel IP Phones and requires that DHCP be enabled. The IP phone is authenticated based on the DHCP signature. Do not enable EAP on the phone. Also, do not enable Guest-VLAN.

9.4.1.1 Go to configuration mode.

ERS4526GTX-1 Step 1 - Enter configuration mode

```
4526GTX-1>enable
4526GTX-1#configure terminal
```

9.4.1.2 Create Data VLAN

ERS4526GTX-1 Step 1 – Remove port members from the default VLAN, create VLAN 25

and 220

```
4526GTX-1(config)#vlan members remove 1 ALL
4526GTX-1(config)#vlan create 25 name data type port
```

9.4.1.3 Enable ADAC Globally

ERS4526GTX-1 Step 1 – Enable ADAC globally with port 24 as the uplink port and set the mode to tagged frames

```
4526GTX-1(config)#adac voice-vlan 220
4526GTX-1(config)#adac op-mode tagged-frames
4526GTX-1(config)#adac uplink-port 24
4526GTX-1(config)#adac enable
```

9.4.1.4 Add VLAN Port members to data VLAN and enable it as the management VLAN

ERS4526GTX-1 Step 1 – Enable VLAN tagging on all appropriate ports

```
4526GTX-1(config)#vlan members add 25 3-11,24
4526GTX-1(config)#vlan mgmt 25
```

9.4.1.5 Enable ADAC at interface level

ERS4526GTX-1 Step 1 – Enable ADAC on ports 3 to 11

```
4526GTX-1(config)#interface fastEthernet 3-11
4526GTX-1(config-if)#no adac detection mac
4526GTX-1(config-if)#adac tagged-frames-tagging untag-pvid-only
4526GTX-1(config-if)#adac enable
4526GTX-1(config-if)#exit
```

9.4.1.6 Configure RADIUS server

ERS4526GTX-1 Step 1 – Add RADIUS server using key 'nortel'

```
4526GTX-1(config)#radius-server host 172.30.30.20 key
Enter key: ******
Confirm key: ******
```

9.4.1.7 Enable EAP globally

ERS4526GTX-1 Step 1 – Enable EAP non-EAP phone

```
4526GTX-1(config)#eapol multihost non-eap-phone-enable
```

ERS4526GTX-1 Step 2 – Enable EAP

```
4526GTX-1(config)#eapol enable
```

9.4.1.8 Enable EAP at interface level

ERS4526GTX-1 Step 1 – Enable EAP on ports 3 to 11 with non-eap-phone and use-radius-assigned-vlan enabled

```
4526GTX-1(config)#interface fastEthernet 3-11
4526GTX-1(config-if)#eapol multihost non-eap-phone-enable
4526GTX-1(config-if)#eapol multihost eap-mac-max 1
4526GTX-1(config-if)#eapol multihost enable
4526GTX-1(config-if)#eapol status auto
4526GTX-1(config-if)#exit
```

9.4.1.9 Configure Management IP address on switch

ERS4526GTX-1 Step 1 – Set the IP address of the switch

```
4526GTX-1(config)#ip address 10.1.25.5 netmask 255.255.255.0
4526GTX-1(config)#ip default-gateway 10.1.25.1
```

9.4.2 Verify Operations

Assuming we have a Nortel IP phone with a Supplicant connected to port 8 and a Nortel IP Phone connected to port 6 with the following characteristics :

- Port 6: i2004 with MAC address 00-0a-e4-09-72-e7
- Port 8:
  - 1120E with MAC address 00-13-65-fe-f1-cb
  - Supplicant with MAC address 00:02:A5:E9:00:28

9.4.2.1 Verify EAP Global and Port Configuration

Step 1 – Verify that EAP has been enabled globally and the correct port members:

```
4526GTX-1# show eapol port 3-11
```

