Grandstream Networks, Inc.

VLAN (Virtual Local Area Network) Guide

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SUPPORTED DEVICES

Following table shows Grandstream products supporting VLAN protocol.

Table 1: List of Supported Products

Model	VLAN Support	LLDP Support	Firmware
Enterprise IP Phones			
GXP21xx	Yes	Yes	1.0.7.25 or higher
Mid-Range IP Phones			
GXP17xx	Yes	Yes	1.0.0.37 or higher
Small Business IP Phones			
GXP16xx	Yes	Yes	1.0.4.6 or higher
IP Video Phones for Android			
GVC3380	Yes	Yes	1.0.1.14 or higher
GXV3350	Yes	Yes	1.0.1.8 or higher
GXV3370	Yes	Yes	1.0.1.28 or higher
Full HD Conferencing System			
GVC3200/3202	Yes	Yes	1.0.1.74 or higher
GVC3210	Yes	Yes	1.0.1.69 or higher
GVC3220	Yes	Yes	1.0.1.24 or higher
GVC3212	Yes	Yes	1.0.0.6 or higher
Audio Conferencing System			
GAC2500	Yes	Yes	1.0.1.44 or higher
Analog VoIP Gateways			
GXW42xx	Yes	Yes	1.0.5.16 or higher
Analog Telephone Adaptors			
HT8xx	Yes	No	1.0.2.5 or higher
Cordless IP Phones			
DP750/752	Yes	Yes	1.0.1.20 or higher

INTRODUCTION

VLAN (Virtual Local Area Network) allows to separate network devices in logical groups despite of their physical location. Only members in same VLAN can communicate with each other. It also confines the broadcast domain to its members.

VLANs are implemented to achieve scalability, security and ease the network management and can quickly adapt to changes in network requirements and relocation of workstations and servers.

802.1Q is the standard that supports VLANs on an Ethernet network, its frames are distinguished from ordinary Ethernet frames by the insertion of a 4-byte VLAN tag (VLAN ID) into the Ethernet header.

VLANs are used to achieve the following:

- **Increase performance:** Grouping users into logical networks will increase performance by limiting broadcast traffic to users performing similar functions within workgroups. Additionally, less traffic will need to be routed, and the latency added to routers will be reduced.
- **Improve manageability:** VLANs make large networks more manageable by allowing centralized configuration of devices located in assorted locations.
- **Increase security options:** VLANs have the ability to provide additional security not available in a shared network environment. A switched network delivers packets only to the intended recipients and packets only to other members of the VLAN. This allows the network administrator to segment users requiring access to sensitive information into separate VLANs from the rest of the general users regardless of physical location.

ABOUT VLAN

General

VLAN tag allows to distinguish between different VLAN broadcast domains on a group of LAN switches.

The inserted field to the Ethernet frame is composed of four bytes (32 bits). The VLAN tag is a two-byte (16 bits) field inserted between the source MAC address and the Ethertype field in an Ethernet frame as shown on Figure 1. Another two-byte field, the Tag Protocol Identifier (TPI or TPID), precedes the VLAN tag field.

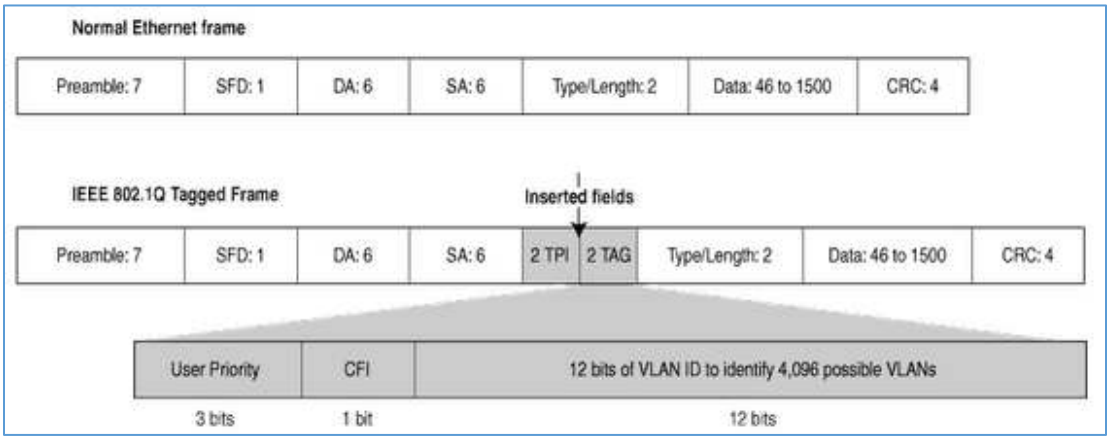


Figure 1: Normal and VLAN-Tagged Ethernet Frames

Two fields are necessary to hold one piece of information:

