

# Using HP-UX VLANs

**HP 9000 Networking for HP-UX 11i**



**Manufacturing Part Number: T1453-90001  
E0302**

U. S. A.

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**1. What are HP-UX VLANs?**

HP-UX VLAN Features . . . . .	12
Benefits of HP-UX VLANs. . . . .	13
Types of VLANs Supported by HP-UX . . . . .	14
HP-UX VLAN Tagging. . . . .	15
System and Software Requirements. . . . .	17
Patches Required for the March 2002 HP-UX 11i-based Version . . . . .	17
Supported Switches . . . . .	19
Unsupported Functionality . . . . .	20

**2. Overview of Installation and Configuration**

Planning HP-UX VLANs . . . . .	22
How to Configure VLANs on the Switch. . . . .	23
How to Configure VLANs on HP-UX . . . . .	25
Choose Configuration Method: Use SAM; Edit vlanconf; Use lanadmin. . . . .	25
Configuration Process . . . . .	26
Properties of a VLAN. . . . .	27
Special Case of VLAN ID 0--Priority Tagged Frames . . . . .	28
Promiscuous Mode Characteristics. . . . .	28
Allowable Values for HP VLANs. . . . .	29
Using VLANs with MC/ServiceGuard . . . . .	31
How is 802.1p Priority Set?. . . . .	32
How do Pri and ToS Override Affect My Inbound and Outbound frames?. . . . .	33
Setting 802.1p Priority, ToS, and Overrides. . . . .	35
Where to Get More Information . . . . .	35

**3. Configuring VLANs Using SAM**

Configuring VLANs Using SAM . . . . .	38
---------------------------------------	----

**4. Configuring VLANs by Editing vlanconf File**

Modifying Parameters in vlanconf File. . . . .	44
--	----

**5. Using lanadmin -V to Administer VLANs**

Using the lanadmin -V Command for Administering VLANs. . . . .	48
lanadmin Syntax. . . . .	48
Using lanadmin to Create a VLAN . . . . .	49
Using a VLAN. . . . .	51
Using lanadmin to Modify a VLAN . . . . .	51

---

# Contents

Using lanadmin to Delete a VLAN .....	52
---------------------------------------	----

## A. Troubleshooting

Diagnostic Flowcharts .....	57
Flowchart 1: Link Level Tests .....	58
Flowchart 1a: Linkloop Test .....	60
Flowchart 2: Network Level Tests .....	64
Flowchart 2 Procedures .....	65
NetTL Trace and Log of VLANs .....	72

<b>Glossary .....</b>	<b>75</b>
-----------------------	-----------

---

## Tables

Table 1-1. Needed Patches for HP-UX VLANs . . . . .	17
Table 2-1. Summary of VLAN Tagging Assignment . . . . .	24
Table 2-2. Allowable Values for Parameters in vlanconf File . . . . .	29
Table 2-3. ToS to 802.1 User Priority Mappings Based on IP Precedence . . . . .	32
Table 2-4. Allowable Settings for VLAN_PRI_OVERRIDE Value in vlanconf File .	33
Table 2-5. Allowable Settings for VLAN_TOS_OVERRIDE Value in vlanconf File.	34
Table A-1. Flowchart Descriptions . . . . .	57

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# Tables

---

## Figures

Figure 1-1. VLANs (Virtual LANs) . . . . .	10
Figure 1-2. IEEE 802.1Q VLAN Tag in Ethernet Frame. . . . .	15
Figure 1-3. VLANS Overlapping or Sharing the Same LAN Card Port . . . . .	16
Figure 2-1. Communication between VLANS Requires an External Router . . . . .	22
Figure 2-2. Tagged and Untagged VLAN Technology in Same Network . . . . .	23
Figure 2-3. VLANs and Service Guard . . . . .	31
Figure 3-1. List Pulldown with Virtual LANs Displayed. . . . .	38
Figure 3-2. Action Pulldown for Creating Virtual LANs . . . . .	39
Figure 3-3. Create Virtual LANs. . . . .	40
Figure 3-4. Add an IP Address for the VLAN. . . . .	41
Figure A-1. Flowchart 1 . . . . .	59
Figure A-2. Flowchart 1a. . . . .	60
Figure A-3. Flowchart 1b. . . . .	62
Figure A-4. Flowchart 2 . . . . .	64
Figure A-5. Flowchart 2a. . . . .	66
Figure A-6. Flowchart 2b. . . . .	68
Figure A-7. Flowchart 2b (continued) . . . . .	70

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# Figures



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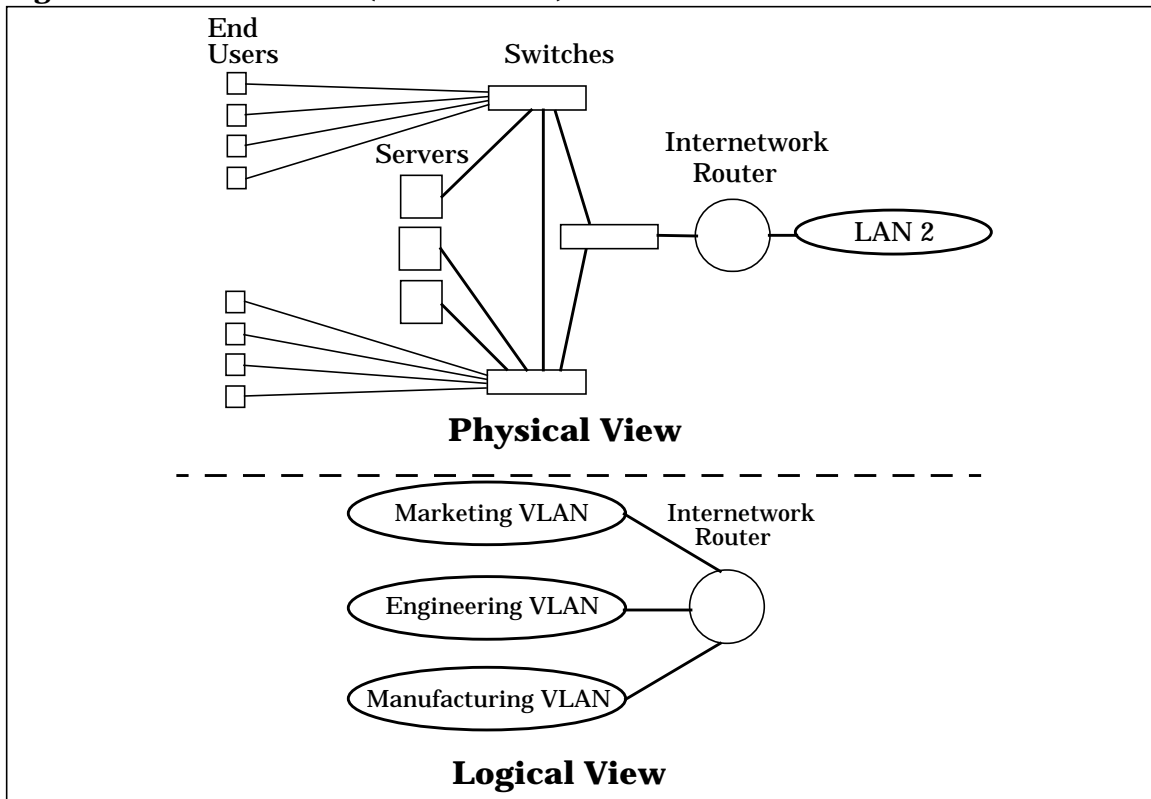
# **1** **What are HP-UX VLANs?**

A Virtual LAN (VLAN) is a logical or *virtual* network segment that can span multiple physical network segments. Using VLANs, you can group switched-network end-stations by:

- department, such as engineering and manufacturing,
- type of user, such as power users or those with special needs,
- application, or
- project

instead of physical location (Figure 1-1).

**Figure 1-1** VLANs (Virtual LANs)



VLANs isolate broadcast and multicast traffic by determining which destinations should receive that traffic, thereby making better use of switch and end-station resources. With VLANs, broadcasts and multicasts go only to the intended nodes in the virtual LAN.

VLANs create broadcast domains using switches instead of routers. While VLANs in some environments may reduce the number of routers needed (and their latency), you still need a router if you want the VLANs to communicate with each other.

## HP-UX VLAN Features

Following are some of the features of HP-UX VLANs:

- HP-UX VLANs are implemented with host-based IEEE 802.1Q/p compliant tagging to allow configuring multiple VLANs on a given Ethernet LAN card based on their IP-subnet, protocol, or LAN card port.
- HP VLANs are for use over fast Ethernet or gigabit Ethernet LAN cards running on HP-UX 11i (11.11) PA-RISC-based servers and workstations. HP-UX supports up to 1024 VLANS per LAN card port.
- HP-UX VLANs do not require you to rewrite applications, install new hardware, or recable. They are also compatible with HP MC/ServiceGuard as well as HP's online addition and replacement (OLAR) capabilities.

## Benefits of HP-UX VLANs

The advantages of HP-UX VLANs are:

- Physically dispersed workgroups can be logically connected within the same broadcast domain to appear as if they are on the same physical LAN.
- A single physical link can simultaneously serve several IP subnets when subnet-based VLANs are configured on that link.
- Switches no longer need to classify and tag traffic. They focus on forwarding packets.
- Workgroups requiring increased security can be logically connected within the same broadcast domain. Broadcast traffic will be isolated within the secure group.
- End stations using VLANs can offer rudimentary class of service (CoS) locally by prioritizing traffic for certain activities.
- HP-UX VLANs can be created, modified, and deleted without rebooting.
- HP-UX VLANs are interoperable with non-VLAN aware devices, that is, devices such as servers or bridges that do not transmit or receive tagged packets.

## Types of VLANs Supported by HP-UX

The types of HP-UX VLANs that you can create are as follows:

- **NIC-Port Based**--A group of physical LAN card ports belong to the same layer-2 broadcast domain. Each LAN card port transmits and receives frames belonging to the VLAN associated with that port. Members of the same port-based VLAN all have the same **VLAN ID**. A VLAN ID uniquely identifies the VLAN to which a frame belongs.
- **Protocol Based**--Common protocols such as IP, IPX, AppleTalk, Decnet, and NetBIOS are grouped into layer-2 broadcast domains.
- **IP Subnet Based**--Each IP subnet has its own unique VLAN. Traffic from different subnets is logically separated from each other as if each subnet were on a different LAN segment.

Please refer to “Planning HP-UX VLANs” in this document for more information on setting up the different types of VLANs described.