Result:

```
EAPOL Administrative State:  Enabled
     Admin          Admin Oper ReAuth ReAuth Quiet  Xmit   Supplic Server  Max
Port Status   Auth Dir   Dir  Enable Period Period Period Timeout Timeout Req
---- -------- ---- ----- ---- ------ ------ ------ ------ ------- ------- ---
3    Auto     Yes  Both  Both No     3600   60     30     30      30      2
4    Auto     No   Both  Both No     3600   60     30     30      30      2
5    Auto     Yes  Both  Both No     3600   60     30     30      30      2
6    Auto     No   Both  Both No     3600   60     30     30      30      2
7    Auto     Yes  Both  Both No     3600   60     30     30      30      2
8    Auto     Yes  Both  Both No     3600   60     30     30      30      2
9    Auto     Yes  Both  Both No     3600   60     30     30      30      2
10   Auto     No   Both  Both No     3600   60     30     30      30      2
11   Auto     Yes  Both  Both No     3600   60     30     30      30      2
```

On the ERS4526GTX verify the following information:

Option	Verify

EAPOL Administrative State	Verify that the EAPOL is ***Enabled*** globally.
Auth	For any port that has a Supplicant which has successfully been authenticated, the Auth state should be ***Yes***

9.4.2.2 Verify EAP Multihost Configuration

Step 1 – Verify that EAP multihost has been globally configurued correctly:

```
4526GTX-1#show eapol multihost
```

Result:

```
        Allow Non-EAPOL Clients:  Disabled
        Use RADIUS To Authenticate Non-EAPOL Clients:  Disabled
        Allow Non-EAPOL Clients After Single Auth (MHSA):  Disabled
        Allow Non-EAPOL VoIP Phone Clients:  Enabled
        EAPOL Request Packet Generation Mode:  Multicast
        Allow Use of RADIUS Assigned VLANs:  Disabled
        EAPOL Reauthentication Security Mode:  Fail on RADIUS Timeout
        Non-EAPOL RADIUS Password Attribute Format:  IpAddr.MACAddr.PortNumber
```

On the ERS4526GTX verify the following information:

Option	Verify
Allow Non-EAPOL VoIP Phone Clients	Verify the allow non-EAPOL VoIP Phone Clients option is ***Enabled*** globally.

9.4.2.3 Verify EAP Multihost Port configuration

Step 1 – Verify that EAP mulltihost configuration:

```
4526GTX-1#show eapol multihost interface 3-11
```

Result, i.e. for port 3:

```
        Port:  3
            MultiHost Status:  Enabled
            Max Eap Clients:  1
            Allow Non-EAP Clients:  Disabled
            Max Non-EAP Client MACs:  1
            Use RADIUS To Auth Non-EAP MACs:  Disabled
            Allow Auto Non-EAP MHSA:  Disabled
            Allow Non-EAP Phones:  Enabled
            RADIUS Req Pkt Send Mode:  Multicast
            Allow RADIUS VLANs:  Disabled
            RADIUS Timeout Mode:  Fail
```

On the ERS4526GTX verify the following information:

Option	Verify
MultiHost Status	Verify that the MultiHost status is ***Enabled*** on port ***3 to 11***.
Max Eap Client	Verify that the maximum EAP client is set to ***1***. If not, check your configuration

Max Non-EAP Client MACs	Verify that the maximum non-EAP client is set to ***1***. If not, check your configuration
Allow Non-EAP Phones	Verify that Allow Non-EAP Phone is set to ***Enabled***. If not, check your configuration

9.4.2.4 Verify EAP Multihost Status

Step 1 – Assuming the Supplicant via port 8 has successfully authenticated via EAP, use the following command to view the EAP status:

```
4526GTX-1#show eapol multihost status
```