TPID *(Tag Protocol Identifier):* 2 Bytes after the source MAC address which will be set to a value of 0x8100 to denote that this frame carries 802.1Q or 802.1p tag information.

TCI *(Tag Control Information):* 2 Bytes which are made of the following:

- 3-bit user *Priority Code Point* (**PCP**) that sets a priority value between 0 and 7, which can be used for Quality of Service (QoS) priority traffic delivery, as shown on Table 1.
- 1-bit *Canonical Format Indicator* (**CFI**) that is a compatibility bit between Ethernet and other network structures, such as Token Ring. For Ethernet networks, this value will also be set to zero.
- 12-bit *VLAN Identifier* (**VID**) identifies the VLAN that the frame belongs to.

Table 2: Priority Level

PCP	Priority	Acronym	Traffic Types
1	0 (lowest)	BK	Background
0	1	BE	Best Effort
2	2	EE	Excellent Effort
3	3	CA	Critical Applications
4	4	VI	Video, < 100ms latency and jitter
5	5	VO	Voice, < 10ms latency and jitter
6	6	IC	Internetwork Control
7	7(highest)	NC	Network Control

Voice VLAN

The Voice traffic is sensitive to delay and jitter, thus it requires a higher priority than data traffic to reduce the delay and packet loss during transmission, separating voice and data traffic using VLANs provides a solid security boundary, preventing data applications from reaching the voice traffic. It also gives user a simpler method to deploy QoS, prioritizing the voice traffic over the data. This feature enables access port of the switch to affect the connected device to a separated logical group, once this feature is enabled the ports set on the voice VLAN will allow simultaneous access for the PC, therefore the device and PC can be connected to one switch port through the device, LAN port will be connected to the Switch and PC port to the PC, after configuring VLAN tags for PC and LAN port the device will tag all packets from those port with VLAN ID, the switch will then forward the received packets to the corresponding VLAN ID.

