Yealink

Virtual Local Area Network (VLAN)

About VLAN

VLAN (Virtual Local Area Network) is used to logically divide a physical network into several broadcast domains. VLAN membership can be configured through software instead of physically relocating devices or connections. Grouping devices with a common set of requirements regardless of their physical location can greatly simplify network design. VLANs can address issues such as scalability, security, and network management.

IEEE 802.1Q

IEEE 802.1Q is the networking standard that supports VLANs on an Ethernet network. The specification defines a standard method for tagging Ethernet packets with VLAN membership information. A VLAN-aware device is the one which understands VLAN memberships and VLAN formats. When a packet from the IP phone enters the VLAN-aware portion of the network, a tag is added to represent the VLAN membership of the IP phone. Each packet must be distinguishable as being within exactly one VLAN. A packet in the VLAN-aware portion of the network that does not contain a VLAN tag is assumed to be flowing on the native (or default) VLAN.

802.1Q adds a 4-byte tag between the source MAC address and the Ethernet type fields of the Ethernet frame. Two bytes are used for the tag protocol identifier (TPID), the other two bytes for tag control information (TCI). The TCI field is further divided into PCP (Priority Code Point), CFI (Canonical Format Indicator), and VID (VLAN ID).

Voice VLAN

As voice traffic is delay and jitter sensitive for the IP phone, it requires higher priority over data traffic to reduce delay and packet loss during transmission. To simplify configuration procedures and better manage voice transmission policies, the connected switch can be configured to provide voice VLAN function and transmit the voice traffic of the IP phone in a dedicated VLAN, called voice VLAN.

Voice VLAN is a special access port feature of the switch which allows IP phones to be automatically configured and easily associated with a logically separate VLAN. This feature provides various benefits, but one particular benefit is that when voice VLAN is enabled on a switch port, this port is also enabled to allow simultaneous access for a PC. This feature allows a PC to be daisy chained to an IP phone and the connection for both PC and IP phone to be trunked through the same physical Ethernet cable.

The purpose of VLAN configurations on the IP phone is to insert tag with VLAN information to the packets generated by the IP phone. When VLAN is properly configured for the ports (Internet port and PC port) on the IP phone, the IP phone will tag all packets from these ports with the VLAN ID. The switch receives and forwards the tagged packets to the corresponding VLAN according to the VLAN ID in the tags described in IEEE Std 802.3.
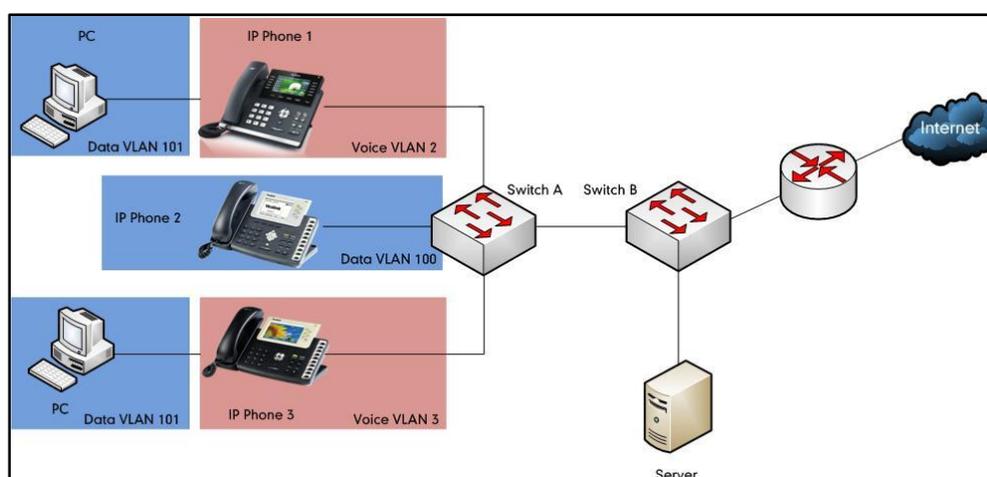
Major Benefits of Using VLANs

VLANs offer many benefits that are not found in typical LANs. Major benefits of segregating IP phones into VLAN(s) are listed as below:

- **Performance Enhancements:** VLAN is used to minimize the broadcast domain. Creating smaller domain for IP phone can reduce overhead and limit resource utilization. Additionally, less traffic will need to be routed, and the latency added by routers will be reduced.

- **Ease of Administration:** Much of the cost associated with network additions and relocations can be saved through the use of VLANs. IP phone can be shifted from one workgroup or department to another without installing new network cabling and reconfiguring hubs or routers.

- **Security:** VLANs can be used to create secure user groups and prevent others outside of the broadcast domain from receiving sensitive data of the IP phone. They can also be used to enhance firewall functions and restrict network access for one or more users. By segregating IP phones into VLANs, security filters can be implemented in the network to prevent the IP phones from receiving unnecessary traffic from other devices. This helps prevent disruption due to DoS attacks or

attempts to compromise the devices. It also allows locking down access to configuration and signaling servers to only allow access from the IP phones.

Yealink IP Phones Compatible with VLAN

There are three ways to get VLAN ID for Internet (WAN) port, but the VLAN used is chosen by priority of each method. The priority is: LLDP>Manual>DHCP VLAN. There is only one way to get VLAN ID for PC port: Manual.