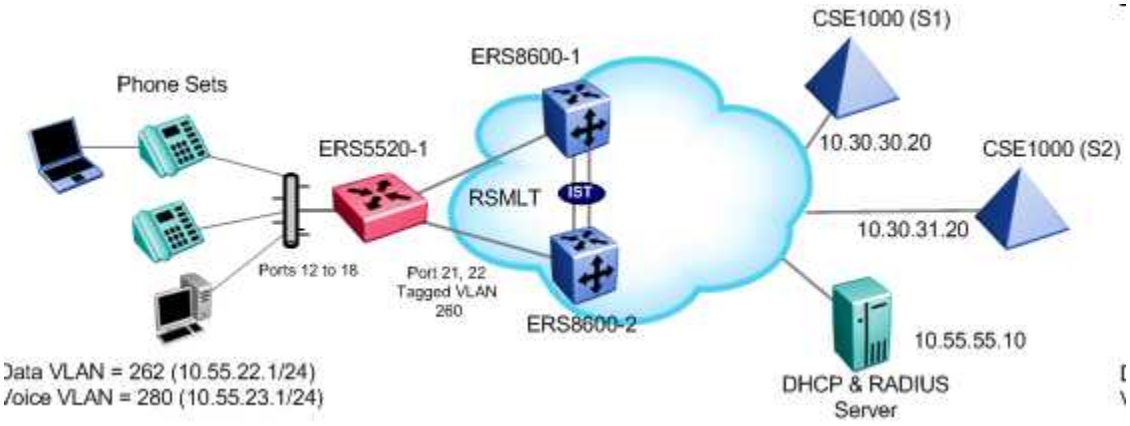
Result:

```
        Port Client MAC Address Pae State      Backend Auth State
        ---- ------------------ -------------- ------------------
        8    00:02:A5:E9:00:28  Authenticated  Idle

        =========Neap Phones============

        unit 0 port 6 mac 00-0a-e4-09-72-e7
        unit 0 port 8 mac 00-13-65-fe-f1-cb
```

On the ERS4526GTX verify the following information:

Option	Verify
Client MAC Address	Verify the actual Supplicant MAC. For this example, this should be ***00:02:A5:E9:00:28*** on port ***8***.
Pae State	Verify the actual Supplicant Pae State. If the Supplicant has successfully authenticated, the Pae State should be displayed as ***Authenticated***
Neap Phones	Verify the actual MAC for the Nortel IP Phone sets. For this example, this should be ***00-0a-e4-09-72-e7*** on port ***6*** and ***00-13-65-fe-f1-cb*** on port ***8***

9.5 EAP Configuration Example - Using Ethernet Routing Switch 5520-PWR with EAP MHMA and LLDP-MED



9.5.1 Ethernet Routing Switch 5520 Configuration

9.5.1.1 Go to configuration mode.

ERS5520-1 Step 1 - Enter configuration mode

```
5520-24T-1>enable
5520-24T-1#configure terminal
```

9.5.1.2 Create VLAN's

ERS5520-1 Step 1 – Remove port members from the default VLAN, create VLAN 260 and 262

```
5520-24T-1(config)#vlan members remove 1 ALL
5520-24T-1(config)#vlan create 260 name trunk type port
5520-24T-1(config)#vlan create 262 name data type port
```

9.5.1.3 Enable ADAC Globally

ERS5520-1 Step 1 – Configure the ADAC voice VLAN 280, set the ADAC mode for tagged-frames

```
5520-24T-1(config)#adac voice-vlan 280
5520-24T-1(config)#adac op-mode tagged-frames
5520-24T-1(config)#adac enable
```

9.5.1.4 Enable ADAC at interface level

ERS5520-1 Step 1 – Configure the ADAC voice VLAN 280, set the ADAC mode for tagged-frames

```
5520-24T-1(config)#interface fastEthernet all
5520-24T-1(config-if)#adac port 3-11 enable
5520-24T-1(config-if)#exit
```

9.5.1.5 Add access port member and set port to untag the default data VLAN

ERS5520-1 Step 1 – Enable VLAN untagPvidOnly on all appropriate ports access ports and enable VLAN tagging on trunk ports.

```
5520-24T-1(config)#vlan port 3-11 tagging untagpvidOnly
5520-24T-1(config)#vlan members add 262 3-11
5520-24T-1(config)#vlan port 3-11 pvid 262
```

9.5.1.6 Add core port member

ERS5520-1 Step 1 – Add port member to VLAN 260 and enable MLT

```
5520-24T-1(config)#vlan members add 260 21,22
```

9.5.1.7 Add MLT

ERS5520-1 Step 1 – Add core port members to MLT and set the loadbalnce mode to advance to support loadbalance using IP

```
5520-24T-1(config)#mlt 1 learning disable
5520-24T-1(config)#mlt 1 member 21,22
5520-24T-1(config)#mlt 1 loadbalance advance
5520-24T-1(config)#mlt 1 enable
```