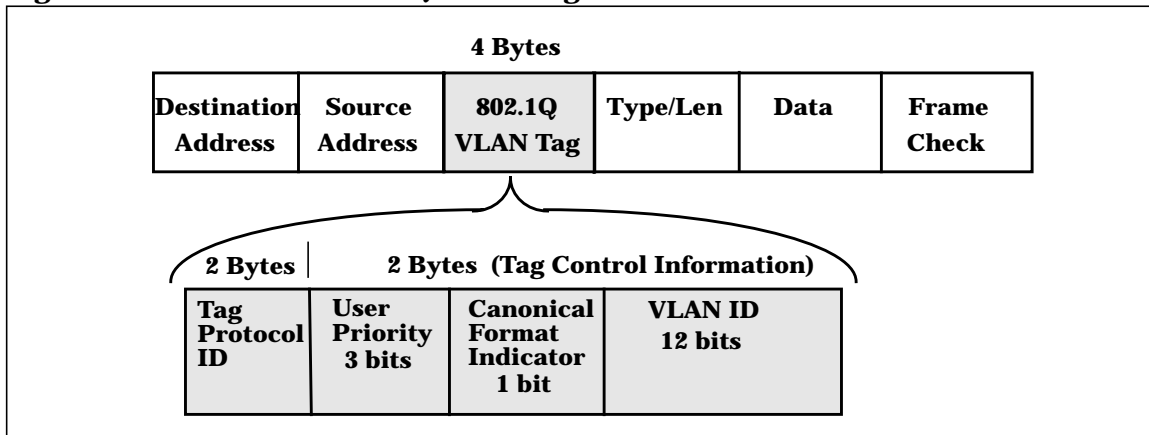
HP-UX VLANs conform to IEEE specifications 802.1Q (for VLAN tagging) and IEEE 802.1p (MAC-level frame prioritizing) to provide end-to-end class of service (CoS).

## HP-UX VLAN Tagging

Network switches and end stations that know about VLANs are said to be **VLAN-aware**. Network switches and end stations that can interpret VLAN tags are said to be **VLAN-tag-aware**. HP-UX VLAN-tag-aware end stations add VLAN tags to standard Ethernet frames--a process called **explicit tagging**. A VLAN tag (Figure 1-2) identifies which VLAN a data frame belongs to and enables traffic from more than one VLAN to use the same switch or LAN card port (Figure 1-3).

When a VLAN-aware switch receives data from an end-station, the switch determines where the data is to go and whether the VLAN ID should be retained. If the data is to go to a device that can recognize the VLAN tag, the VLAN tag is retained. If the data is to go to a device that has no knowledge of VLANs (**VLAN-unaware**), the switch sends the data without the VLAN tag.

**Figure 1-2 IEEE 802.1Q VLAN Tag in Ethernet Frame**

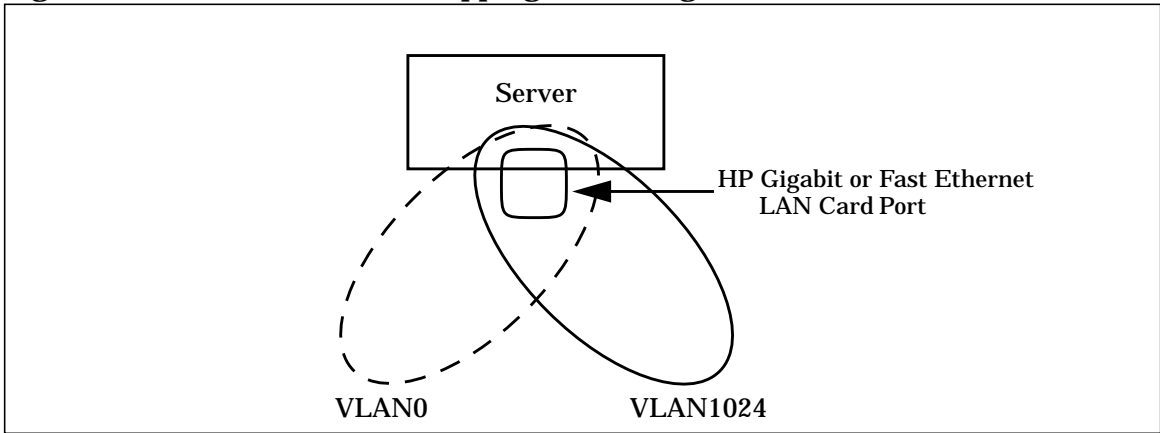


You must configure VLAN tagging on switch ports that interface to end-stations that have tagged VLANs. If a switch or end-station port is member of only a single, port-based VLAN, tagging is not required.

To transmit tagged frames, you must configure a VLAN on the end-station with a VLAN ID that matches the VLAN ID of a tagged VLAN on the switch port and the VLAN ID of a VLAN at the remote end-station. Refer to the next 3 chapters in this guide for complete details on configuring VLANs on your HP-UX end stations.

What are HP-UX VLANs?  
HP-UX VLAN Tagging

**Figure 1-3** VLANS Overlapping or Sharing the Same LAN Card Port





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## System and Software Requirements

Following are the hardware and software requirements for VLANs as of March 2002:

- Type of HP System Required
  - HP-UX Precision Architecture (PA-RISC).
- OS Required
  - HP-UX 11i (11.11). New HP servers and workstations shipped after March 2002 already have VLAN technology pre-installed in the operating environment. For computers shipped before March 2002, check the product Information Sheet to see if the VLAN product can be loaded by way of required patches.
- VLANs work over all HP HSC and PCI 100Base LAN cards and all HP HSC and PCI 1000Base LAN cards.

### Patches Required for the March 2002 HP-UX 11i-based Version

The following patches are required in order to use the HP-UX VLAN software on HP-UX 11i-based systems.

These patch numbers are current at the time of publication and may be superseded. Check to see if these patches are superseded, and download patches at the following URL: <http://us-support.external.hp.com/>

**Table 1-1** Needed Patches for HP-UX VLANs

Driver	11i Patch #
Transport	PHNE_25644
100Base-T *	PHNE_23465
Gigabit *	PHNE_24491
nettl, netfmt, and nettladm	PHNE_24473
LAN--core patch that enables VLANs	PHNE_25388

**Table 1-1**                      **Needed Patches (Continued)for HP-UX VLANs (Continued)**

<b>Driver</b>	<b>11i Patch #</b>
SAM	PHCO_25866
* Either the 100Base-T or Gigabit patch may be optional depending on which link type you have.	

## **Supported Switches**

HP-UX VLANs are supported with switches that implement IEEE 802.1Q-compliant VLAN tagging. The switches must implement at least port-based VLANs and must be VLAN-tag aware. The following switches are among those that support HP-UX VLANs:

- HP ProCurve 9304M
- HP ProCurve 4000M/8000M
- Extreme Summit 7i
- Cisco Catalyst 6509

## **Unsupported Functionality**

HP-UX VLANs do not support the following functionality:

- GARP VLAN registration protocol (GVRP) is currently not supported. HP-UX VLANs will not send GVRP messages or interpret them.
- HP-UX VLANs do not operate on:
  - Any Itanium-based servers whether the LAN card is factory installed or customer installed.
  - HP-UX 11.20, 11.0, and 10.20.
  - FDDI, Token Ring, ATM, 100VG, EISA, and HP-PB LAN cards.

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## **2** **Overview of Installation and Configuration**

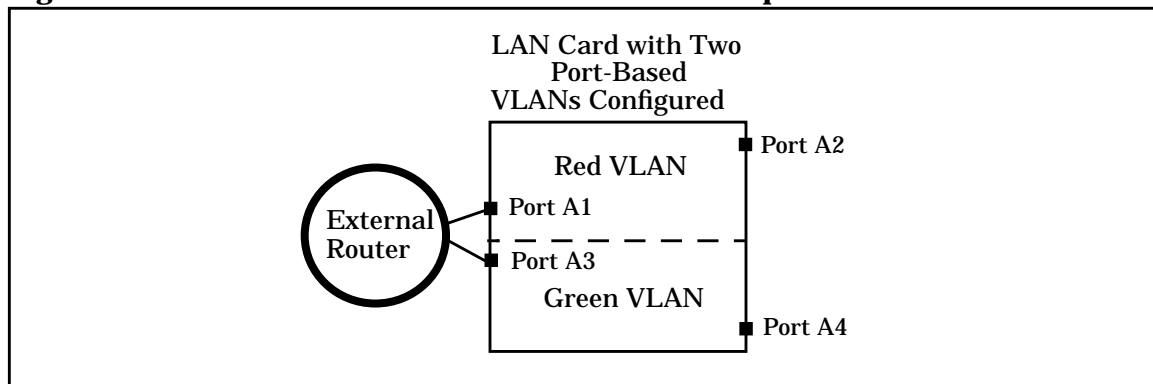
## Planning HP-UX VLANs

The following requirements must be satisfied before setting up VLANs in an HP-UX network:

- In order for both end stations of a VLAN to communicate, both the end-station LAN cards and the switch ports that are connected to those LAN cards on a point-to-point link need to be VLAN-tag-aware.
- For VLANs to communicate with each other, an external VLAN-aware switch or router is required (Figure 2-1). However, it is not possible to extend a single vln across a router.
- If a hub is connected to a network of VLANs, every port on the hub must belong to the same VLAN. Hubs do not have the ability to provide VLANs to individual ports.

VLAN awareness does not provide any benefit in a shared LAN environment (using hubs or repeaters). In these shared LAN environments, all stations see all traffic whether it is VLAN tagged or not.

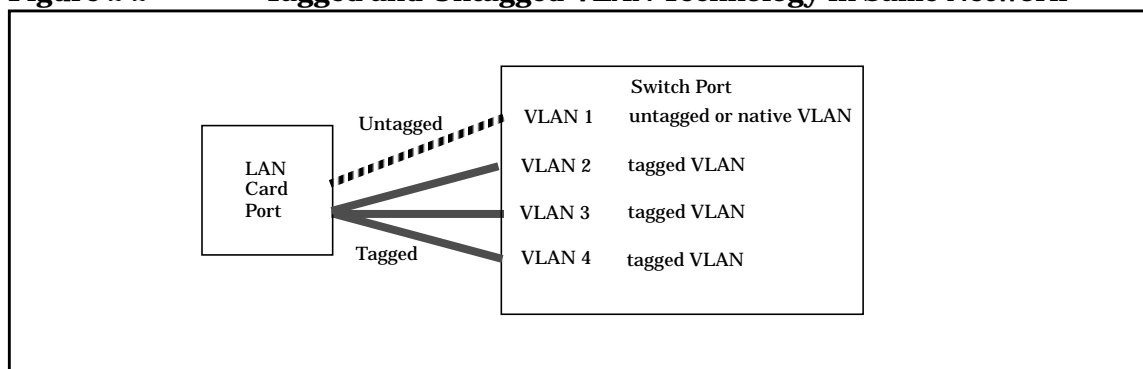
**Figure 2-1**      **Communication *between* VLANS Requires an External Router**



## How to Configure VLANs on the Switch

IEEE 802.1Q compliant devices and legacy/untagged VLANs can coexist on the same networks, but legacy/untagged VLANs require a separate link, whereas the 802.1Q tagged VLANs can combine several VLANs into one link. On 802.1Q-compliant devices, separate ports (configured as untagged) must be used to connect separate VLANs to non-802.1Q devices.