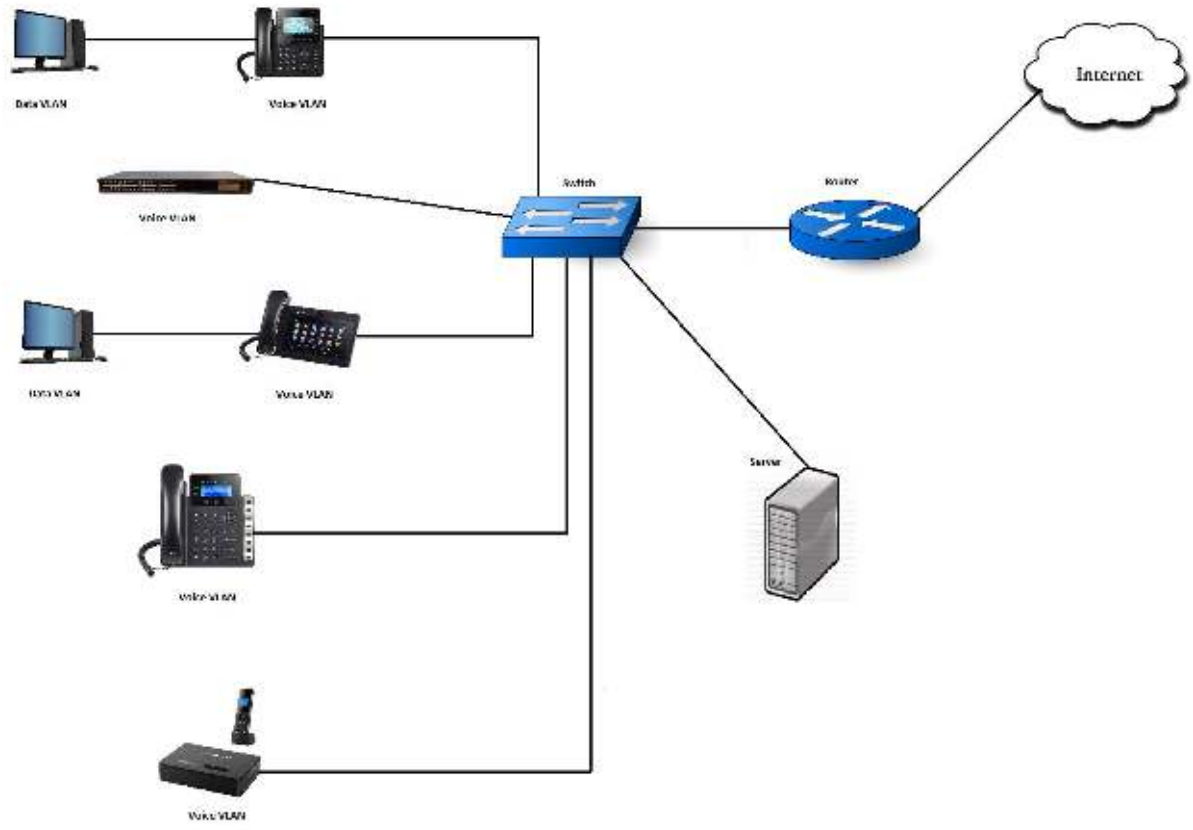


Figure 2: SIP clients VLAN architecture

VLAN CONFIGURATION

There are 3 ways to get VLAN ID on Grandstream products for the LAN port:

1. Discovery using LLDP
2. DHCP VLAN Option 132, 133
3. Manual configuration

Notes:

- The Grandstream products only support manual method to get VLAN ID for the PC port.
- DHCP VLAN options “132” and “133” are supported only on GXV32xx series.

LLDP (Link Layer Discovery Protocol)

The Link Layer Discovery Protocol (LLDP) is a Layer 2 discovery protocol defined in the IEEE 802.1ab. Nodes transmit information about themselves and listen for information about the devices on each connection, LLDP defines a standard SNMP MIB (Management Information Base) which can store information gathered locally and can be queried by SNMP to facilitate network management.

LLDP encapsulates all the device information in LLDPDUs (LLDP Data Units), which are then sent to neighboring nodes. A LLDPDU contains a variety of type length values (**TLV**s). In a TLV, **“T”** indicates the information type, **“L”** indicates the information length, and **“V”** indicates the value or the content to be sent.

Devices send/receive LLDPDUs with different TLVs to advertise their local information and receive neighbor information.

Table 3: TLVs transported in LLDPDUs

TLV Type	TLV Name	Usage in LLDPDU	Description
0	End of LLDPDU	Mandatory	This marks the end of the TLV sequence in the LLDPDU. After this TLV, there is no further processing. This is a mandatory filed that need to be present at the end of the data stream.
1	Chassis ID	Mandatory	Contains the IP address of the sending port.
2	Port ID	Mandatory	Contains the MAC address of the device.
3	Time to Live	Mandatory	Specifies the life of the transmitted information on the device.
4	Port description	Optional	Describes the sending port.
5	System Name	Optional	Specifies the assigned name for the device.
6	System Description	Optional	Specifies the description of the device.
7	System Capabilities	Optional	Specifies the supported and enabled capabilities of the device, the supported and enabled capabilities by default are Bridge and Telephone.
8	Management Address	Optional	The type of management address used in LLDPDU
9-126	Reserved	-	-
127	Organizationally specific TLVs	Optional	LLDP specification allows for various organizations to define and encode their own TLVs.

LLDP-MED

LLDP-MED is an extension of LLDP, that exchanges messages between Network devices such as switches and VoIP devices, it is published by the Telecommunications Industry Association (TIA). It provides the following capabilities for VoIP devices:

Table 4: LLDP-MED TLVs type

LLDP-MED TLVs	Description
LLDP-MED capabilities	Allows endpoints to determine the capabilities that the connected device supports and what capabilities the device has enabled.
Network Policy	Allows both network connectivity devices and endpoints to advertise VLAN configurations and associated Layer 2 and Layer 3 attributes for the specific application on that port. For example, the switch can notify the device of the VLAN number that it should use. The device can connect into any switch, obtain its VLAN number, and then start communicating with the call control.
Power Management	Enables advanced power management between LLDP-MED endpoint and network connectivity devices. Allows switches and devices to convey power information, such as how the device is powered, power priority, and how much power the device needs.
Inventory Management	Allows an endpoint to transmit detailed inventory information about itself to the switch, including information hardware revision, firmware version, software version, serial number, manufacturer name, model name, and asset ID TLV.
Location	Provides location information from the switch to the endpoint device. The location TLV can send this information: • **Civic location information:** Provides the civic address information and postal information. Examples of civic location information are street address, road name, and postal community name information. • **ELIN location information:** Provides the location information of a caller. The location is determined by the Emergency location identifier number (ELIN), which is a device number that routes an emergency call to the local public safety answering point (PSAP) and which the PSAP can use to call back the emergency caller.

Note: In order to enable/disable LLDP option from the Web GUI, please refer to following table showing the location of LLDP option.

Table 5: LLDP Option Location on The Web GUI

Devices	Location in the Web GUI
GXP21xx Color	Network → Advanced Settings
GXP17xx	Network → Advanced Settings
GXP16xx	Network → Advanced Settings
GXV32xx	Maintenance → Network Settings

GXW42xx	Maintenance → Network Settings
DP750	Settings → Network Settings → Advanced Settings
GAC2500	Maintenance → Network Settings
GVC32xx	Settings > Network Settings

Configuring LLDP via Configuration File

For GXP21xx color, GXP17xx, GXP16xx, GXV32xx, DP750, GXW42xx, GVC32xx and GAC2500 series, administrator can edit following P-values:

- **P1684=0** to disable the LLDP feature.
- **P1684=1** to enable the LLDP feature.

LLDP Flow (Wireshark)

Since the LLDP feature is activated by default, the SIP client will behave as follows:

- Send LLDP advertisement each 30 second.
- Send/receive LLDP packets from LAN port.
- Support the MAC/PHY Configuration/Status.
- Obtain VLAN information (ID, L2 Priority, DSCP Priority…) from the Network policy.

The following trace shows the packets advertised and received by the GXP1625.