LLDP and Manual methods are available on all Yealink IP phones. The Manual method for PC port is not available on Yealink W52P and VP530 IP phones. DHCP VLAN method is available on Yealink SIP-T28P, SIP-T26P, SIP-T22P, SIP-T20P, SIP-T21P, SIP-T19P, SIP-T46G, SIP-T42G and SIP-T41P IP phones running firmware version 71 or later, and Yealink W52P IP DECT phones running firmware version 30 or later.

VLAN Discovery Method on Yealink IP Phones

Automatic Discovery Method for VLAN

LLDP

Introduction

LLDP (Link Layer Discovery Protocol) allows Ethernet network devices to receive and/or transmit device-related information to directly connected devices on the network that are also using the protocol, and store the information that is learned about other devices. Information gathered with LLDP is stored in the device as a management information database (MIB) and can be queried with the Simple Network Management Protocol (SNMP) as specified in RFC 2922. LLDP transmits information as packets called LLDP Data Units (LLDPDUs). An LLDPDU consists of a set of Type-Length-Value (TLV) elements, each of which contains a particular type of information about the device or port transmitting it.

Each of the TLV components has the following basic structure:

Type	Length	Value
7 bits	9 bits	0-510 octets

LLDP supports advertising the following TLVs:

- **Mandatory LLDP TLVs**: Chassis ID, Port ID, and Time to Live (TTL) are included in an LLDPDU by default.

- **Optional LLDP TLVs**: System Name, System Description and so on, the phone sends the optional TLVs along with the mandatory TLVs in an LLDPDU.

- **Organizationally Specific TLVs**: MAC/PHY Configuration/Status and Port VLAN ID, which are defined in IEEE Standard 802.3 and 802.1 respectively.

The LLDP frame ends with a special TLV, named **end of LLDPDU** in which both the **type** and **length** fields are 0.

LLDP-MED

LLDP-MED (Media Endpoint Discovery) is published by the Telecommunications Industry Association (TIA). It is an extension to LLDP that operates between endpoint devices and network connectivity devices. LLDP-MED specifically provides support for voice over IP (VoIP) applications and provides the following capabilities:

- Capabilities Discovery—allows LLDP-MED endpoints to determine the capabilities that the connected device supports and has enabled. It can be used to indicate whether the connected device is a phone, a switch, a repeater, etc.

- Voice VLAN Configuration—provides a mechanism for a switch to notify a device which VLAN to use, which enables "plug and play" networking.

- Power Management—provides information related to how the device is powered, power priority, and how much power the device needs.

- Inventory Management—provides a means to manage device and the attributes of the device such as model number, serial number, software revision, etc.

- Location Identification Discovery—provides location information from the switch to the device when placing an emergency call.

In addition to the TLVs advertised by LLDP, LLDP-MED also supports advertising the following TLVs:

- LLDP-MED capabilities TLV

- Network policy TLV

- Power management TLV

- Inventory management TLV

- Location identification TLV (not supported by IP phones)

It should be noted that either LLDP or LLDP-MED—but not both—can be used at any given time on an interface between two devices.

LLDP Feature on Yealink IP Phones

LLDP provides exceptional interoperability benefits, IP telephony troubleshooting, automatic deployment of policies and advanced PoE (Power over Ethernet). When LLDP feature is enabled on IP phones, the IP phones periodically advertise their own information to the directly connected LLDP-enabled switch. The IP phones can also receive LLDP packets from the connected switch. When the application type is "voice", IP phones decide whether to update the VLAN configurations obtained from the LLDP packets. When the VLAN configurations on the IP phones are different from the ones sent by the switch, the IP phones perform an update and reboot. This allows the IP phones to be plugged into any switch, obtain their VLAN IDs, and then start communications with the call control.

Supported TLVs of IP Phones

TLVs supported by IP phones are summarized in the following table:

TLV Type	TLV Name	Description
Mandatory TLVs	Chassis ID	Specifies the IP address of the sending port.
	Port ID	Specifies the MAC address of the IP phone.
	Time To Live	Specifies the life of the transmitted information on the IP phone. The default value is 60s.
	End of LLDPDU	Marks the end of the TLV sequence in the LLDPDU. No further processing of TLVs after this is necessary. This is a mandatory TLV and therefore must be present at the end of the data stream.
Optional TLVs	System Name	Specifies the administratively-assigned name for the IP phone (per RFC3418).
	System Description	Specifies the description of the IP phone.
	System Capabilities	Specifies the supported and enabled capabilities of the IP phone. The supported capabilities are Bridge, Telephone and Router. The enabled capabilities are Bridge and Telephone by default.

TLV Type	TLV Name	Description
	Port Description	Specifies the description of the sending port. The default value is "WAN PORT".
IEEE Std 802.3 Organizationally Specific TLV	MAC/PHY Configuration/Status	Specifies duplex and bit rate settings of the IP phone. The Auto Negotiation is supported and enabled by default. The advertised capabilities of PMD Auto-Negotiation are: • 100BASE-TX (full duplex mode) • 100BASE-TX (half duplex mode) • 10BASE-T (full duplex mode) • 10BASE-T (half duplex mode)
LLDP-MED TLVs	Media Capabilities	Specifies the MED device type of the IP phone and the supported LLDP-MED TLV type can be encapsulated in LLDPDU. The supported LLDP-MED TLV types are: • LLDP-MED Capabilities • Network Policy • Extended Power via MDI-PD • Inventory
	Network Policy	Specifies the port VLAN ID, application type, L2 priority and DSCP value.
	Extended Power-via-MDI	Specifies power type, source, priority and value.
	Inventory – Hardware Revision	Specifies the hardware revision of IP phone.
	Inventory – Firmware Revision	Specifies the firmware revision of IP phone.
	Inventory – Software Revision	Specifies the software revision of IP phone.
	Inventory – Serial Number	Specifies the serial number of IP phone.
	Inventory –	Manufacturer name of IP phone.