**Figure 2-2** Tagged and Untagged VLAN Technology in Same Network



When you assign a *switch* port to a given VLAN, you must implement the VLAN tag if the *switch* port will carry traffic for more than one VLAN. Otherwise, the port VLAN assignment can remain **untagged** because the tag is not needed. On a given switch, use the untagged designation for a port VLAN assignment where the port is connected to a non-802.1Q-compliant device or is assigned to only one VLAN as in VLAN 1 in Figure 2-2. Use the **tagged** designation when more than one VLAN is assigned to the port, or the port is connected to a device that *does* comply with the 802.1Q standard as in VLANs 2 through 4 in Figure 2-2. These simple rules are summarized in Table 2-1.

**Table 2-1**                      **Summary of VLAN Tagging Assignment**

<b>VLANs Per Port</b>	<b>Tagging Scheme</b>
1	Untagged or Tagged. If the device connected to the port is 802.1Q-compliant, then the recommended choice is “Tagged.”
2 or more	1 VLAN Untagged; all others Tagged or All VLANs Tagged
A given VLAN must have the same VLAN ID on any 802.1Q-compliant device in which the VLAN is configured.	



## How to Configure VLANs on HP-UX

### Choose Configuration Method: Use SAM; Edit `vlanconf`; Use `lanadmin`

There are three ways to configure VLANs: the first two methods preserve configuration changes across reboots; the third applies changes immediately but doesn't preserve configuration changes across reboots:

To permanently save your configurations, you can either:

- Use the GUI-based system admin manager (SAM). To use SAM, refer to the instructions in “Configuring VLANs Using SAM” in this document for details, and then do the steps for verifying VLANs. Using SAM reduces risk of errors and saves your data permanently. If you use, SAM, configuration doesn't require a reboot to take effect.  
or
- Edit the `/etc/rc.config.d/vlanconf` configuration file using an editor such as “vi.” Changes will not take effect until the next reboot. Refer to “Configuring VLANs by Editing the `vlanconf` File” in this document for instructions on editing the configuration file for VLANs.

To temporarily configure VLANs on a live system, you can:

- Use the `lanadmin` command from the HP-UX command line.

---

#### CAUTION

If you use the `lanadmin` command to administer VLANs, those changes are *not* preserved across reboots. See “Using the `lanadmin` Command for Administering VLANs” for details on the `lanadmin` command.

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## Configuration Process

Following are the steps to configure HP-UX VLANs. These steps are for defining VLAN membership, assigning names, VLAN IDs, and port assignments. This procedure assumes that the switches can add VLAN tags:

1. Determine the network topology affected. Either draw the affected network topology or list it. Include all affected end stations--workstations and servers.
2. Define the VLANs. Decide, according to your requirements, which systems belong to which logical groups.
3. Assign VLAN IDs to each VLAN. Ensure that the assignments are consistent across endstations and switches; otherwise, stations will not communicate with each other. A VLAN ID can be any number between 0 and 4094 that is used only once within that port.

---

### NOTE

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The VLAN ID is *not* the same as the number of VLANs supported --HP-UX supports up to 1024 VLANs per LAN card port.

4. Determine which LAN card ports need tagged VLANs and which do not. Typically, you may need to put a server LAN card port in several VLANs while a desktop LAN card port can belong to just one VLAN.
5. Assign VLAN IDs to each LAN card port on end stations and switches. Mark VLANs on the switches as tagged or untagged according to the LAN card port to which they are connected.
6. On HP-UX servers that must belong to several VLANs, create VLANs on the corresponding LAN card ports.

## Properties of a VLAN

When a VLAN is created on a given LAN card port, (see “Creating a VLAN”), the system generates a virtual PPA or **VPPA** which can be used to send and receive 802.1Q tagged frames on that LAN card. Each HP-UX VLAN has a Virtual PPA associated with it. A VPPA has essentially the same properties as a physical point of attachment (PPA) on a LAN card. The differences are:

1. A VPPA is associated with a VLAN, the properties of which are determined by the create (or modify) command. The PPA of a physical interface doesn't have a VLAN associated with it.
2. A VLAN doesn't have a unique hardware instance. VPPA values are assigned such that they don't overlap with hardware instance numbers of physical interfaces on the system.

Note: the PPA assigned to a LAN card port is the same as its hardware instance number.

3. A VLAN shares all the link properties of the physical interface on which it is configured. Any changes to the underlying physical interface will be propagated to all its VPPAs.

In the sample lanscan output in the section “Displaying a VLAN and its Properties,” lan5000 shares all the properties (such as speed, duplexity, MTU, MAC address) of the physical port with which it is associated, lan0.

4. All frames transmitted via a VPPA are VLAN tagged. Frames transmitted via a physical PPA are sent untagged.
5. `lanadmin` non-interactive mode options to set the value of MTU (-M), speed (-S or -X), station address (-A) and reset the MTU (-R) and interactive mode options “reset” and “special” are not supported for VPPAs.
6. `lanadmin` interactive mode displays and clears driver statistics for VPPAs.

## **Special Case of VLAN ID 0--Priority Tagged Frames**

VLAN ID 0 means that the frame doesn't belong to any VLAN but has 802.1p priority information. Ensure that any switches used with HP-UX VLANs support VLAN ID 0.

---

## **Promiscuous Mode Characteristics**

Only one stream can be running in unfiltered promiscuous mode per physical interface plus all its VLAN interfaces put together.

The promiscuous stream will be able to see all frames transmitted or received on the physical LAN card port--all tagged and untagged.

## Allowable Values for HP VLANs

Table 2-2 lists the allowable values for configuring VLANs in the `/etc/rc.config.d/vlanconf` file. It describes the parameter functions, default values, and allowable ranges.

For the format of the `/etc/rc.config.d/vlanconf` file, refer to “Configuring VLANs by Editing `vlanconf` File” in this document.

**Table 2-2 Allowable Values for Parameters in `vlanconf` File**

<b>Parameter -- description</b>	<b>Range and Restrictions</b>	<b>Default</b>	<b>Type</b>
VLAN_ID -- VLAN ID	0 - 4094; unique within NIC 1 VLAN ID per VLAN;	None	Integer
VLAN_PRIORITY -- 802.1p priority for outbound VLAN frames	0 - 7	0	Integer
VLAN_TOS -- Type of Service value	0 - 255	0	Integer
VLAN_PRI_OVERRIDE -- Priority Override level	CONF_PRI/ IP_HEADER/ CONF_TOS	CONF_PRI	Case-sensitive character string.
VLAN_TOS_OVERRIDE -- Type of service Override Level	IP_HEADER/ ETHER_HEADER/ CONF_TOS/ CONF_PRI	IP_HEADER	Case-sensitive character string.
VLAN_NAME -- VLAN name	31 chars; keyword not allowed; unique within NIC; 1 VLAN name per VLAN	None <sup>1</sup>	Alphanumeric character string. Case-sensitive
VLAN_VPPA -- Virtual PPA number	starts at # 5000; 1 VPPA per vlanid; unique per system	None	Integer

**Table 2-2 Allowable Values for Parameters in vlanconf File (Continued)**

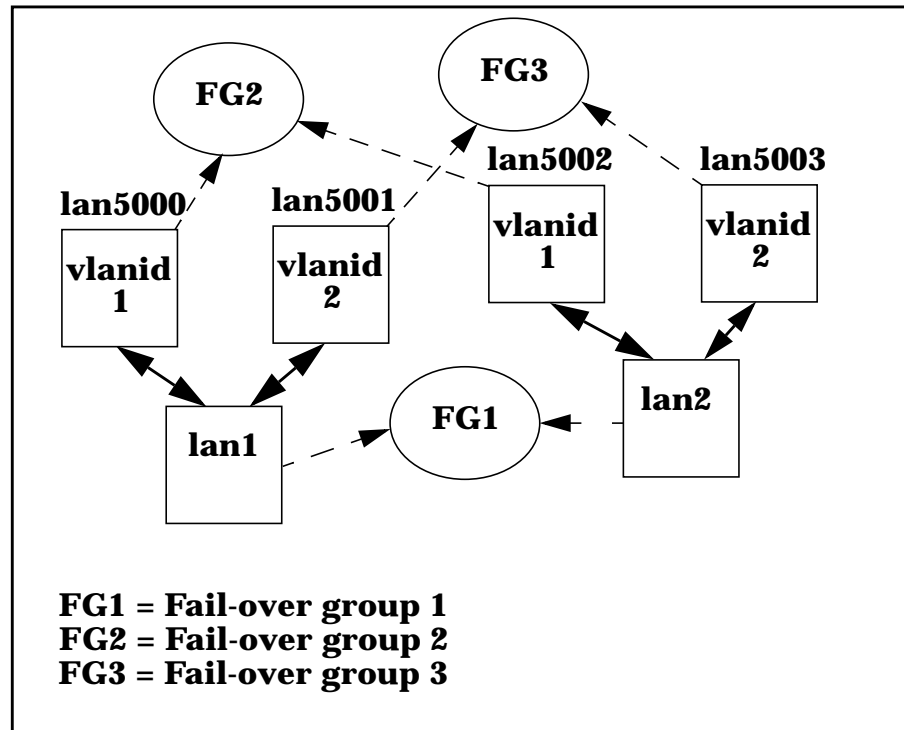
<b>Parameter -- description</b>	<b>Range and Restrictions</b>	<b>Default</b>	<b>Type</b>
<sup>1</sup> Default is an empty string; lanadmin will display it as UNNAMED.			

## Using VLANs with MC/ServiceGuard

You can create MC ServiceGuard fail-over groups with VLANs as long as the primary and standby links are both VLAN interfaces with the same VLAN ID. See Figure 2-2 for an example. Please refer to HP MC ServiceGuard documentation for more details.

**Example:**

**Figure 2-3** VLANs and Service Guard



## How is 802.1p Priority Set?

IP packets are classified and marked into different priority levels and the markings are transported through a type of service (ToS) octet in the IPv4 header and a traffic class field in the IPv6 header.

HP-UX end stations transmit IPv4 type-of-service (ToS) values but do not enforce priority. The end stations perform ToS-to-802.1p conversion and vice-versa for IP packets depending on how the VLAN overrides are set. They also allow 802.1p priority setting for non-IP packets.

Priority may be set by user, destination address, input port, output port, access priority, or by VLAN. User priority is a 3-bit field which allows priority information to be encoded in the frame. The eight levels of IEEE 802.1p recommended user priorities are shown in Table 2-3.