9.5.1.8 Add RADIUS server

ERS5520-1 Step 1 – Configure the RADIUS server and enter the shared key

```
5520-24T-1(config)#radius-server host 172.30.30.20 key
Enter key: ******
Confirm key: ******
```

9.5.1.9 Enable EAP globally

ERS5520-1 Step 1 – Enable EAP globally

```
5520-24T-1(config)#eapol enable
```

9.5.1.10 Enable EAP at interface level

ERS5520-1 Step 1 – Configure EAP on ports 3 to 11 and set the MHMA limit to two MACs to limit the number of host to two devices

```
5520-24T-1(config)#interface fastEthernet all
```

```
5520-24T-1(config-if)#eapol multihost port 3-11 enable eap-mac-max 2
5520-24T-1(config-if)#exit
```

9.5.1.11 Enable LLDP-Med on access port members

ERS5520-1 Step 1 – Enable LLDP-med on port 3 to 11

```
5520-24T-1(config)#interface fastEthernet 3-11
5520-24T-1 (config-if)#lldp tx-tlv local-mgmt-addr port-desc sys-cap sys-desc sys-name
5520-24T-1 (config-if)#lldp status txAndRx config-notification
5520-24T-1 (config-if)# lldp tx-tlv med extendedPSE med-capabilities network-policy
5520-24T-1 (config-if)#exit
```

9.5.1.12 Set PoE level on access port

ERS5520-1 Step 1 – Set PoE Power level high on all VoIP ports

```
5520-24T-1(config)# interface fastEthernet 3-11
5520-24T-1 (config-if)# poe poe-priority high
```

9.5.1.13 Add IP address to VLAN and enable OSPF

ERS5520-1 Step 1 – Add IP address to VLAN 260 and enable OSPF

```
5520-24T-1(config)#interface vlan 260
5520-24T-1(config-if)#ip address 10.55.20.3 255.255.255.0
5520-24T-1(config-if)#ip ospf enable
5520-24T-1(config-if)#exit
```

ERS5520-1 Step 2 – Add IP address to VLAN 262 and enable OSPF

```
5520-24T-1(config)# interface vlan 262
5520-24T-1(config-if)#ip address 10.55.22.1 255.255.255.0
5520-24T-1(config-if)#ip ospf network passive
5520-24T-1(config-if)#ip ospf enable
5520-24T-1(config-if)#exit
```

ERS5520-1 Step 3 – Add IP address to VLAN 280 and enable OSPF

```
5520-24T-1(config)# interface vlan 280
5520-24T-1(config-if)#ip address 10.55.23.1 255.255.255.0
5520-24T-1(config-if)#ip ospf network passive
5520-24T-1(config-if)#ip ospf enable
5520-24T-1(config-if)#exit
```

9.5.1.14 Enable IP routing and OSPF globlally

ERS5520-1 Step 1 – Enable IP routing

```
5520-24T-1(config)#ip routing
```

ERS5520-1 Step 2 – Enable OSPF globally

```
5520-24T-1(config)#router ospf enable
```

ERS5520-1 Step 3 – Enable OSPF networks

```
5520-24T-1(config)#router ospf
5520-24T-1(config-router)#network 10.55.20.3
5520-24T-1(config-router)#network 10.55.22.1
5520-24T-1(config-router)#network 10.55.23.1
5520-24T-1(config-router)#exit
```

9.5.1.15 Enable DHCP-Relay agents

ERS5520-1 Step 1 – Enable IP routing

```
5520-24T-1(config)#ip dhcp-relay
5520-24T-1(config)#ip dhcp-relay fwd-path 10.55.22.1 10.55.55.10 mode DHCP
5520-24T-1(config)#ip dhcp-relay fwd-path 10.55.23.1 10.55.55.10 mode DHCP
```

9.5.1.16 Enable SNMP - Optional

ERS5520-1 Step 1 – Enable SNMP if you wish to use JDM to access switch

```
5520-24T-1(config)#snmp-server enable
```

9.5.2 Verify ERS5520 Operations

Assuming we have a Nortel IP Phone 2004 Phase II with a PC connected to port 4 and assuming both devices have successfully passed EAP authentication, use the following commands to verify operations.