TLV Type	TLV Name	Description
	Manufacturer Name	
	Inventory – Model Name	Specifies the model name of IP phone.
	Asset ID	Specifies the asset identifier of IP phone. The default value is "asset".

Configuring LLDP Feature

LLDP is enabled on IP phones by default. You can configure LLDP via web user interface or using configuration files. You can also configure the sending frequency of LLDP packet. The default sending frequency is 60s. The followings take configurations of a SIP-T28P IP phone running firmware version 71 as examples.

To configure LLDP feature via web user interface:

1. Log into the web user interface with the administrator credential.

    The default administrator user name and password are both "admin".

2. Click on **Network**->**Advanced**.

3. In the **LLDP** block, select the desired value from the pull-down list of **Active**.

4. Enter the desired time (in seconds) in the **Packet Interval (1~3600s)** field.

5. Click **Confirm** to accept the change.

    The web user interface prompts the warning "Some settings you changed take effect when you restart your machine! Do you want to reboot now?".

6. Click **OK** to reboot the IP phone.

To configure LLDP feature using configuration files:

1. Add/Edit LLDP parameters in configuration files.

   The following table shows the information of parameters:

Parameter	Description	Valid Value	Default Value
network.lldp.enable	Enables or disables LLDP on the IP phone. **0**-Disabled **1**-Enabled	Boolean	1
network.lldp.packet_interval	Sets the sending frequency (in seconds) of LLDP packets.	Integer (1 to 3600)	60

   The following shows an example of LLDP configuration in configuration files:

   ```
   network.lldp.enable = 1
   network.lldp.packet_interval = 60
   ```

2. Upload configuration files to the root directory of the provisioning server and trigger IP phones to perform an auto provisioning for configuration update.

   For more information on auto provisioning, refer to Yealink IP Phones Auto Provisioning Guide.

Verifying the Configuration

After LLDP feature is enabled, the IP phone performs the following:

- Periodically advertises information (e.g., hardware revision, firmware revision, serial number) of the IP phone to a multicast address on the network.

- Allows LLDP packets to be received from the Internet (WAN) port.

- Supports the MAC/PHY configuration (e.g., speed rate, duplex mode).

- Obtains VLAN info from the network policy, which takes precedence over manual settings.

The following figure shows the LLDP packets sent and received by the IP phone, each packet contains multiple TLVs.

DHCP VLAN

IP phones support VLAN discovery via DHCP. When the VLAN Discovery method is set to DHCP, the IP phone will detect DHCP option for a valid VLAN ID. The predefined option 132 is used to supply the VLAN ID by default. You can customize the DHCP option used to detect the VLAN ID.

Configuring DHCP Option on a DHCP Server

Before using DHCP VLAN feature on IP phones, you must make sure that the DHCP option on the DHCP server is configured properly. This section provides instructions on how to configure a DHCP option for windows using DHCP Turbo.
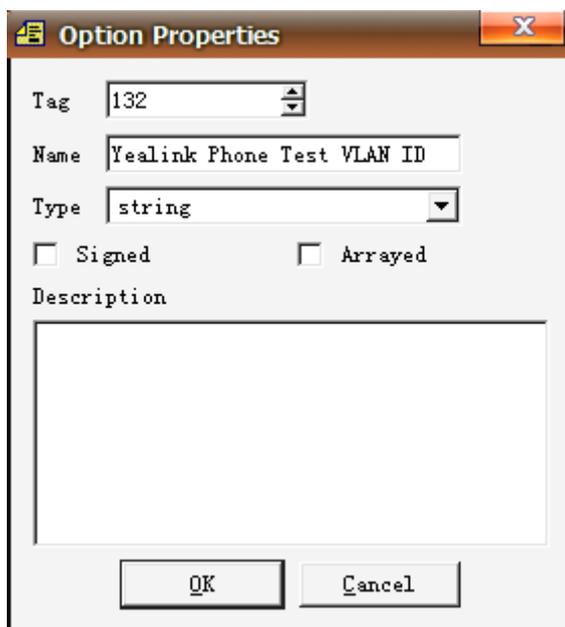
To configure DHCP option on a DHCP server:

1. Start the DHCP Turbo application.

2. Right click **Option Types**, and then select **New Option Type**.
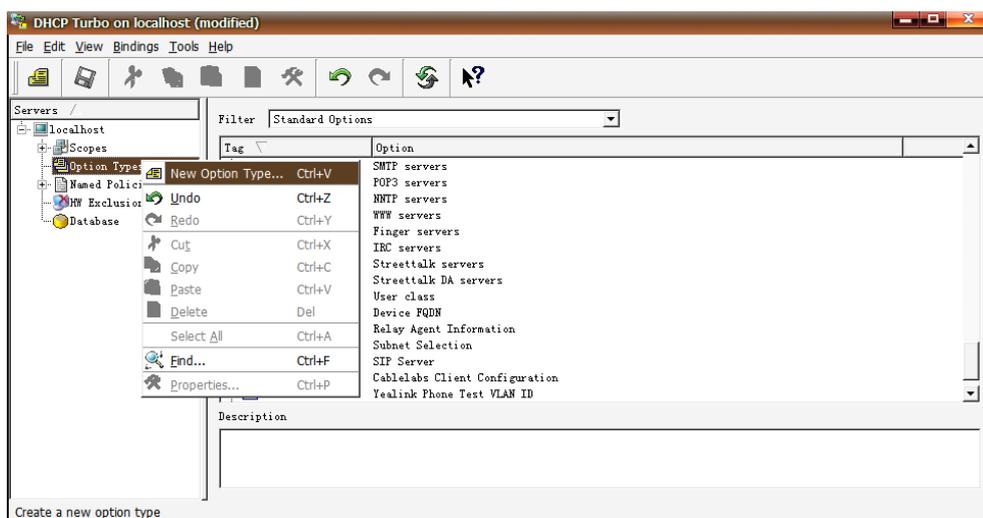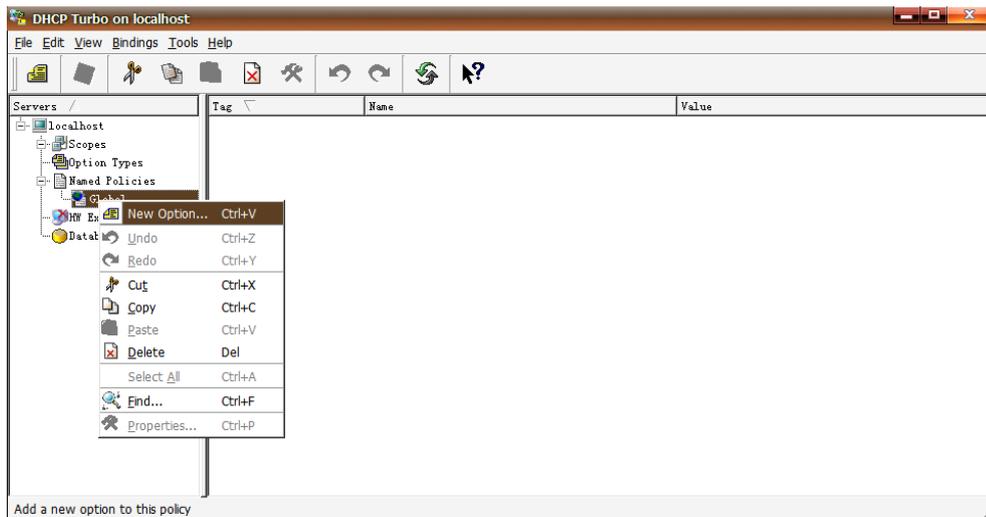

3. Enter the desired option in the **Tag** field.

    The custom options range from 128 to 254.

4. Enter the desired name in the **Name** field.

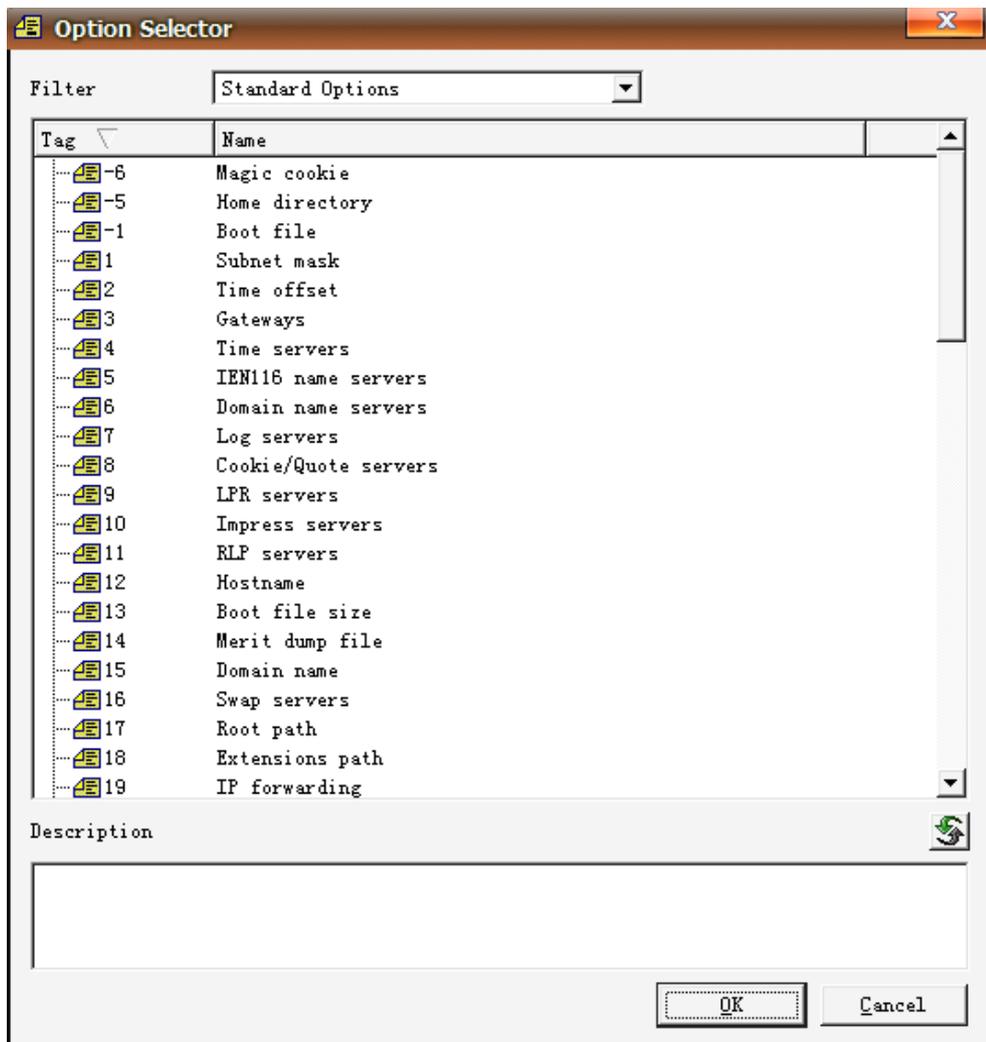5. Select **string** from the pull-down list of **Type**.

