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Cabletron's SecureFast VLAN Operational Model Version 1.8

Status of this Memo

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Abstract

Cabletron's SecureFast VLAN (SFVLAN) product implements a distributed connection-oriented switching protocol that provides fast forwarding of data packets at the MAC layer. The product uses the concept of virtual LANs (VLANs) to determine the validity of call connection requests and to scope the broadcast of certain flooded messages.

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1. Introduction

This memo is being distributed to members of the Internet community in order to solicit reactions to the proposals contained herein. While the specification discussed here may not be directly relevant to the research problems of the Internet, it may be of interest to researchers and implementers.

1.1 Data Conventions

The methods used in this memo to describe and picture data adhere to the standards of Internet Protocol documentation [RFC1700]. In particular:

> The convention in the documentation of Internet Protocols is to express numbers in decimal and to picture data in "big-endian" order. That is, fields are described left to right, with the most significant octet on the left and the least significant octet on the right.
>
> The order of transmission of the header and data described in this document is resolved to the octet level. Whenever a diagram shows a group of octets, the order of transmission of those octets is the normal order in which they are read in English.
>
> Whenever an octet represents a numeric quantity the left most bit in the diagram is the high order or most significant bit. That is, the bit labeled 0 is the most significant bit.

Similarly, whenever a multi-octet field represents a numeric quantity the left most bit of the whole field is the most significant bit. When a multi-octet quantity is transmitted the most significant octet is transmitted first.

1.2 Definitions of Commonly Used Terms

This section contains a collection of definitions for terms that have a specific meaning for the SFVLAN product and that are used throughout the text.

Switch ID

A 10-octet value that uniquely identifies an SFVLAN switch within the switch fabric. The value consists of the 6-octet base MAC address of the switch, followed by 4 octets of zeroes.

Network link

The physical connection between two switches. A network link is associated with a network interface (or port) of a switch.

Network port

An interface on a switch that attaches to another switch.

Access port

An interface on a switch that attaches to a user endstation.

Port ID

A 10-octet value that uniquely identifies an interface of a switch. The value consists of the 6-octet base MAC address of the switch, followed by the 4-octet local port number of the interface.

Neighboring switches

Two switches attached to a common (network) link.

Call connection

A mapping of user traffic through a switch that correlates the source and destination address pair specified within the packet to an inport and outport pair on the switch.

Call connection path

A set of 0 to 7 network links over which user traffic travels between the source and destination endstations. Call connection paths are selected from a list of alternate equal cost paths calculated by the VLS protocol [IDvlsp], and are chosen to load balance traffic across the fabric.

Ingress switch

The owner switch of the source endstation of a call connection. That is, the source endstation is attached to one of the local access ports of the switch.

Egress switch

The owner switch of the destination endstation of a call connection. That is, the destination endstation is attached to one of the local access ports of the switch.

Intermediate switches

Any switch along the call connection path on which user traffic enters and leaves over network links. Note that the following types of connections have no intermediate switches:

- Call connections between source and destination endstations that are attached to the same switch -- that is, the ingress switch is the same as the egress switch. Note also that the path for this type of connection consists of 0 network links.

- Call connections where the ingress and egress switches are physical neighbors connected by a single network link. The path for this type of connection consists of a single network link.

InterSwitch Message protocol (ISMP)

The protocol used for interswitch communication between SFVLAN switches.

Undirected messages

Messages that are (potentially) sent to all SFVLAN switches in the switch fabric -- that is, they are not directed to any particular switch. ISMP messages with a message type of 5, 7 or 8 are undirected messages.

Switch flood path

The path used to send undirected messages throughout the switch fabric. The switch flood path is formed using a spanning tree algorithm that provides a single path through the switch fabric that guarantees loop-free delivery to every other SFVLAN switch in the fabric.

Upstream Neighbor

That switch attached to the inport of the switch flood path -- that is, the switch from which undirected messages are received. Note that each switch receiving an undirected message has, at most, one upstream neighbor, and the originator of any undirected ISMP message has no upstream neighbors.

Downstream Neighbors

Those switches attached to all outports of the switch flood path except the port on which the undirected message was received. Note that for each undirected message some number of switches have no downstream neighbors.

Virtual LAN (VLAN) identifier

A VLAN is a logical grouping of ports and endstations such that all ports and endstations in the VLAN appear to be on the same physical (or extended) LAN segment even though they may be geographically separated.