1. Use the following command to verify that ADAC has been applied to both IP Phone 2004 phone sets.

   - 5520-24T-1#***show eapol port 4***

```
EAPOL Administrative State:  Enabled
EAPOL User Based Policies:  Disabled
     Admin          Admin Oper ReAuth ReAuth Quiet  Xmit   Supplic Server  Max
Port Status   Auth Dir   Dir  Enable Period Period Period Timeout Timeout Req
---- -------- ---- ----- ---- ------ ------ ------ ------ ------- ------- ---
4    Auto     Yes  Both  Both Yes    3600   60     30     30      30      2
6    Auto     No   Both  Both Yes    3600   60     30     30      30      2
```

   - 5520-24T-1#***show eapol multihost status 4***

```
Port Client MAC Address Pae State      Backend Auth State
---- ------------------ -------------- ------------------
4    00:0A:E4:09:72:E7  Authenticated  Idle
4    00:50:8B:E1:58:E8  Authenticated  Idle
```

2. The following command is used to retrieve LLDP neighbor information from the IP Phone 2004 phone set.

- 5520-24T-1#***show lldp port 4 neighbor detail***

```
-------------------------------------------------------------------------------
                            lldp neighbor
-------------------------------------------------------------------------------
Port: 4     Index: 4                  Time: 0 days, 00:01:43
        ChassisId: Network address    ipV4  47.133.58.220
        PortId:    MAC address        00:0a:e4:09:72:e7
        SysCap:    TB / TB            (Supported/Enabled)
        PortDesc:  Nortel IP Phone
        SysDescr:  Nortel IP Telephone 2004, Firmware:C604DB1


 PVID: 0                              PPVID Supported: not supported(0)
 VLAN Name List: 280                  PPVID Enabled: none

 Dot3-MAC/PHY Auto-neg: supported/enabled       OperMAUtype:  100BaseTXFD
 PSE MDI power:         not supported/disabled  Port class:   PD
 PSE power pair:        signal/not controllable Power class:  1
 LinkAggr: not aggregatable/not aggregated      AggrPortID:   0
                                                MaxFrameSize: 1522
 PMD auto-neg:          (FdxS, FdxB)Pause, 1000Base(XFD, T)

 MED-Capabilities: CNSD / CNDI        (Supported/Current)
 MED-Device type:  Endpoint Class 3
 MED-Application Type: Voice                    VLAN ID: 280
 L2 Priority: 6         DSCP Value: 46          Tagged Vlan, Policy defined
 Med-Power Type: PD Device            Power Source: Unknown
 Power Priority: High                 Power Value:    5.4 Watt
 HWRev:                               FWRev: C604DB1
 SWRev:                               SerialNumber:
 ManufName: Nortel-01                 ModelName: IP Phone 2004
 AssetID:
-------------------------------------------------------------------------------
Sys capability: O-Other; R-Repeater; B-Bridge; W-WLAN accesspoint; r-Router;
T-Telephone; D-DOCSIS cable device; S-Station only.
Med Capabilities-C: N-Network Policy; L-Location Identification; I-Inventory;
S-Extended Power via MDI - PSE; D-Extended Power via MDI - PD.
```

- ERS5520i#***show lldp port 4 neighbor med***

```
-------------------------------------------------------------------------------
                            lldp neighbor
-------------------------------------------------------------------------------
Port: 4     Index: 4                  Time: 0 days, 00:01:43
        ChassisId: Network address    ipV4  47.133.58.220
        PortId:    MAC address        00:0a:e4:09:72:e7
        SysCap:    TB / TB            (Supported/Enabled)
        PortDesc:  Nortel IP Phone
        SysDescr:  Nortel IP Telephone 2004, Firmware:C604DB1


 MED-Capabilities: CNSD / CNDI        (Supported/Current)
 MED-Device type:  Endpoint Class 3
 MED-Application Type: Voice                    VLAN ID: 280
 L2 Priority: 6         DSCP Value: 46          Tagged Vlan, Policy defined
 Med-Power Type: PD Device            Power Source: Unknown
 Power Priority: High                 Power Value:    5.4 Watt
-------------------------------------------------------------------------------
Sys capability: O-Other; R-Repeater; B-Bridge; W-WLAN accesspoint; r-Router;
T-Telephone; D-DOCSIS cable device; S-Station only.
Med Capabilities-C: N-Network Policy; L-Location Identification; I-Inventory;
S-Extended Power via MDI - PSE; D-Extended Power via MDI - PD.
```