6. Click **OK** to finish setting the option properties.

7. Click ⬚ to accept the change.

8. Double click **Named Policies**.

9. Right click **Global**, and then select **New Option**.

The Option Selector screen displays as below:

10. Scroll down and double click the option created above.

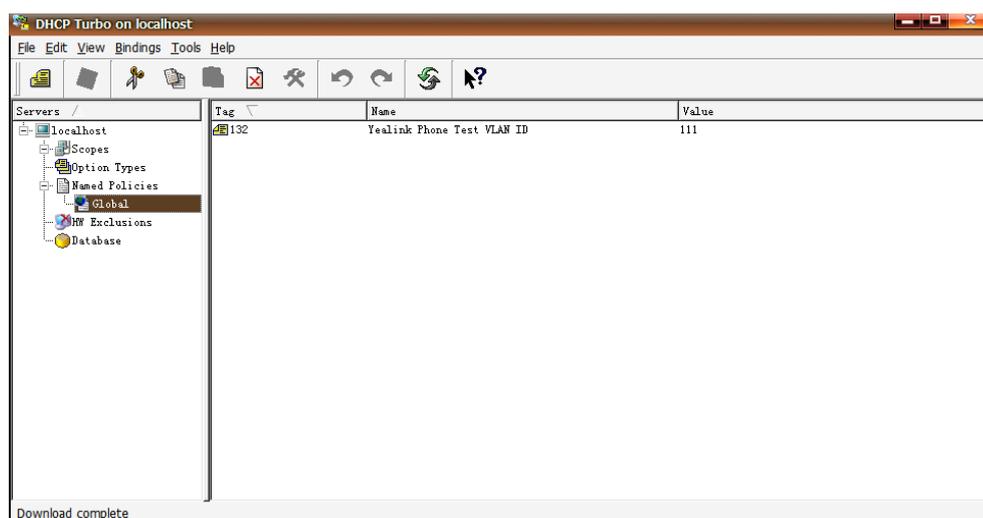**11.** Fill the VLAN ID to be assigned in the input field.

Three formats of valid values: VLAN-A=*VLANID, VLANID* and VID=*VLANID*. VLAN ID ranges from 1 to 4094.

12. Click **OK** to finish setting a custom option.

13. Click [icon] to accept the change.

Then you can find the configured option under **Global** option.

Configuring DHCP Option on Yealink IP Phones

DHCP VLAN is enabled on IP phones by default. You can configure DHCP VLAN via web user interface or using configuration files. You can also configure the DHCP option. The default DHCP option is 132.The followings take configurations of a SIP-T28P IP phone running firmware version 71 as examples.

To configure DHCP VLAN feature via web user interface:

1. Log into the web user interface with the administrator credential.

The default administrator user name and password are both "admin".

2. Click on **Network**->**Advanced**.

3. In the **VLAN** block, select the desired value from the pull-down list of **DHCP VLAN Active**.

4. Enter the desired value in the **Option** field.

    You can specify 5 options at most and separate options by commas. The default value is 132.
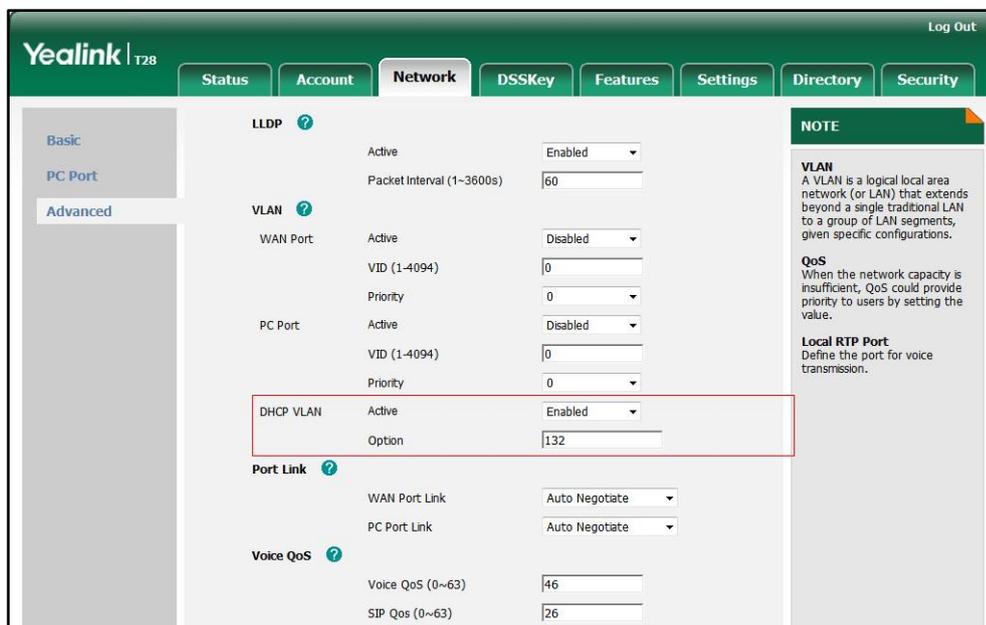
5. Click **Confirm** to accept the change.