A VLAN identifier consists of a variable-length string of octets. The first octet in the string contains the number of octets in the remainder of the string -- the actual VLAN identifier value. A VLAN identifier can be from 1 to 16 octets long.

VLAN policy

Each VLAN has an assigned policy value used to determine whether a particular call connection can be established. SFVLAN recognizes two policy values: Open and Secure.

2. SFVLAN Overview

Cabletron's SecureFast VLAN (SFVLAN) product implements a distributed connection-oriented switching protocol that provides fast forwarding of data packets at the MAC layer.

2.1 Features

Within a connection-oriented switching network, user traffic is routed through the switch fabric based on the source and destination address (SA/DA) pair found in the arriving packet. For each SA/DA pair encountered by a switch, a "connection" is programmed into the switch hardware. This connection maps the SA/DA pair and the port on which the packet was received to a specific outport over which the packet is to be forwarded. Thus, once a connection has been established, all packets with a particular SA/DA pair arriving on a particular inport are automatically forwarded by the switch hardware out the specified outport.

A distributed switching environment requires that each switch be capable of processing all aspects of the call processing and switching functionality. Thus, each switch must synchronize its various databases with all other switches in the fabric or be capable of querying other switches for information it does not have locally.

SFVLAN accomplishes the above objectives by providing the following features:

- A virtual directory of the entire switch fabric.

- Call processing for IP, IPX and MAC protocols.

- Automatic call connection, based on VLAN policy.

- Automatic call rerouting around failed switches and links.

In addition, SFVLAN optimizes traffic flow across the switch fabric by providing the following features:

- Broadcast interception and address resolution at the ingress port.

- Broadcast scoping, restricting the flooding of broadcast packets to only those ports that belong to the same VLAN as the packet source.

- A single loop-free path (spanning tree) used for the flooding of undirected interswitch control messages. Only switches running the SFVLAN switching protocol are included in this spanning tree calculation -- that is, traditional bridges or routers configured for bridging are not included.

- Interception of both service and route advertisements with readvertisement sourced from the MAC address of the original advertiser.

2.2 VLAN Principles

Each SFVLAN switch port, along with its attached endstations, belongs to one or more virtual LANs (VLANs). A VLAN is a logical grouping of ports and endstations such that all ports and endstations in the VLAN appear to be on the same physical (or extended) LAN segment even though they may be geographically separated.

VLAN assignments are used to determine the validity of call connection requests and to scope the broadcast of certain flooded messages.

2.2.1 Default, Base and Inherited VLANs

Each port is explicitly assigned to a default VLAN. At start-up, the default VLAN to which all ports are assigned is the base VLAN -- a permanent, non-deletable VLAN to which all ports belong at all times.

The network administrator can change the default VLAN of a port from the base VLAN to any other unique VLAN by using a management application known here as the VLAN Manager. A port's default VLAN is persistent -- that is, it is preserved across a switch reset.

When an endstation attaches to a port for the first time, it inherits the default VLAN of the port. Using the VLAN Manager, the network administrator can reassign an endstation to another VLAN.

Note:

When all ports and all endstations belong to the base VLAN, the switch fabric behaves like an 802.1D bridging system.

2.2.2 VLAN Configuration Modes

For both ports and endstations, there are a variety of VLAN configuration types, or modes.

2.2.2.1 Endstations

For endstations, there are two VLAN configuration modes: inherited and static.

- Inherited

  An inherited endstation becomes a member of its port's default VLAN.

- Static

  A static port becomes a member of the VLAN to which it has been assigned by the VLAN Manager.

The default configuration mode for an endstation is inherited.

2.2.2.2 Ports

For ports, there are two VLAN configuration modes: normal and locked.

- Normal

  All inherited endstations on a normal port become members of the port's default VLAN. All static endstations are members of the VLAN to which they were mapped by the VLAN Manager.

  If the VLAN Manager reassigns the default VLAN of a normal port, the VLAN(s) for the attached endstations may or may not change, depending on the VLAN configuration mode of each endstation. All inherited endstations will become members of the new default VLAN. All others will retain membership in their previously mapped VLANs.

- Locked

  All endstations attached to a locked port can be members only of the port's default VLAN.

  If the VLAN Manager reconfigures a normal port to be a locked port, all endstations attached to the port become members of the port's default VLAN, regardless of any previous VLAN membership.

The default configuration mode for ports is normal.

2.2.2.3 Order of Precedence

On a normal port, static VLAN membership prevails over inherited membership.

On a locked port, default VLAN membership prevails over any static VLAN membership.