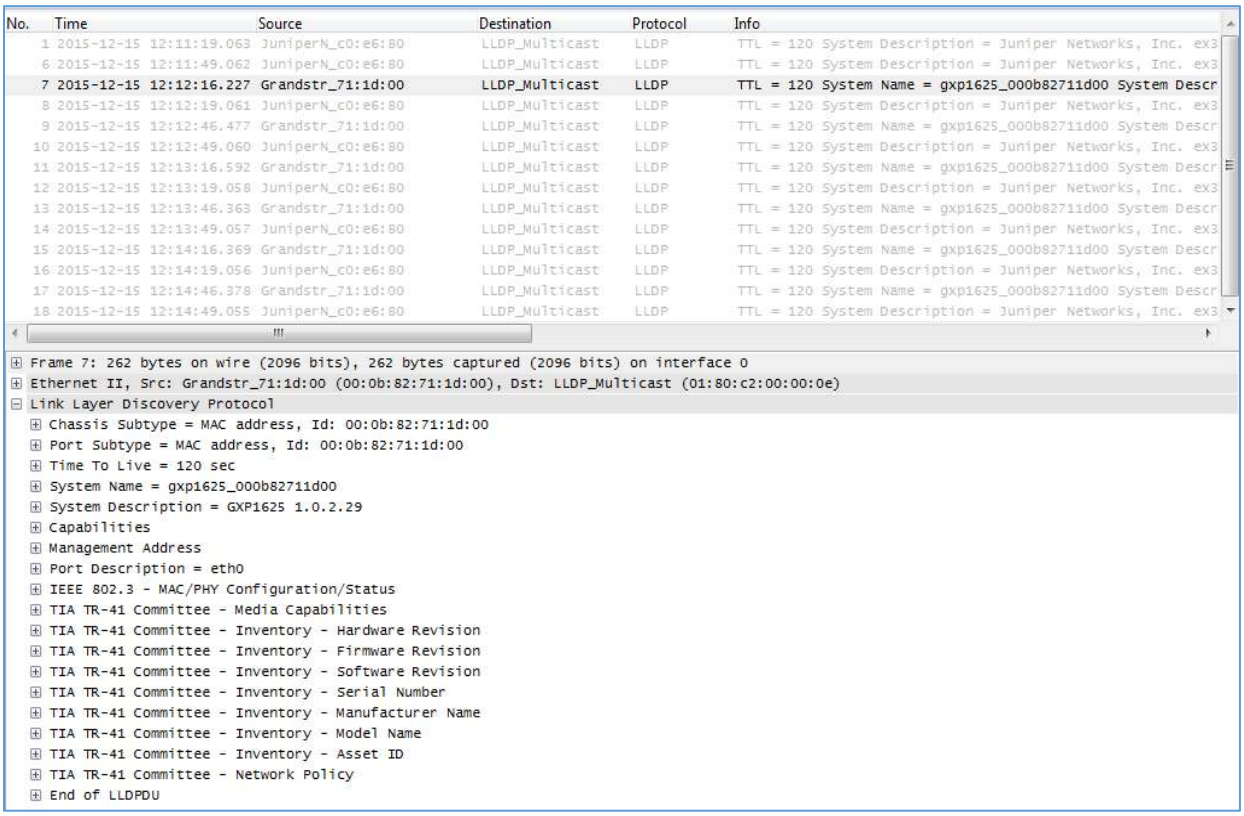


Figure 3: LLDP advertisement on GXP1625

Manual Configuration

For manual configuration user can make the settings either via configuration file or via Web GUI.

Configuring VLAN Manually via Web GUI

Table 6: Set VLAN Manually

Devices	Location in the Web GUI
GXP21xx	Network → Advanced Settings
GXP17xx	Network → Advanced Settings
GXP16xx	Network → Advanced Settings
GXV32xx	Maintenance → Network Settings
GXW42xx	Maintenance → Network Settings
DP750	Settings → Network Settings → Advanced Settings
HT8xx/HT7xx/HT5xx	Advanced Settings
GVC32xx	Settings → Network Settings
GAC2500	Maintenance → Network Settings

Configuring VLAN Manually via Configuration File

Table 7: VLAN Manual Configuration

Devices	Fields	P-Value
GXP21xx	• Layer 2 QoS. 802.1Q/VLAN Tag	P51
	• Layer 2 QoS 802.1p Priority Value	P87
	• PC Port VLAN Tag	P229
	• PC Port Priority Value	P230
GXP17xx	• Layer 2 QoS. 802.1Q/VLAN Tag	P51
	• Layer 2 QoS 802.1p Priority Value	P87
	• PC Port VLAN Tag	P229
	• PC Port Priority Value	P230
GXP16xx	• Layer 2 QoS 802.1Q/VLAN Tag	P51
	• Layer 2 QoS 802.1p Priority Value	P87
	• PC Port VLAN Tag	P229
	• PC Port Priority Value	P230
GXV32xx	• Layer 2 QoS 802.1Q/VLAN Tag	P51
	• Layer 2 QoS 802.1p Priority Value	P87
	• Layer 2 QoS 802.1Q/VLAN Tag (Wi-Fi)	P22047
	• Layer 2 QoS 802.1p Priority Value (Wi-Fi)	P22048
	• PC Port VLAN Tag	P229
	• PC Port Priority Value	P230

GXW42xx	• Layer 2 QoS 802.1Q/VLAN Tag	P51
	• Layer 2 QoS 802.1p Priority Value for SIP signaling	P5038
	• Layer 2 QoS 802.1p Priority Value for RTP media	P5042
DP750	• Layer 2 QoS 802.1Q/VLAN Tag	P51
	• Layer 2 QoS 802.1p Priority Value for SIP signaling	P5038
	• Layer 2 QoS 802.1p Priority Value for RTP media	P5042
	• Enable VLAN	P27004
HT8xx/HT7xx/HT5xx	• Layer 2 QoS 802.1Q/VLAN Tag	P51
	• Layer 2 QoS 802.1p Priority Value for SIP signaling	P5038
	• Layer 2 QoS 802.1p Priority Value for RTP media	P5042
GVC32xx	• Layer 2 QoS 802.1Q/VLAN Tag	P51
	• Layer 2 QoS 802.1p Priority	P87
GAC2500	• Layer 2 QoS 802.1Q/VLAN Tag (Ethernet)	P51
	• Layer 2 QoS 802.1p Priority Value (Ethernet)	P87
	• Layer 2 QoS 802.1Q/VLAN Tag (Wi-Fi)	P22047
	• Layer 2 QoS 802.1p Priority Value (Wi-Fi)	P22048