**Table 2-3 ToS to 802.1p User Priority Mappings Based on IP Precedence**

<b>HP WebQoS ToS Value Range</b>	<b>IEEE 802.1p User Priority</b>	<b>Traffic Type</b>
0xE0 - 0xFF	7 (highest)	Network Management
0xC0 - 0xDF	6	Voice
0xA0 - 0xBF	5	Video
0x80 - 0x9F	4	Controlled Load
0x60 - 0x7F	3	Excellent Effort
0x40 - 0x5F	0 (routine traffic)	Best Effort
0x20 - 0x3F	2	Undefined
0x00 - 0x1F	1 (lowest)	Background



---

## How do Pri and ToS Override Affect My Inbound and Outbound frames?

Consider the following command.

```
lanadmin -V create vlanid VID pri PRI tos TOS pri_override  
PO tos_override TO 6
```

This command will create a VLAN interface on PPA 6, with VID as the VLAN ID, PRI as the 802.1p priority, TOS as the IPv4 ToS value.

- All frames transmitted via the newly created interface will be VLAN tagged.
- The VLAN ID field in the tag will be VID without exception.
- Please note that non-IP packets are not affected by PO, TO, and TOS settings. Outbound non-IP packets are always tagged with VLAN ID VID and 802.1p priority PRI.

The following information applies only to inbound and outbound IP traffic.

- The 802.1p priority value in the VLAN tag is determined by the PRI, PO, and TOS settings as shown in Table 2-4.
- The ToS value of an inbound IP packet header is determined by TOS, TO, and PRI settings as shown in Table 2-5.

**Table 2-4 Allowable Settings for VLAN\_PRI\_OVERRIDE Value in vlanconf File**

<b>Priority Override Setting</b>	<b>Outbound IP Packets</b>
CONF_PRI (default)	VLAN Tag priority setting is PRI.
IP_HEADER	VLAN Tag priority comes from ToS to 802.1p mapping table (see Table 2-3). The ToS value is taken from the IP header.

**Table 2-4 Allowable Settings for VLAN\_PRI\_OVERRIDE Value in vlanconf File (Continued)**

<b>Priority Override Setting</b>	<b>Outbound IP Packets</b>
CONF_TOS	VLAN Tag priority comes from ToS to 802.1p mapping table (see Table 2-3). The ToS value used is TOS.

**Table 2-5 Allowable Settings for VLAN\_TOS\_OVERRIDE Value in vlanconf File**

<b>ToS Override Setting</b>	<b>Inbound IP Packet Header ToS Setting</b>
IP_HEADER (default)	IP header ToS value is undisturbed.
CONF_TOS	IP header ToS value is overwritten with TOS
ETHER_HEADER	IP header ToS value is overwritten with a value from the 802.1p to ToS mapping table (see Table 2-3). The 802.1p value used comes from the VLAN tag of the inbound frame.
CONF_PRI	IP header ToS value is overwritten with a value from the 802.1p to ToS mapping table (see Table 2-3). The 802.1p value used is PRI.

## Setting 802.1p Priority, ToS, and Overrides

802.1p priority is the priority in the tag in the frame header. Switches can use the 802.1p priority.

ToS is the IP precedence in the IP header. Switches ignore ToS. Routers may use it.

The Priority Override Levels for Outbound Traffic are as follows:

CONF_PRI	Your specified priority will be used.
IP_HEADER	IP header ToS will be converted to 802.1p priority.
CONF_TOS	Your specified ToS value will be converted to 802.1p priority according to the values shown in Table 2-1.

The ToS Override Levels for Inbound Traffic are as follows:

IP_HEADER	ToS value in the IP header will be used.
ETHER_HEADER	Ether header 802.1p priority will be converted to ToS value.
CONF_TOS	ToS specified by user will used.
CONF_PRI	Your specified 802.1p priority will be converted to ToS.

---

## Where to Get More Information

For information on using the `lanadmin` command to temporarily modify HP-UX VLANs (between reboots), type:

```
man vlan.
```



---

## **3** **Configuring VLANs Using SAM**

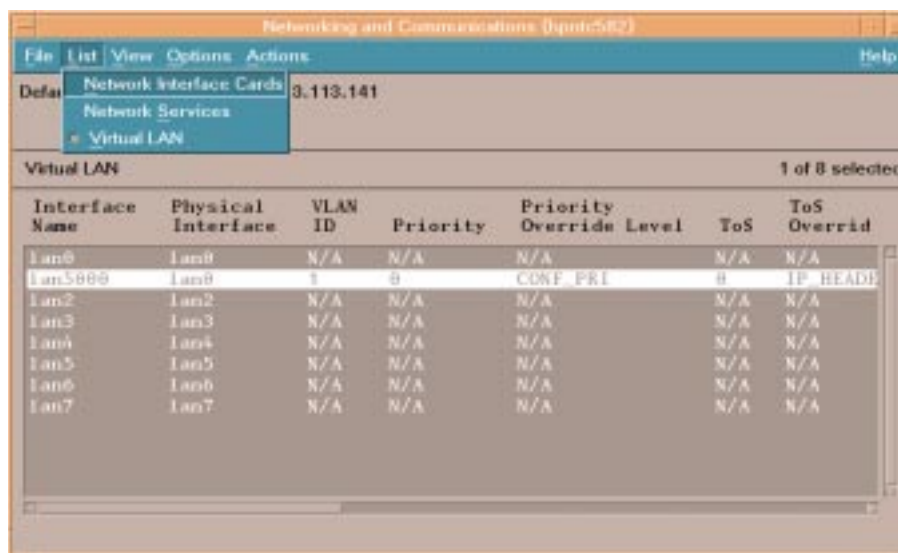
## Configuring VLANs Using SAM

You can use SAM to configure VLANs by completing the following steps:

1. Log in as root.
2. Check the HP-UX version by typing: `uname -a`. The version should be HP-UX 11i (11.11)
3. At the HP-UX prompt, type: `sam`
4. At the SAM main window, double click:  
**Networking and Communications**
5. There are then 2 ways to access VLAN configuration. Either choose the icon **Virtual LAN**, or choose **Network Interface Cards** and then show the VLANs by using the **List Pulldown**.

SAM displays a list of VLAN-aware physical interfaces and all VLANs created on them (Figure 3-1).

**Figure 3-1** List Pulldown with Virtual LANs Displayed

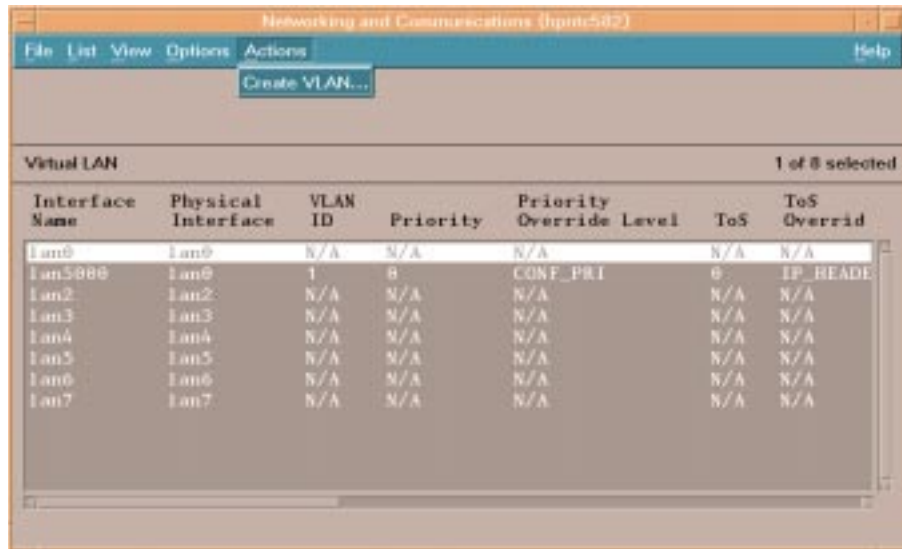


- On the **Virtual LAN** screen, available VLAN-aware cards are displayed. When you select a LAN card and then use the **Create VLAN** pulldown (Figure 3-2), the **Create VLAN** screen appears (Figure 3-3). For the **VLAN ID**, enter any number between 0 and 4094 and use it only once within that port.

**NOTE**

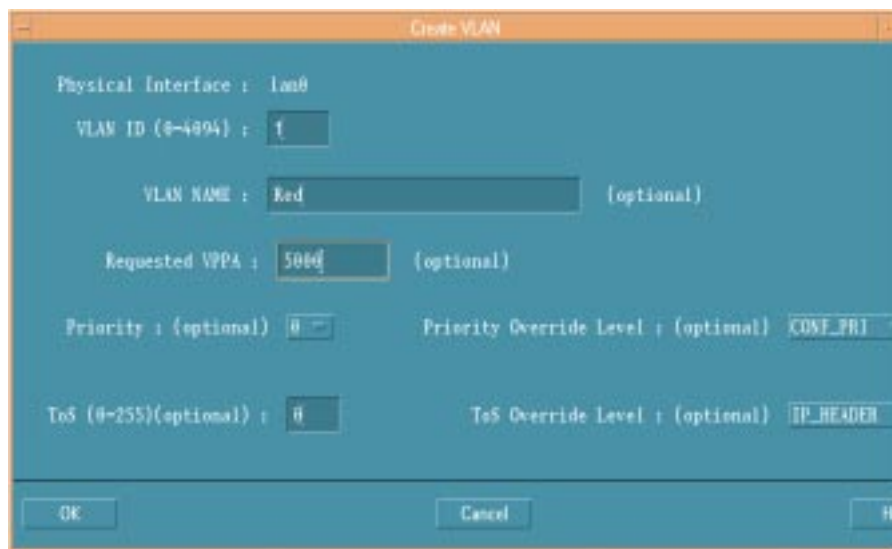
The VLAN ID is *not* the same as the number of VLANs supported --HP-UX supports up to 1024 VLANS per LAN card port.

**Figure 3-2 Action Pulldown for Creating Virtual LANs**



On this screen, you can optionally add a VLAN Name (31 chars, and unique within a LAN card), priority, ToS, and overrides. See the chapter “Overview of Installation and Configuration:” or the online help for details.

**Figure 3-3** Create Virtual LANs



After you have assigned a VLAN ID, the VLAN then shows on the main screen with the status **Not Configured**. You then highlight the VLAN, and select the **Configure IP Address** pulldown action. This displays the Add an IP Address for the VLAN screen (Figure 3-4). After you have configured an IP address for the VLAN, its status on the main screen will show as **Enabled**.

Assign VLAN IDs to each VLAN. Ensure that the assignments are consistent across endstations and switches; otherwise, stations will not communicate with each other.

---

**NOTE**

On a switch or end-station, all the frames for a specific VLAN must be either tagged or untagged. All devices in a VLAN's data path must be VLAN-aware (one that understands VLAN membership and formats).