    The web user interface prompts the warning "Some settings you changed take effect when you restart your machine! Do you want to reboot now?".

6. Click **OK** to reboot the IP phone.

To configure DHCP VLAN feature using configuration files:

1. Add/Edit DHCP VLAN parameters in configuration files.

    The following table shows the information of parameters:

Parameter	Description	Valid Value	Default Value
network.vlan. dhcp_enable	Enables or disables DHCP VLAN discovery feature on the IP phone. **0**-Disabled **1**-Enabled	Boolean	1
network.vlan. dhcp_option	Specifies the DHCP option used to detect the VLAN ID. You can specify 5 options at most and separate options by commas.	Integer (128 to 254)	132

The following shows an example of DHCP VLAN configuration in configuration files:

```
network.vlan.dhcp_enable = 1

network.vlan.dhcp_option = 132
```

2. Upload configuration files to the root directory of the provisioning server and trigger IP phones to perform an auto provisioning for configuration update.

   For more information on auto provisioning, refer to Yealink IP Phones Auto Provisioning Guide.

Verifying the Configuration

When the IP phone is configured to use DHCP for VLAN discovery, and the DHCP option is set to 132, the following processes occur:

1. The IP phone broadcasts a DHCP Discover message to find out if there is a DHCP server available.

2. If the DHCP server sends a DHCP Offer message with the Option 132, the phone will accept the Offer, send a DHCP Request, and save the VLAN ID provided by the DHCP server in the DHCP option 132.

3. After the DHCP server has sent the ACK message to the phone, the phone will release the leased IP address and start a new DHCP Discover cycle using the now known Voice VLAN ID tag.

After this process, the phone will send all packets with the VLAN ID obtained from the DHCP server in the DHCP option 132.

The following figure shows the DHCP messages sent and received by the IP phone:

Manual Configuration for VLAN

VLAN is disabled on IP phones by default. You can configure VLAN via web user interface or phone user interface or using configuration files. Before configuring VLAN

on the IP phone, you need to obtain the VLAN ID from your network administrator. When you configure VLAN feature, the most important issue is to confirm the type of the connected port (access, trunk, and hybrid) on the switch. This ensures that the traffics (tagged/untagged) from the IP phones can be transmitted properly. VLAN feature could affect the ability of the IP phones to function in the network. Contact your network administrator for more information before configuration.

Configuring VLAN Feature

You can enable or disable VLAN, and set specific VLAN IDs and priorities for the Internet (WAN) port and PC port respectively. The followings take configurations of a SIP-T28P IP phone running firmware version 71 as examples.

To configure VLAN for Internet (WAN) port via web user interface:

1. Log into the web user interface with the administrator credential.

    The default administrator user name and password are both "admin".

2. Click on **Network**->**Advanced**.

3. In the **VLAN** block, select the desired value from the pull-down list of **WAN Port Active**.

4. Enter the VLAN ID in the **VID (1-4094)** field.

5. Select the desired value (0-7) from the pull-down list of **Priority**.

    7 is the highest priority.
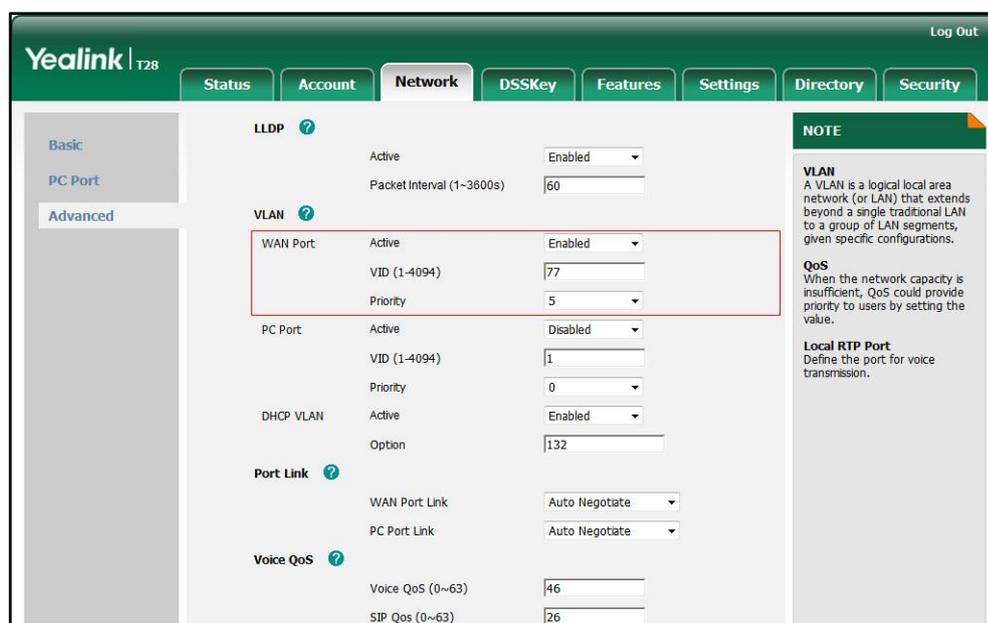
6. Click **Confirm** to accept the change.