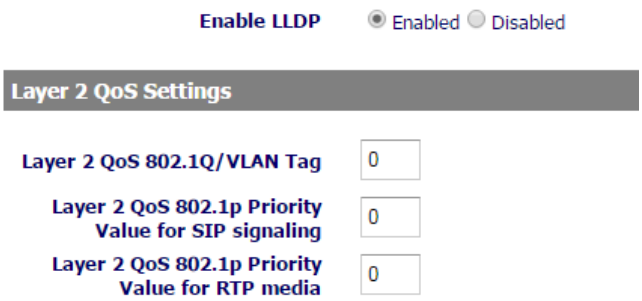
Note: Make sure to set VLAN Tag with appropriate Tag on the P value, for Priority set a value from 1 to 7.

Screenshots Examples for LLDP and Manual Configuration Settings

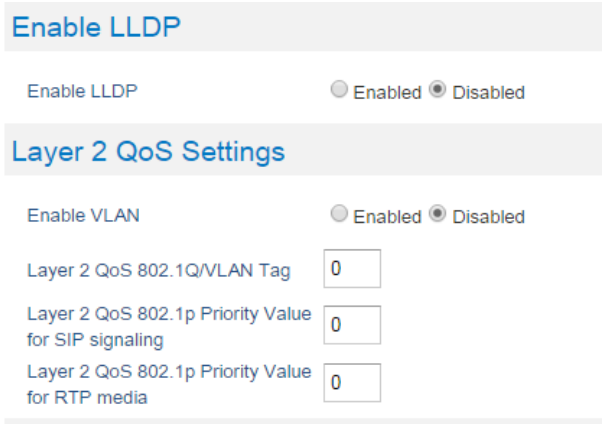
GXP21xx, GXP17xx & GXP16xx Series
Network → Advanced Settings

GXV32xx Series
Maintenance → Network Settings

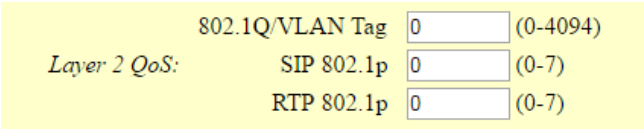
GXW42xx Series
Maintenance > Network Settings



DP750
Settings > Network Settings > Advanced Settings



HT8xx/HT7xx/HT5xx Series
Advanced Settings



GVC32xx Series
Settings > Network Settings

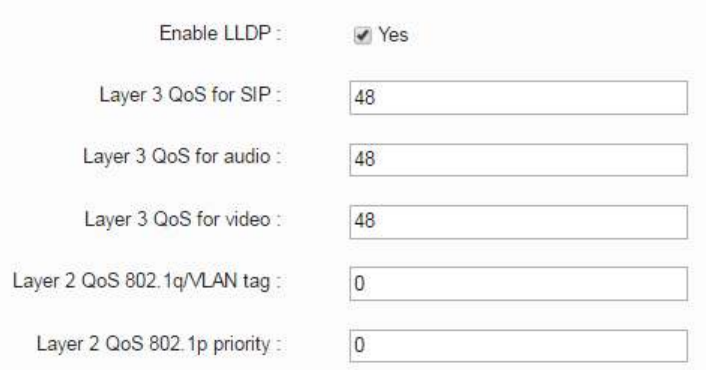


Figure 4: Screenshots for LLDP and Manual Configuration Settings

Automatic Configuration using DHCP VLAN options (GXV32xx only)

To use this feature, DHCP server needs to support Option 132 (VLAN option).

Following steps show how to install and configure a DHCP server supporting option 132.

In this guide, we will use isc dhcp server on Ubuntu 12.