Once a VLAN has been configured, you can modify its properties even if it is in the **Enabled** state.



On the Modify VLAN Properties screen, the fields are all optional; the data elements are the same as discussed in the chapter “Overview of Installation and Configuration.” VLAN name, VPPA, priority, ToS, and overrides.

**Figure 3-4** Add an IP Address for the VLAN

The screenshot shows a window titled "Configure IP Address" with a teal background. At the top, it displays the following information: "Interface Name: lan5000", "Physical Interface: lan0", and "Hardware Path: VLAN5000". Below this, there are several input fields: "Internet Address:" with a text box containing "0.0.0.0" and a small "Add Host Name" button to its right; "Subnet Mask:" with a text box and "(optional)" to its right; "Comments:" with a text box and "(optional)" to its right; and "Internet Broadcast Address:" with a text box and "(optional)" to its right. At the bottom of the window, there are two buttons: "OK" on the left and "Cancel" on the right.

7. At any time, view the online help pulldown menu for doing any of the listed tasks or for finding help on a specific field.



---

## **4** **Configuring VLANs by Editing vlanconf File**

## Modifying Parameters in vlanconf File

Following is the format of the `/etc/rc.config.d/vlanconf` file. To permanently save changes to this file, either use SAM or use a text editor such as “vi.” If you use the `lanadmin` command line interface to make changes to VLANs, your configuration *will not* be preserved after reboots unless you modify the **vlanconf** file manually.

```
# vlanconf: configuration values to create VLAN Virtual
#           Interface. This file will maintain the VLAN
#           information across reboot, and will be modified
#           by SAM. You can also edit this file.
#
# VLAN_PHY_INTERFACE : Physical interface name, see
#                       lanscan(lm)output. This value must be
#                       specified.
#
# VLAN_ID             : Unique VLAN id for VLAN. VLAN id is a
#                       positive integer value which can range
#                       from 0 to 4094. This value must be
#                       specified.
#
# VLAN_PRIORITY       : Priority for the VLAN. Priority is
#                       a positive integer value which can
#                       range from 0 to 7. Default value of 0
#                       will be taken if not specified.
#
# VLAN_TOS             : Inbound ToS value applicable to IP
#                       packets. Its a positive integer value
#                       that ranges from 0 to 255. A default
#                       value of 0 will be taken if not
#                       specified.
#
# VLAN_PRI_OVERRIDE   : Outbound priority override level. It
#                       tells the system what priority to
#                       choose, when tagging the packets with
#                       VLAN information. Allowed priority
#                       override levels are as follows:
#
#                       CONF_PRI - User specified priority
#                               will be used (default if
#                               not specified).
#
#                       IP_HEADER - IP header ToS will be
#                               converted to 802.1p
```

```
#           priority. Only for
#           IP packets. For non-IP
#           packets, CONF_PRI
#           will be used.
#           CONF_TOS - User specified ToS, taken
#           from VLAN_TOS[] will be
#           converted to
#           802.1p priority.
#
# VLAN_TOS_OVERRIDE : Inbound ToS value to be used for IP
#           packets.
#           Allowed ToS override levels are as follows:
#
#           IP_HEADER - ToS value in the IP
#           header will be used
#           (default if not
#           specified).
#           ETHER_HEADER - Ether header 802.1p
#           priority will be
#           converted to ToS
#           value.
#           CONF_TOS - ToS specified by the user
#           will be used.
#           CONF_PRI - 802.1p priority given in
#           VLAN_PRIORITY[] will
#           be converted to ToS
#           value.
#
# VLAN_NAME : Name of the VLAN. Its a simple string,
#           which consists of alphanumeric
#           characters. No special characters
#           allowed.
#
# VLAN_VPPA : User requested VPPA for the VLAN Virtual
#           Interface that will be created by the
#           information given above. If not
#           specified system will assign a VPPA.
#
# For each VLAN configuration, add a set of variable # assignments like the ones
# below, changing the index to "[1]", # "[2]" et cetera.
#####
#
# Sample Entry
#
# VLAN_PHY_INTERFACE[1]=
```

### Modifying Parameters in vlanconf File

```
# VLAN_ID[1]=  
# VLAN_PRIORITY[1]=  
# VLAN_TOS[1]=  
# VLAN_PRI_OVERRIDE[1]=  
# VLAN_TOS_OVERRIDE[1]=  
# VLAN_NAME[1]=" "  
# VLAN_VPPA[1]=
```

Example:

**Following is an example where the physical interface lan0 has been assigned a VLAN ID of 1, default values for VLAN priority, VLAN ToS, VLAN priority override, VLAN ToS override, the name "Red," and a VLAN PPA of 5000.**

```
VLAN_PHY_INTERFACE[0]=lan0  
VLAN_ID[0]=1  
VLAN_PRIORITY[0]=0  
VLAN_TOS[0]=0  
VLAN_PRI_OVERRIDE[0]=CONF_PRI  
VLAN_TOS_OVERRIDE[0]=IP_HEADER  
VLAN_NAME[0]=Red  
VLAN_VPPA[0]=5000
```

# 5 **Using lanadmin -V to Administer VLANs**

---

## Using the lanadmin -V Command for Administering VLANs

To configure VLANs, you use either the GUI-based system admin manager (SAM) or edit the configuration file with an editor. VLAN configuration doesn't require a reboot to take effect. If you use SAM, your configurations *will* be preserved after reboots in a configuration file called `/etc/rc.config.d/vlanconf`.

If you use the `lanadmin` command line interface, your configuration *will not* be preserved after reboots unless you also save the configuration in the `vlanconf` file by either using SAM or editing it. See "Modifying Parameters in `vlanconf` File" in this document for the format of the `/etc/rc.config.d/vlanconf` file.

### lanadmin Syntax

If you use the `lanadmin` command line interface to work with VLANs, you can display the general usage string by typing:

```
lanadmin -v help
```

General usage string:

```
lanadmin -V create vlanid <vlanid> (range 0-4094)
    [pri <priority> (range 0 - 7, default 0)]
    [tos <ToS value> (range 0-255, default 0)]
    [vppa <vppa>]
    [name <name> (31 characters alphanumeric
        string)]
    [tos_override <level>(IP_HEADER, ETHER_HEADER,
        CONF_TOS or CONF_PRI,
        default IP_HEADER)]
    [pri_override <level>(CONF_PRI, IP_HEADER
        or CONF_TOS, default CONF_PRI)] <ppa>
-V delete <vppa>
-V modify [vlanid <vlanid> (range 0-4094)]
    [pri <priority> (range 0 - 7)]
    [tos <ToS value> (range 0-255)]
    [name <name> (31 characters alpha numeric
        string)]
    [tos_override <level>(IP_HEADER, ETHER_HEADER,
```



```
CONF_TOS or CONF_PRI)  
[pri_override <level>(CONF_PRI,IP_HEADER or  
CONF_TOS)] <vppa>  
-V scan  
-V info <vppa>  
-V basevppa  
-V help
```

## Using lanadmin to Create a VLAN

Assume that the system has the following configuration as shown by the lanscan command output.

### lanscan

Hardware	Station	Crld	Hdw	Net-Interface	NM	MAC	HP-DLPI	DLPI
Path	Address	In#	State	NamePPA	ID	Type	Support	Mjr#
1/2/3	0x001083FF9951	0	UP	lan0 snap0	1	ETHER	Yes	119
1/2/4	0x006023456789	1	DOWN	lan1 snap1	2	ETHER	Yes	119

To configure a VPPA with VLAN ID 454 and a priority of 6 on “lan0”, execute the following command.

```
lanadmin -V create vlanid 454 pri 6 0
```

```
Successfully configured  
lan5000: vlanid 454 name UNNAMED pri 6 tos 0 tos_override IP_HEADER pri_override  
CONF_PRI ppa 0
```

This command created a VLAN “lan5000” on top of the physical interface lan0. The PPA associated with this VLAN, 5000, is referred to as a VPPA, short for Virtual PPA. Note: the parameters that were not specified in the command have been assigned default values.

## Displaying a VLAN and its Properties

You can use the default lanscan command to view all the interfaces as follows.

### lanscan

VLAN0	0x001083FF9951	5000	UP	lan5000snap5000	14	ETHER	Yes	119
1/2/4	0x006023456789	1	DOWN	lan1 snap1	2	ETHER	Yes	119

The VLAN (lan5000) appears in lanscan output just like a physical interface. VPPAs are identified by the string “VLANx” in the hardware path, where x is a number and is unique per VPPA. In the lanscan output, VPPAs of a given physical interface are displayed just after the corresponding physical interface.

The verbose option of the lanscan command displays more information about the VLAN.

**lanscan -v**

```

Hardware   Station      Crd Hdw  Net-Interface  NM   MAC  HP-DLPI DLPI
Path       Address      In# State  Name   PPA   ID   Type Support Mjr#
VLAN0     0x001083FF9951 5000 UP    lan5000 snap5000 14   ETHER  Yes 119
Extended Station
Address    LLC Encapsulation
0x001083FF9951      Methods

Driver Specific Information
vlan
.....
Vlan ID Phy-PPA Priority ToS Priority-Override ToS-Override Name
454      0          6          0  CONF_PRI          IP_HEADER  UNNAMED

```

**Using lanadmin to Set 802.1p Priority, ToS, and Overrides**

The lanadmin -V create vlanid command has options to set the 802.1p priority, called pri, and/or the Type of Service (ToS) value, called tos. It also has pri\_override and tos\_override. For more details, refer to “Setting 802.1p Priority, ToS, and Overrides” in this document.

**Using lanadmin to Query for VLANs on a System**

The following command can be used to query for the list of VPPAs configured and their properties.

**lanadmin -V scan**

A sample output for the successful command is as follows:

```

VLAN      Physical  VLAN   Pri  Pri      ToS      ToS      NAME
Interface Interface ID      Override
Name      Level
lan5000   lan0      5      2      CONF_PRI  25      IP_HEADER
lan5003   lan0      11     5      CONF_PRI  204     CONF_PRI  purple
lan5001   lan1      1      4      IP_HEADER  64      IP_HEADER  newone
lan5002   lan2      3      7      CONF_TOS  200     CONF_PRI  UNNAMED

```

Note: UNNAMED will be displayed as the VLAN name if there is no name associated with the VPPA.

**Querying for a Single VPPA on a System** You can query the Virtual PPA using the following command:

```
lanadmin -V info <vppa>
```

The info command will return the output in the following format when successful.