9.5.3 IP Phone 2004 Phone Set Configuration

Assuming we are using auto-configuration via the DHCP server, the IP Phone should be setup as follows :

IP Phone 2004 Phase I Phone Set Configuration:

- EAP Enable? [1=Y, 0=N]: **1**
- LLDP Enable? [1=Y, 0=N]: **1**
- DHCP? [0-No, 1-Yes]: **1**
- Cached IP? [0-N, 1-Y]: **0**
- DHCP: 0-Full, 1-Partial: **0**
- Cfg XAS: [0-No, 1-Yes]: **0**
- Voice VLAN? [0-N, 1-Y]: **1**
- VLAN Cfg? 0- Auto, 1-Man: **0**
- LLCP MED? 0-No, 1-Yes: **1**
- VLANFILTER? [0-No, 1-Yes]: **1**
- PC Port? [0-OFF, 1-ON]: **1**
- DATA VLAN? [0-N, 1-Y]: **0**
- PCUntagAll? 0-No, 1-Yes: **0**
- DUPLEX [0-AUTO, 1-FULL]: **0**
- GARP Ignore? [0-No, 1-Yes]: **0**
- PSK SRTP? [0-No, 1-Yes]: **0**

9.5.4 DHCP Server

For this example, only DHCP Option 128 (Call Server) needs to be set as follows:

Nortel-i2004-A,10.30.30.20:5000,1,5;10.30.31.20:5000,1,5.

10. Reference Documentation

Document Title	Publication Number	Description
Converging the Data Network with VoIP Fundamentals	NN43001-260	
IP Phones Fundamentals	NN43001-368	
IP Phones Description, Installation, and Operation	553-3001-368	
Nortel Ethernet Routing Switch 2500 Series Release 4.1 Document Collection	ERS2500_4.1_20071123,Rev 02	Ethernet Routing Switch 2500 Software Release 4.1
Nortel Ethernet Routing Switch 4500 Series Release 5.1 Document Collection	ERS4500_5.1_Doc_Collection_20071206, Rev 02	Ethernet Routing Switch 4500 Software Release 5.1
Nortel Ethernet Switch 470 Series Release 3.7 Document Collection	ES460-470_3.7_Document_Collection_20070313, Rev 04	Nortel Ethernet Switches 470 Software Release 3.7
Nortel Ethernet Routing Switch 5500 Series Release 5.1 Document Collection	ERS5500_5.1_Doc_Collection_20070827, Rev 01	Ethernet Routing Switch 5500 Software Release 5.1
Nortel Ethernet Routing Switch 8300 Series Release 3.0 Document Collection	ERS8300_4_0_NEW_COLLECTION_DOC, Rev 03.01	Ethernet Routing Switch 8300 Software Release 3.0
Nortel PoE Calculator		
PP8300 Technical Configuration Guide for QoS (NNCLI and CLI)		
PP8300 Technical Configuration Guide for Power over Ethernet		
PP8300 Technical Configuration Guide for Filters (NNCLI and CLI)		
PP8300 Technical Configuration Guide for EAP (NNCLI and CLI)		
BS5500 Technical Configuration Guide for CoS		
BayStack 5510 Technical Configuration Guide for QoS and Filters		
PP8300 Technical Configuration Guide for Filters (NNCLI and CLI)		
Technical Configuration Guide for EAP		Ethernet Switch 460-PWR/470-PWR

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From the Technical Support page, you can open a Customer Service Request online or find the telephone number for the nearest Technical Solutions Center. If you are not connected to the Internet, call 1-800-4NORTEL (1-800-466-7835) to learn the telephone number for the nearest Technical Solutions Center.

An Express Routing Code (ERC) is available for many Nortel products and services. When you use an ERC, your call is routed to a technical support person who specializes in supporting that product or service. To locate an ERC for your product or service, go to www.nortel.com/erc.