1. In order to install the server, open a terminal login as root and type the following command:

```
root@admin:/# apt-get install isc-dhcp-server
```

Figure 5: Download and Install isc

2. Once the server is downloaded and installed successfully, we need to set the PC interface which will listen and advertise DHCP packets. This can be done by editing:

```
# nano /etc/default/isc-dhcp-server
```

Figure 6: Editing Configuration File

3. Once the above command is typed, the following window will be shown:

```
  GNU nano 2.2.6        File: /etc/default/isc-dhcp-server

# Defaults for dhcp initscript
# sourced by /etc/init.d/dhcp
# installed at /etc/default/isc-dhcp-server by the maintainer scripts

#
# This is a POSIX shell fragment
#

# On what interfaces should the DHCP server (dhcpd) serve DHCP requests?
#       Separate multiple interfaces with spaces, e.g. "eth0 eth1".
INTERFACES="eth0"

^G Get Help  ^O WriteOut  ^R Read File ^Y Prev Page ^K Cut Text  ^C Cur Pos
^X Exit      ^J Justify   ^W Where Is  ^V Next Page ^U UnCut Text^T To Spell
```

Figure 7: Listening Interface

4. Replace **eth0** on the above screenshot with the name of user network interface the server will lease addresses on, then save and exit the file using **"Ctrl+X"**

5. Now we need to edit the dhcp configuration file to set our option:

```
root@admin:/# nano /etc/dhcp/dhcpd.conf
```

Figure 8: Editing dhcp.conf

6. Once the above command is typed the configuration file will be prompted, add following lines to activate DHCP option 132.

```
option vlan-id code 132 = text;
option vlan-id "20";
```

Figure 9: DHCP option 132

7. This will affect the device to vlan20.
8. Administrator can save changes made on that file by typing **"Ctrl+X"** then confirm with **"Y"**
9. Restart DHCP services with the following command:

```
# /etc/init.d/isc-dhcp-server restart
```

Figure 10: Restart DHCP Service

Configuring DHCP VLAN option on GXV32xx via Web GUI

To activate option 132 on the GXV32XX series, administrator can activate it from the Web GUI.

- Log in to the Web GUI.
- Go under "Maintenance > Network Settings".
- Click on the checkbox "**Enable DHCP VLAN**", this will allow the device to retrieve the VLAN ID and priority from the DHCP server (Option 132, Option 133).
- Click on "Save" to save the changes.

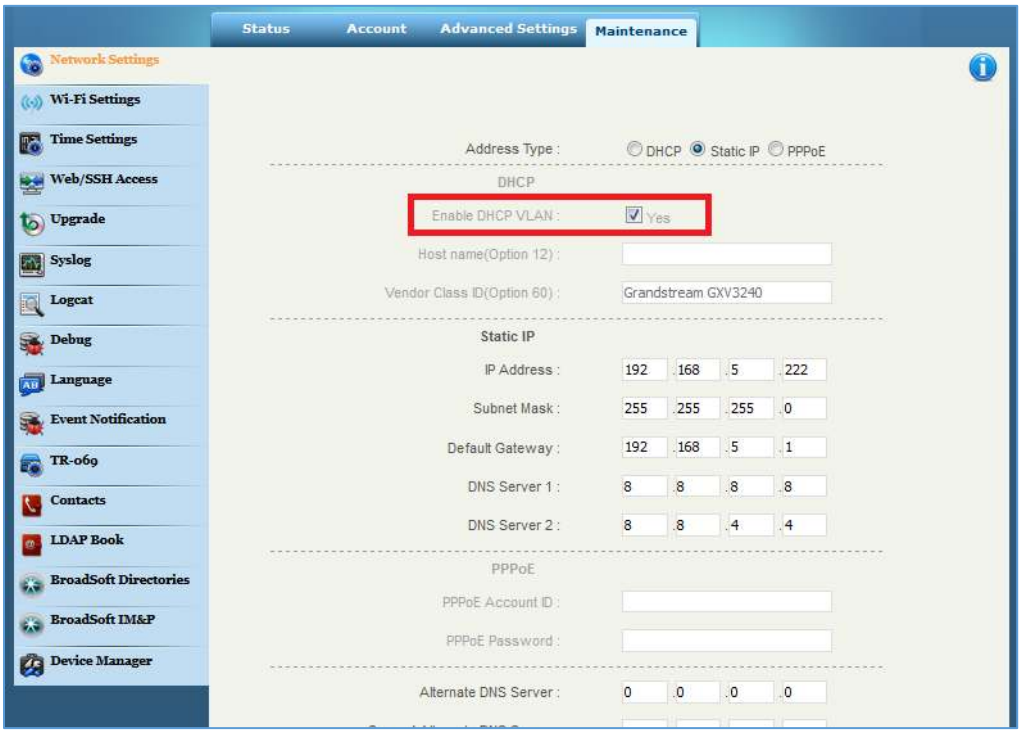


Figure 11: Enable DHCP VLAN

Configuring the DHCP VLAN option on the GXV32xx via configuration file

For the GXV32xx series user can edit P-value:

P8300=0 to disable the DHCP VLAN option.
P8300=1 to enable the DHCP VLAN option.