    The web user interface prompts the warning "Some settings you changed take effect when you restart your machine! Do you want to reboot now?".

7. Click **OK** to reboot the IP phone.

To configure VLAN for PC port via web user interface:

1. Log into the web user interface with the administrator credential.

    The default administrator user name and password are both "admin".

2. Click on **Network**->**Advanced**.

3. In the **VLAN** block, select the desired value from the pull-down list of **PC Port Active**.

4. Enter the VLAN ID in the **VID (1-4094)** field.

5. Select the desired value (0-7) from the pull-down list of **Priority**.
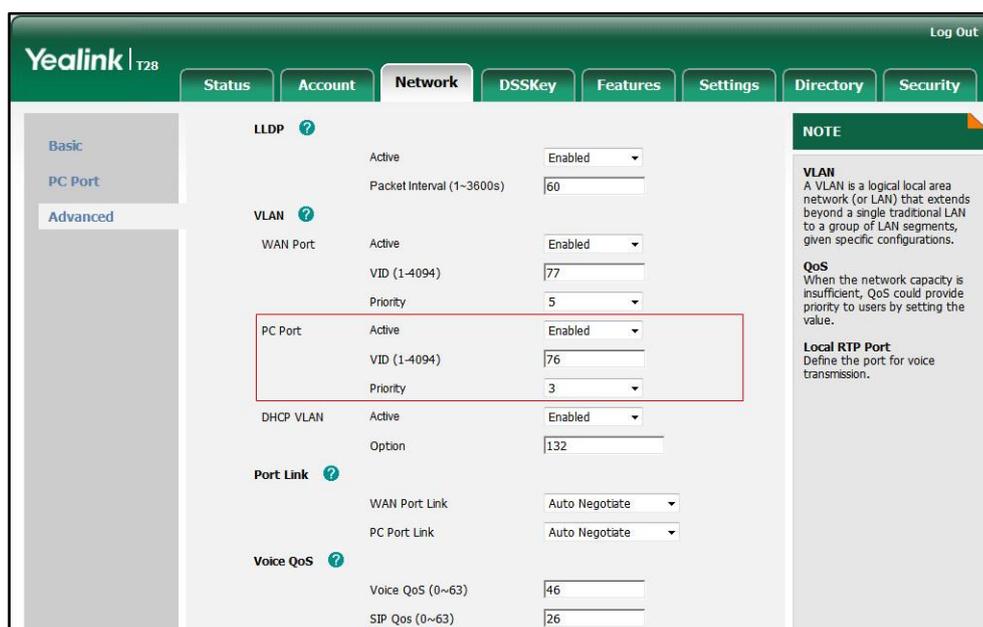
    7 is the highest priority.

6. Click **Confirm** to accept the change.

    The web user interface prompts the warning "Some settings you changed take effect when you restart your machine! Do you want to reboot now?".

7. Click **OK** to reboot the IP phone.

To configure VLAN for Internet (WAN) port via phone user interface:

1. Press **Menu**->**Settings**->**Advanced Settings** (password: admin)
    ->**Network**->**VLAN**->**WAN Port**.

2. Press (◄) or (►) , or the **Switch** soft key to select the desired value from **VLAN Status** field.

3. Enter the VLAN ID (1-4094) in the **VID Number** field.

4. Enter the desired value (0 to 7) in the **Priority** field.

    7 is the highest priority.
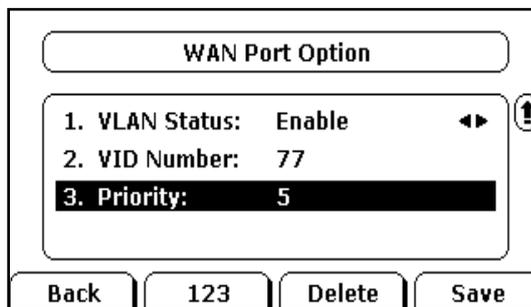
```
┌──────────────────────────────────────┐
│  ┌────────────────────────────────┐  │
│  │         WAN Port Option        │  │
│  └────────────────────────────────┘  │
│                                  ┌──┐ │
│   1. VLAN Status:   Enable    ◀▶ │⬆│ │
│   2. VID Number:    77           └──┘ │
│  ▐3. Priority:          5           ▌ │
│                                       │
│  ┌──────┐┌──────┐┌────────┐┌──────┐  │
│  │ Back ││ 123  ││ Delete ││ Save │  │
│  └──────┘└──────┘└────────┘└──────┘  │
└──────────────────────────────────────┘
```

5. Press the **Save** soft key to accept the change.

    The IP phone reboots automatically to make settings effective after a period of time.