Example: `lanadmin -V info 5000`

VLAN Interface Name	Physical Interface	VLAN ID	Pri Override Level	Pri CONF_PRI	ToS	ToS Override Level	NAME
lan5000	lan0	5	2	CONF_PRI	25	IP_HEADER	

**Querying for a Base VPPA Value** You can determine the minimum acceptable value for a Virtual PPA using the following command:

```
lanadmin -V basevppa
```

Example: `lanadmin -V basevppa`

```
5000
```

## Using a VLAN

Once a VLAN is created, its VPPA can be used to configure protocols, send commands, and transmit and receive data just like a physical point of attachment (PPA). For example, to configure an IP address on the VLAN, type:

```
ifconfig lan5000 inet 100.2.1.1 netmask 255.255.255.0 up
```

---

### NOTE

You cannot change physical link properties such as speed, duplexity, or maximum transmission unit (MTU) over a VLAN. If you make changes to a physical interface, those changes will be reflected in the VLANs on that interface.

---

## Using lanadmin to Modify a VLAN

The properties of a VLAN can be modified using `lanadmin`. For example, to change the VLAN ID to 53 and priority to 3, on `lan5000`, type:

```
lanadmin -V modify vlanid 53 pri 3 5000
```

```
Successfully modified lan5000  
Old value: vlanid 454 pri 6  
New value: vlanid 53 pri 3
```

After the modification, the lanscan -v output will display:

```
Hardware Station      Crd Hdw  Net-Interface  NM MAC  HP-DLPI DLPI  
Path   Address          In#  State NamePPA      ID Type Support Mjr#  
VLAN0  0x001083FF9951  5000 UP   lan5000 snap5000 14 ETHER Yes    119  
Extended Station          LLC Encapsulation  
Address                   Methods  
0x001083FF9951  
  
Driver Specific Information  
vlan  
.....  
Vlan ID Phy-PPA Priority ToS Priority-Override ToS-Override Name  
53      0      3      0      CONF_PRI      IP_HEADER      UNNAMED
```

## Using lanadmin to Delete a VLAN

Before deleting a VLAN, ensure that there are no applications or upper layer protocols active on the VLAN by running:

```
lanadmin -p <VPPA>.
```

This command displays the applications and commands that are presently using the interface. For example, if the only thing done to lan5000 is configure an IP address, the lanadmin -p command output would look like:

```
lanadmin -p 5000  
  
ifconfig  
ifconfig
```

Since ifconfig command is used to configure an IP address the same is displayed. There are two entries because when an IPv4 address is configured using ifconfig, it configures both IP and ARP on the interface.

To remove the IP and ARP streams, do:

```
ifconfig lan5000 unplumb.
```

The lanadmin -p 5000 output will not show any entries now, which means the interface can be deleted. To delete this VLAN use the delete option as follows:

```
lanadmin -v delete 5000
```

The `lanadmin -p <PPA>`, command always displays the displays the applications and commands that use or are configured on the interface. Lets take another example. Before deleting, the interface lan5001, check if there are any applications running on it by typing:

```
lanadmin -p 5001
```

```
ifconfig  
ifconfig  
mib2agt  
scopeux
```

In addition to IP and ARP being configured on the interface, two applications, `mib2agt` and `scopeux`, are using the interface. These applications are started during system bootup via the startup scripts `/sbin/rc2.d/S565SnmpMib2` and `/sbin/rc2.d/S810mwa` respectively. To stop these utilities, run the `stop` sequence of the scripts. To delete the lan5001 interface, type the following commands:

```
ifconfig lan5001 unplumb  
/sbin/rc2.d/S565SnmpMib2 stop  
/sbin/rc2.d/S810mwa stop
```

Now, `lanadmin -p 5001` will not display anything, and the interface can be deleted using `lanadmin -v delete vppa`.

Once the interface is deleted, you can restart the script by issuing the `start` sequence:

```
/sbin/rc2.d/S565SnmpMib2 start  
/sbin/rc2.d/S810mwa start
```

NOTE: The `start` and `stop` sequence of the startup scripts will affect all the interfaces on the system, and they must be restarted once the delete operation is completed.

The output from the commands just described may not look exactly the same on your system. The output can vary depending on the applications using the interfaces in your environment.

Using lanadmin -V to Administer VLANs

## Using the lanadmin -V Command for Administering VLANs

---

# **A Troubleshooting**

This chapter provides guidelines for troubleshooting VLANs. It contains the following sections:

- Diagnostic Flowcharts.
- Use of `lanadmin` and `lanscan` commands and scripts for testing or troubleshooting VLANs.



## Diagnostic Flowcharts

Table A-1 summarizes the types of network tests in the diagnostic flowcharts. Follow the flowcharts in sequence beginning with Flowchart 1.

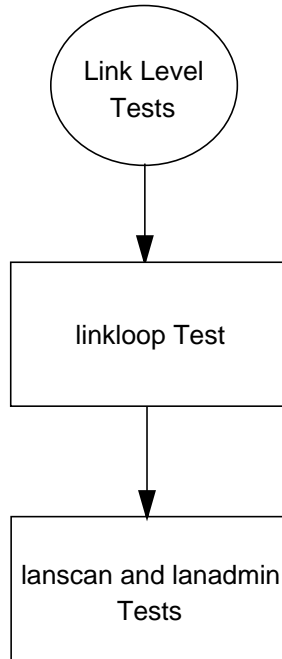
**Table A-1**      **Flowchart Descriptions**

<b>Chart</b>	<b>Type of Test</b>	<b>Purpose</b>
1	Link Level Tests	Checks communications between link levels. Verifies VLAN creation.
1a	linkloop Test	Verifies link-level address of remote hosts.
1b	lanscan, lanadmin Tests	Verifies VLAN IDs and tests VLAN creation.
2	Network Level Tests	Validate ARP(1M) entries and remote host availability. Check communication between network layers on source and target host.
2a	ARP Test	Verifies that an entry exists for the remote host in your system's ARP cache.
2b	ping Test	Checks roundtrip communication between Network Layers on the source and target host.

## Flowchart 1: Link Level Tests

Check communications between link levels on the source and target host using the `linkloop`, `lanscan`, and `lanadmin` commands. The source interface should be a VPPA, that is, a PPA corresponding to a VLAN interface. The destination MAC address is the remote VPPA's MAC address.