DHCP VLAN Option Wireshark Flow

Once the DHCP VLAN option activated the device will behave as follow:

- Send DHCP Discover that include Option 132 requesting for a VLAN Tag.
- Complete the Process of DHCP, (Discover, Offer, Request, ACK), the Offer and ACK will include the Tag value set on the DHCP server (VLAN ID = 20).
- The device will send another DHCP Discover this time including the VLAN Tag 20 in order to take an IP within this range.
- After the DCHP Process finish, the device will grab an IP address from the VLAN range.

The following trace show the packets advertised and received by the GXV3240.

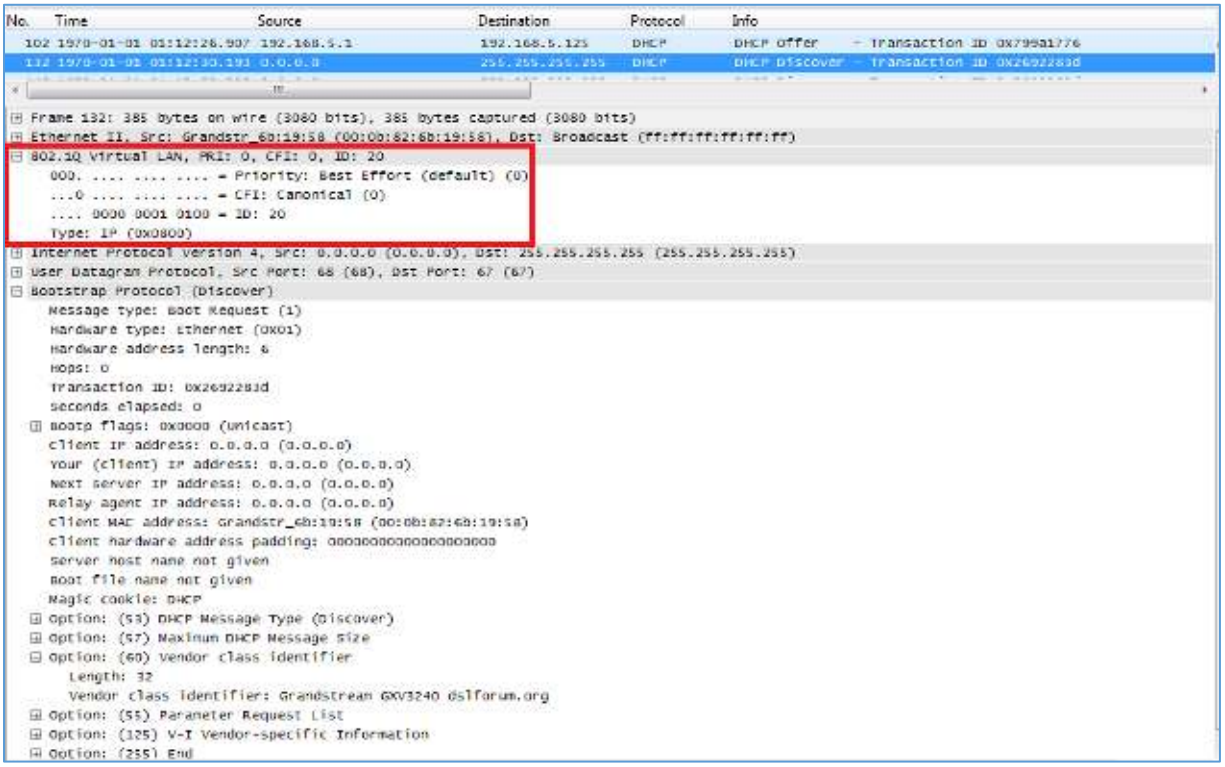


Figure 12: DHCP Discovery on GXV3240