To configure VLAN for PC port via phone user interface:

1. Press **Menu**->**Settings**->**Advanced Settings** (password: admin)
    ->**Network**->**VLAN**->**PC Port**.

2. Press (◀) or (▶) , or the **Switch** soft key to select the desired value from **VLAN Status** field.

3. Enter the VLAN ID (1-4094) in the **VID Number** field.

4. Enter the desired value (0 to 7) in the **Priority** field.

    7 is the highest priority.

```
┌──────────────────────────────────────┐
│  ┌────────────────────────────────┐  │
│  │         PC Port Option         │  │
│  └────────────────────────────────┘  │
│                                  ┌──┐ │
│   1. VLAN Status:   Enable    ◀▶ │⬆│ │
│   2. VID Number:    76           └──┘ │
│  ▐3. Priority:          3           ▌ │
│                                       │
│  ┌──────┐┌──────┐┌────────┐┌──────┐  │
│  │ Back ││ 123  ││ Delete ││ Save │  │
│  └──────┘└──────┘└────────┘└──────┘  │
└──────────────────────────────────────┘
```
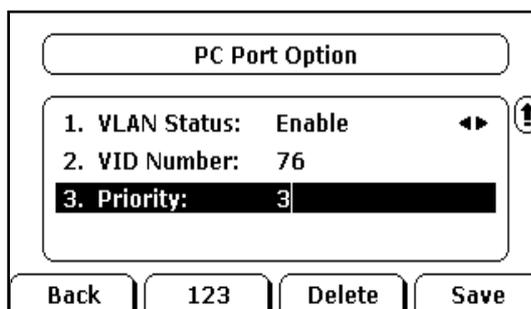
5. Press the **Save** soft key to accept the change.

    The IP phone reboots automatically to make settings effective after a period of time.

To configure VLAN for Internet (WAN) port and PC port using configuration file:

1. Add/Edit VLAN for Internet (WAN) port and PC port parameters in configuration files.

    The following table shows the information of parameters:

Parameter	Description	Valid Value	Default Value
network.vlan. internet_port_ enable	Enables or disables the IP phone to tag VLAN ID in packets sent from the Internet (WAN) port. **0**-Disabled **1**-Enabled	Boolean	0
network.vlan. internet_port_ vid	Configures the VLAN ID that associates with the particular VLAN.	Integer (1 to 4094)	1
network.vlan. internet_port_ priority	Specifies the priority used for transmitting VLAN packets.	Integer (0 to 7)	0
network.vlan. pc_port_ena ble	Enables or disables the IP phone to tag VLAN ID in packets sent from the PC port. **0**-Disabled **1**-Enabled	Boolean	0
network.vlan. pc_port_vid	Configures the VLAN ID that associates with the particular VLAN.	Integer (1 to 4094)	1
network.vlan. pc_port_priori ty	Specifies the priority used for transmitting VLAN packets.	Integer (0 to 7)	0

The following shows an example of VLAN configuration in configuration files:

```
network.vlan.internet_port_enable = 1
network.vlan.internet_port_vid = 77
network.vlan.internet_port_priority = 2
network.vlan.pc_port_enable = 1
network.vlan.pc_port_vid = 76
network.vlan.pc_port_priority = 3
```

2.   Upload configuration files to the root directory of the provisioning server and trigger IP phones to perform an auto provisioning for configuration update.

For more information on auto provisioning, refer to Yealink IP Phones Auto Provisioning Guide.

Verifying the Configuration

The IP phone reboots after VLAN feature has been enabled. After starting up, the IP phone will be assigned with a subnet address defined for VLAN 77.

The following figure shows the VLAN ID sent and received by the IP phone:

Glossary

IEEE (Institute of Electrical and Electronics Engineers) –a professional association headquartered in New York City that is dedicated to advancing technological innovation and excellence.

TIA (Telecommunications Industry Association) –accredited by the American National Standards Institute (ANSI) to develop voluntary, consensus-based industry standards for a wide variety of ICT products.

IEEE 802.3 –a working group and a collection of IEEE standards produced by the working group defining the physical layer and data link layer's media access control (MAC) of wired Ethernet.

Port-based VLAN –a port-based VLAN is a group of ports on a Gigabit Ethernet Switch that form a logical Ethernet segment. Each port of a port-based VLAN can belong to only one VLAN at a time.

Port and Protocol-based VLAN –initially defined in IEEE 802.1v (currently amended as part of 802.1Q-2003) enables data frame classification and assignment to unique VLANs based on the received data frame type and the protocol information in its payload.

TPID (tag protocol identifier) –a 16-bit field set to a value of 0x8100 in order to identify the frame as an IEEE 802.1Q-tagged frame. It is used to distinguish the frame from

untagged frames.

PCP (Priority Code Point) –a 3-bit field which refers to the IEEE 802.1p priority. It indicates the frame priority level. Values are from 0 (best effort) to 7 (highest); 1 represents the lowest priority.

CFI (Canonical Format Indicator) –used for compatibility reason between Ethernet type network and Token Ring type network. It is always set to zero for Ethernet switches. If a frame received at an Ethernet port has a CFI set to 1, then that frame should not be forwarded as it is to an untagged port.

Normative References

LLDP and LLDP-MED: http://en.wikipedia.org/wiki/Link_Layer_Discovery_Protocol

IEEE 802.3: http://www.ieee802.org/3/

VLAN: http://en.wikipedia.org/wiki/Virtual_LAN

IEEE 802.1q: http://en.wikipedia.org/wiki/802.1Q

LLDP on Cisco Switch:

http://www.cisco.com/en/US/docs/switches/lan/catalyst3750/software/release/12.2_55_s
e/configuration/guide/swlldp.html

Customer Feedback

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