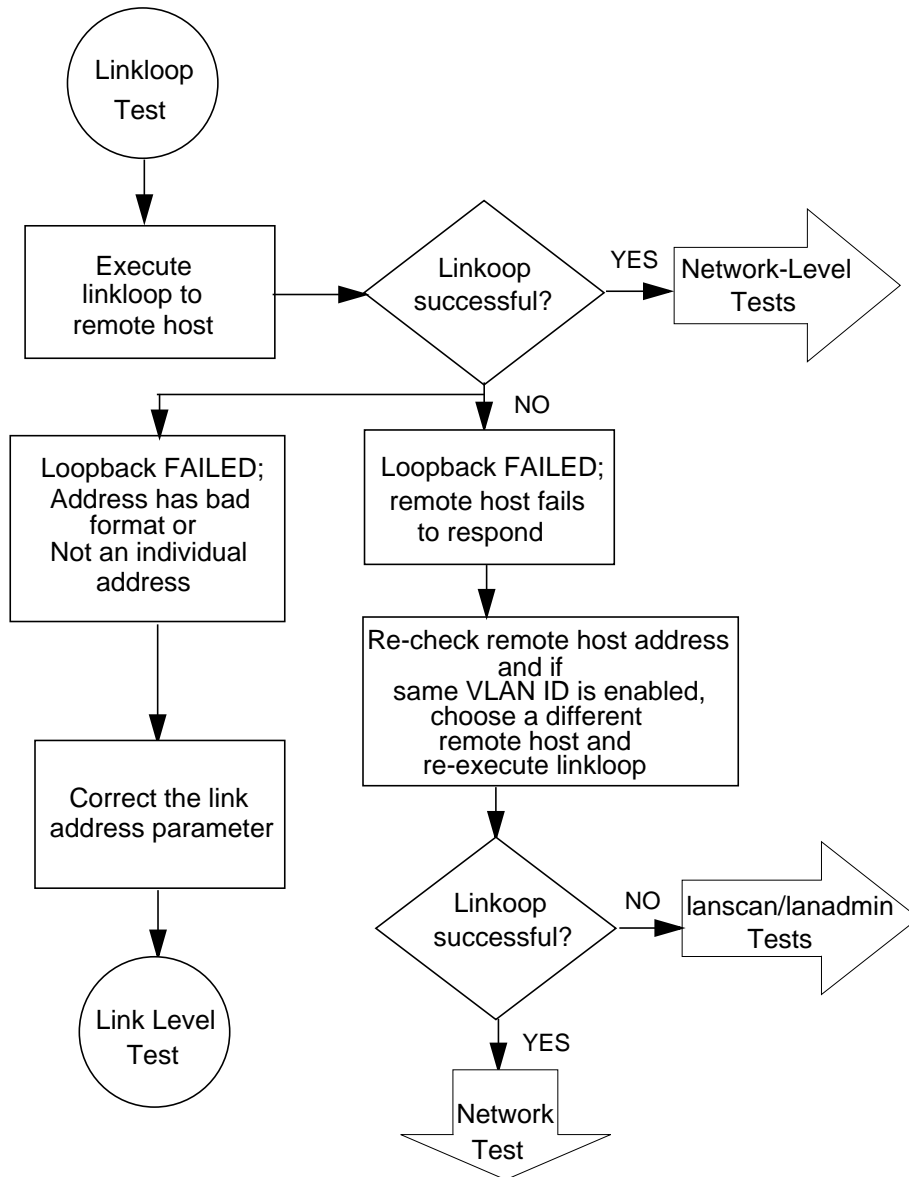
**Figure A-1**      **Flowchart 1**



### Flowchart 1a: Linkloop Test

Figure A-2

Flowchart 1a



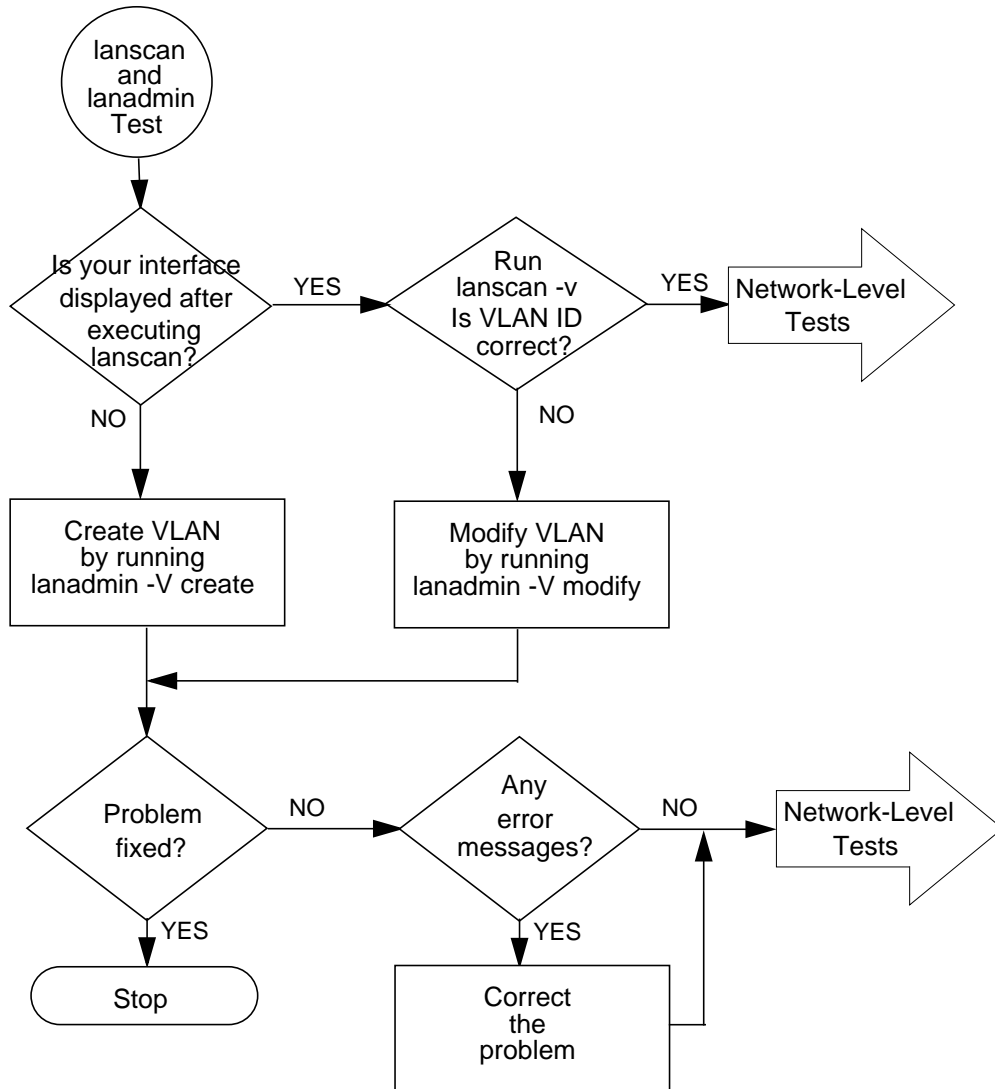
## Flowchart 1a Procedures

- Execute `linkloop` to remote host. If `linkloop` is successful, continue to Network Test. Else if `linkloop` fails note which error was returned.
- If loopback failed error = “Address has bad format” or “not an individual address” then correct the link level address with the proper station address format/value and repeat the Link Level Test.
- Otherwise, loopback failed because the remote host did not respond. Double check the remote host address and VLAN ID, or choose another remote host and re-execute `linkloop`.
  - Ensure VLAN IDs are the same by using `lanadmin -v scan` on both the source and destination.
  - Ensure switches along the path are configured with the correct VLAN ID and marked “tagged” or “untagged” as appropriate.
  - Ensure MTUs match as well.
  - Ensure that link parameters for autonegotiation, flow control speed and duplexity are compatible.
  - Ensure that the link is up. Refer to the documentation for each specific link for details.

If `linkloop` is successful, continue to Network Test. You may also want to contact the node manager of the remote that did not respond (if this was the case).

**Flowchart 1b: lanscan and lanadmin Test**

**Figure A-3**      **Flowchart 1b**

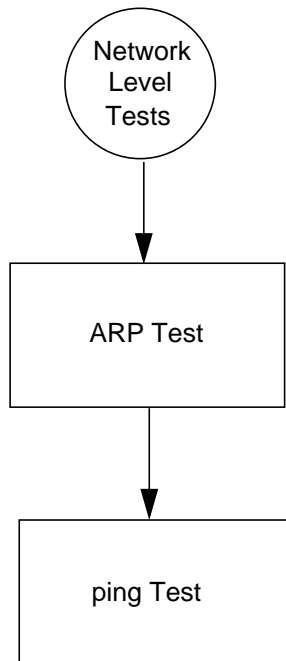


### Flowchart 1b Procedures

- Execute `lanscan` command and verify your interface is displayed by the system.
  - If it is displayed, run `lanscan -v` to ensure the VLAN ID is correct. If so, return to the network Test. If not, modify the VLAN to the correct one by running the command `lanadmin -v modify`.
  - If the interface is not displayed, run `lanadmin -v create` to create the VLAN.
- If the problem is fixed, Stop. Else, check for any error messages.
  - If there are error messages correct them according to the error message.
  - If there are no error messages, return to the network Test.

## Flowchart 2: Network Level Tests

Figure A-4      Flowchart 2



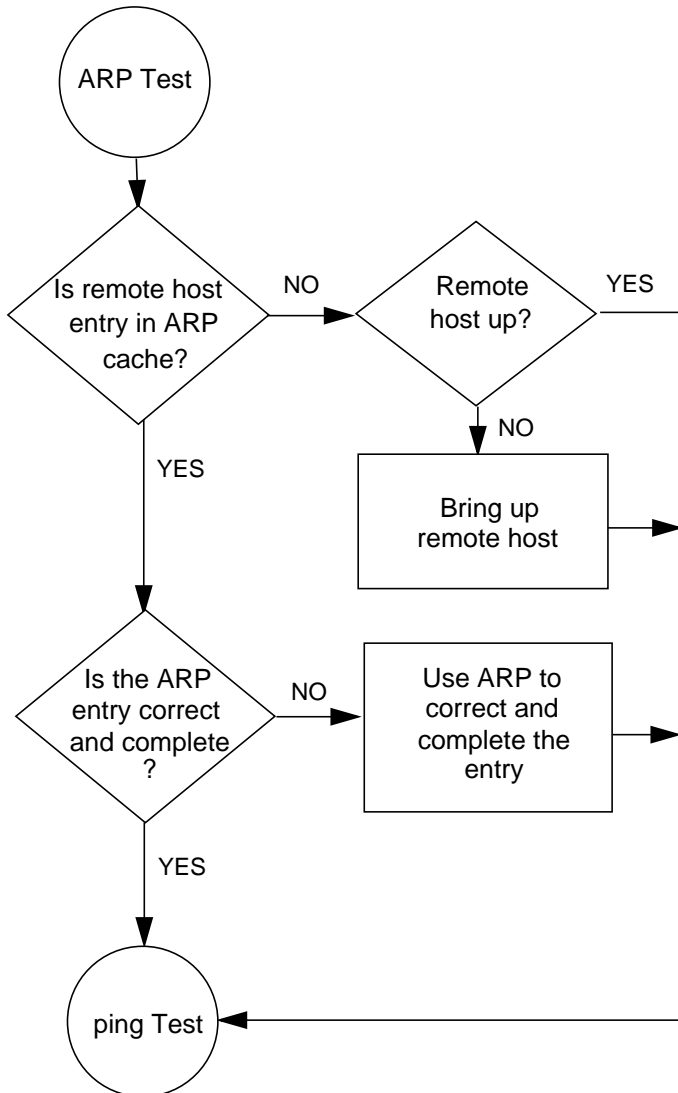


## Flowchart 2 Procedures

- See Flowchart 2a to validate ARP entries and remote host availability.
- See Flowchart 2b to check communication between network layers on source and target host using ping.

**Flowchart 2a: ARP Test**

**Figure A-5**      **Flowchart 2a**



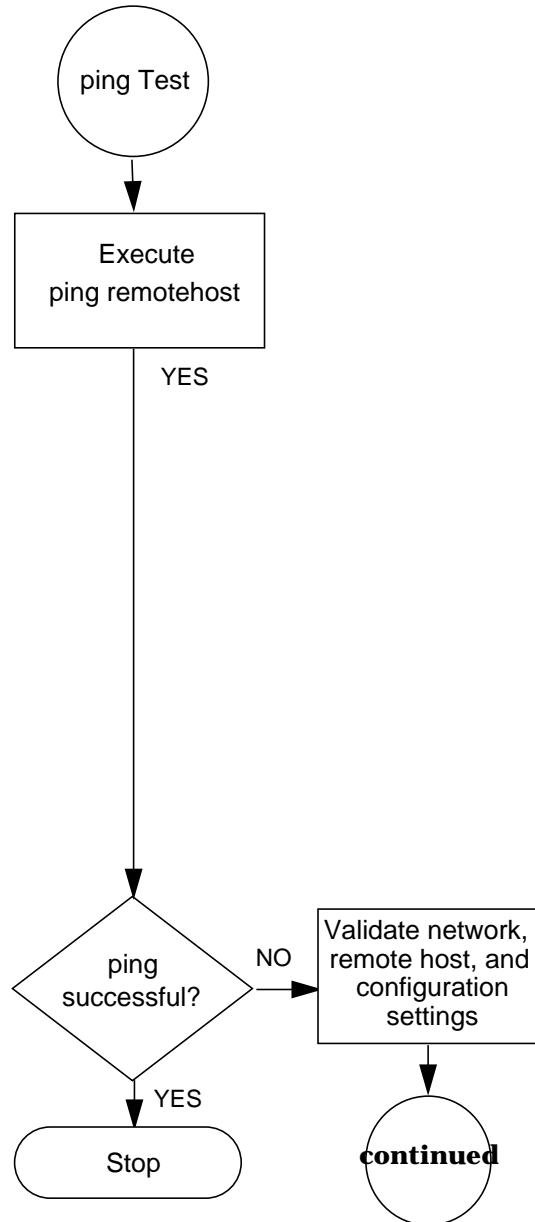
### Flowchart 2a Procedures

- Use ARP to verify that an entry exists for the remote host in your system's ARP cache by executing `arp hostname`
- If there is no ARP entry for the remote host, check to see if the remote host is up. If not, bring up remote host and continue to ping Test.
- If the ARP entry is incorrect or not complete, use `ARP` to enter the correct station address of the remote system and continue to ping Test. Otherwise, continue to ping Test.

**Flowchart 2b: ping Test**

**Figure A-6**

**Flowchart 2b**



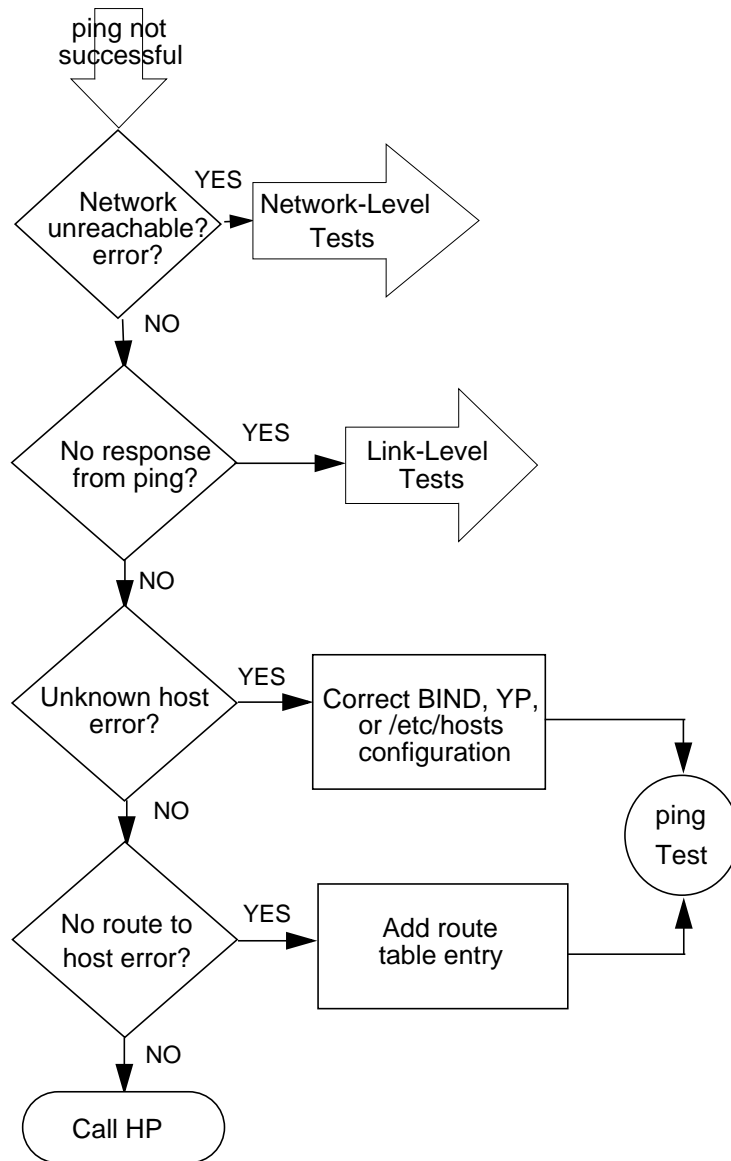
### Flowchart 2b Procedures

- Execute ping to remote host using `ping`.
- If ping is successful, stop. If not, validate network, remote host, and configuration settings. Verify the routing tables using the `netstat -rn` command.

**Flowchart 2b (continued):**

**Figure A-7**

**Flowchart 2b (continued)**



### Flowchart 2b (continued) Procedures

- If network unreachable error, go to the Configuration Tests.
- If no response from ping, validate switches in path support VLANs and remote host supports them as well. Otherwise, reconfigure network path, or configure VLANs on remote host and/or switches then repeat ping Test. Return to linkloop test.
- If you receive an unknown hosts error, add the missing host name and repeat ping Test.
- If you receive “error=SendTo: No route to host”, then using route add route table entry for the missing host and repeat ping Test. Otherwise, call HP.





```

Device ID           : 1                      Path ID           : -1
Connection ID      : 0
Location           : 00123
~~~~~
Received 1480 bytes via Ethernet  Wed Nov 07 11:08:03.961449 PST 2001
      pid=[ICS]  interface=[1]
      Dest: 00-10-83-05-16-7d  Source: 00-10-83-05-16-7e
00-10-83-05-16-7e  VLAN Tag: 0x4004
  0: 45 00 05 b6 be 49 40 00 ff 01 21 8a 65 03 66 2f  E....I@...!.e.f/
 16: 65 03 66 3d 00 00 77 9c 71 c9 00 02 3b e9 86 6d  e.f=..w.q...;..m
 32: 00 06 ab cc 08 09 0a 0b 0c 0d 0e 0f 10 11 12 13  .....
 48: 14 15 16 17 18 19 1a 1b 1c 1d 1e 1f 20 21 22 23  ..... !"#
 64: 24 25 26 27 28 29 2a 2b 2c 2d 2e 2f 30 31 32 33  $%&'()*+,-./0123
 80: 34 35 36 37 38 39 3a 3b 3c 3d 3e 3f 40 41 42 43  456789:;<=>?@ABC
 96: 44 45 46 47 48 49 4a 4b 4c 4d 4e 4f 50 51 52 53  DEFGHIJKLMNOPQRS
112: 54 55 56 57 58 59 5a 5b 5c 5d 5e 5f 60 61 62 63  TUVWXYZ[\]^_`abc
128: 64 65 66 67 68 69 6a 6b 6c 6d 6e 6f 70 71 72 73  defghijklmnopqrs
.....
.....
864: 44 45 46 47 48 49 4a 4b 4c 4d 4e 4f 50 51 52 53  DEFGHIJKLMNOPQRS
1456: 94 95 96 97 98 99 -- -- -- -- -- -- -- -- -- -- -- .....
```

### Logging Example

If you try to create a VLAN with a VLANID that is already present on the physical PPA you get the following output in verbose formatting mode:

```

*****VLAN Subsystem*****
Timestamp           : Wed Nov 07 PST 2001 11:23:44.311001
Process ID          : 8631177                Subsystem         : VLAN
User ID ( UID )    : 0                      Log Class         : ERROR
Device ID          : -1                    Path ID           : 0
Connection ID      : 0                    Log Instance      : 0
~~~~~
<2003> Create: User specified VLANID 53 is already in use by another VLAN.
(Error) The VLANID specified is already in use by another
VLAN created on the same physical interface(PPA). Choose
another VLANID or try creating the VLAN on another
physical interface(PPA).
```



---

## Glossary

**802.1p:** IEEE Standard supplement, now incorporated in IEEE 802.1D. Defines 8 priority levels for traffic classification at the data link level and suggests how they might be used.

**802.1Q:** IEEE Standard that specifies the architecture for VLAN tagging, association, and VLAN-capable bridges.

**100Base-T:** A 100 Mbit/s communication method specified in the IEEE 802.3u-1995 standard. The official name for Fast Ethernet.

**Alias:** Name of the interface that corresponds to a given Internet address on a system.

**Canonical format indicator:** The CFI bit indicates that all MAC addresses present in the MAC data field are in canonical format. HP-UX always transmits a CFI of 0.

**Card Instance Number:** A number that uniquely identifies a device within a class. A class of devices is a logical grouping of similar devices.

**CoS:** Class of Service. The ability to provide different levels of service to various traffic flows. A flow may be determined explicitly via tags or implicitly from the frame contents (such as the IP address or ToS field). Class of Service (CoS) network management is when similar types of traffic (for example, voice, video, or data) are grouped together and assigned a priority. Unlike Quality of Service (QoS) traffic management, CoS does not guarantee a level of service in terms of bandwidth and delivery time.

**Destination Address:** A field in the message packet format identifying the end node(s) to which the packet is being sent.

**Ethernet:** A 10 Mbit/s LAN, developed by Digital Equipment Corporation, Intel, and Xerox Corporation, upon which the IEEE 802.3 network is based.

**Fast Ethernet:** A commonly used name applied to 100Base-T.

**HSC:** High speed connect bus.

**Hardware Path:** An identifier assigned by the system according to the physical location (slot) of a card in the hardware backplane.

**Hostname:** Name of system on the network.

**Hub:** A network interconnection device that allows multiple devices to share a single logical link segment. Hubs are generally either 10 Mbit/s or 100 Mbit/s devices.

**IEEE:** The Institute of Electrical and Electronics Engineers. A national association, whose activities include publishing standards applicable to various electronic technologies. The IEEE technical committees are numbered and grouped by area. For example, the 800 committees study local area network technologies. The 802.3 committee produced the standard for a CSMA/CD local area network, which has been adopted by ANSI.

**Internet Address:** The network address of a computer node. This address identifies both which network the host is on and which host it is. Refer to the *Installing and Administering LAN/9000 Software* manual for detailed information about network addressing.

**IP:**

**IP:** Internet protocol.

**IP Address:** See Internet Address glossary entry.

**LAN:** See Local Area Network.

**Local Area Network (LAN):** A data communications system that allows a number of independent devices to communicate with each other.

**Local Network:** The network to which a node is directly attached.

**Maximum Transmission Unit (MTU).**

Largest amount of data that can be transmitted through that interface. This value does not include the LLC or MAC headers.

**NetTL.** HP's tracing and logging facility for HP-UX networking.

**Network Interface:** A communication path through which messages can be sent and received. A hardware network interface has a hardware device associated with it, such as a LAN card. A software network interface does not include a hardware device, for example the loopback interface. For every IP address instance, there must be one network interface configured.

**NIC:** Network interface card.

**PCI:** Peripheral component interconnect.

**PPA:** Physical point of attachment. A PPA is the point at which a system is attached to a physical communications medium. All communication on that physical medium funnels through the PPA.

**QoS:** Quality of Service. The ability to provide guarantees for data transfer -- for example, latency, throughput, and discard priority.

**SAM:** System admin manager. GUI-based HP tool for system configuration and management.

**Shared media LAN:** A local area network (LAN) that shares all its bandwidth among all stations.

**Switch:** A network interconnection device that allows multiple connected senders and receivers to communicate simultaneously in contrast to a hub (repeater) where only one device can send at a time. Some switches have fixed port speeds (10 Mbit/s or 100 Mbit/s) while others allow port speeds to be configured or autonegotiated.

**Tag aware:** Devices such as switches, routers, and end-stations that can interpret VLAN tags. *See also VLAN-aware.*

**TCP:** Transmission control protocol.

**Topology:** The physical and logical geometry governing placement of nodes in a computer network. Also, the layout of the transmission medium for a network.

**ToS:** IPv4 Type of Service field which indicates the desired service expected by an IP packet for delivery through routers across the IP internetwork. The size of this field is 8 bits, which contain bits for precedence, delay, throughput, and reliability characteristics.

**UTP (Unshielded Twisted Pair)**

**Cabling:** A data cable type consisting of pairs of wires twisted together without an electrically shielding jacket.

**Virtual PPA or VPPA:** Virtual Interfaces which are dynamically created by you (using lanadmin or SAM). The interfaces are “virtual” because they do not have a unique hardware instance. A virtual PPA is the PPA associated with a VLAN.

**VLAN:** Virtual LAN. VLANs, are a mechanism to determine which end stations should receive broadcast traffic, since it should not be sent arbitrarily to every connected user. Each packet transmitted by an end-station is assigned to a VLAN. An end-station only receives all the multicast and broadcast traffic on the LANs to which it belongs, and an end-station receives unicast traffic addressed to it on the VLAN to which it belongs.

**VLAN-aware:** Devices such as switches and end-stations that can recognize VLAN tags, but they do not actually interpret them. *See also tag-aware.*

**VLAN ID:** A VLAN ID uniquely identifies the VLAN to which a frame belongs.

**VLAN tag:** A 4-byte extension to the MAC header consisting of a 2-byte VLAN protocol ID (0x8100) and 2-bytes of tag control information. VLAN tags enable traffic from more than one VLAN to use the same port.

**VPPA:** see Virtual PPA.