If a statically assigned endstation moves from a locked port back to a normal port, the endstation's static VLAN membership must be preserved.

2.2.3 Ports with Multiple VLAN Membership

A port can belong to multiple VLANs, based on the VLAN membership of its attached endstations.

For example, consider a port with three endstations, a default VLAN of "blue" and the following endstation VLAN assignments:

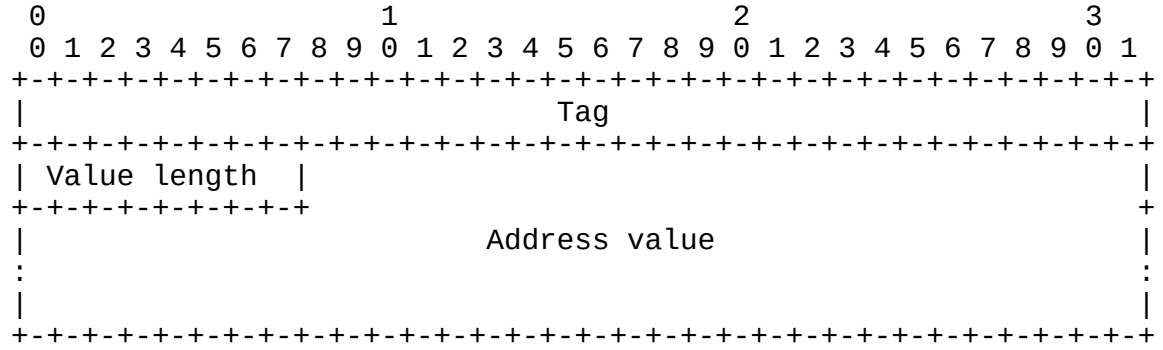
- One of the endstations is statically assigned to VLAN "red."
- Another endstation is statically assigned to VLAN "green."
- The third endstation inherits the default VLAN of "blue."

In this instance, the port is explicitly a member of VLAN "blue." But note that it is also implicitly a member of VLAN "red" and VLAN "green." Any tag-based flooding (Section 4.8) directed to any one of the three VLANs ("red," "green," or "blue") will be forwarded out the port.

2.3 Tag/Length/Value Method of Addressing

Within most computer networks, the concept of "address" is somewhat elusive because different protocols can (and do) use different addressing schemes and formats. For example, Ethernet (physical layer) addresses are six octets long, while IP (network layer) addresses are only four octets long.

To distinguish between the various protocol-specific forms of addressing, many software modules within the SFVLAN product specify addresses in a format known as Tag/Length/Value (TLV). This format uses a variable-length construct as shown below:



Tag

This 4-octet field specifies the type of address contained in the structure. The following address types are currently supported:

Tag name	Value	Address type
aoMacDx	1	DX ethernet dst/src/type
aoIpxSap	2	Sap
aoIpxRIP	3	RIP
aoInstYP	4	YP (YP name and version)
aoInstUDP	5	UDP (Port #)
aoIpxIpx	6	Ipx
aoInetIP	7	IP (Net address)
aoInetRPC	8	RPC (Program #)
aoInetRIP	9	INET RIP
aoMacDXMcast	10	Multicast unknown type
aoAtDDP	11	AppleTalk DDP
aoEmpty	12	(no address type specified)
aoVlan	13	VLAN identifier
aoHostName	14	Host name
aoNetBiosName	15	NetBIOS name
aoNBT	16	NetBIOS on TCP name
aoInetIPMask	17	IP Subnet Mask
aoIpxSap8022	18	Sap 8022 type service
aoIpxSapSnap	19	Sap Snap type service
aoIpxSapEnet	20	Sap Enet type service
aoDHCPXID	21	DHCP Transaction ID
aoIpMcastRx	22	IP class D receiver
aoIpMcastTx	23	IP class D sender
aoIpxRip8022	24	Ipx Rip 8022 type service
aoIpxRipSnap	25	Ipx Rip type service
aoIpxRipEnet	26	Ipx Rip Enet service
aoATM	27	ATM
aoATMELAN	28	ATM LAN Emulation Name

Value length

This 1-octet field contains the length of the value of the address. The value here depends on the address type and actual value.

Address value

This variable-length field contains the value of the address. The length of this field is stored in the Value length field.

2.4 Architectural Overview

The SFVLAN software executes in the switch CPU and consists of the following elements as shown in Figure 1:

- The SFVLAN base services that handles traffic intercepted by the switch hardware. The base services are described in Section 3.

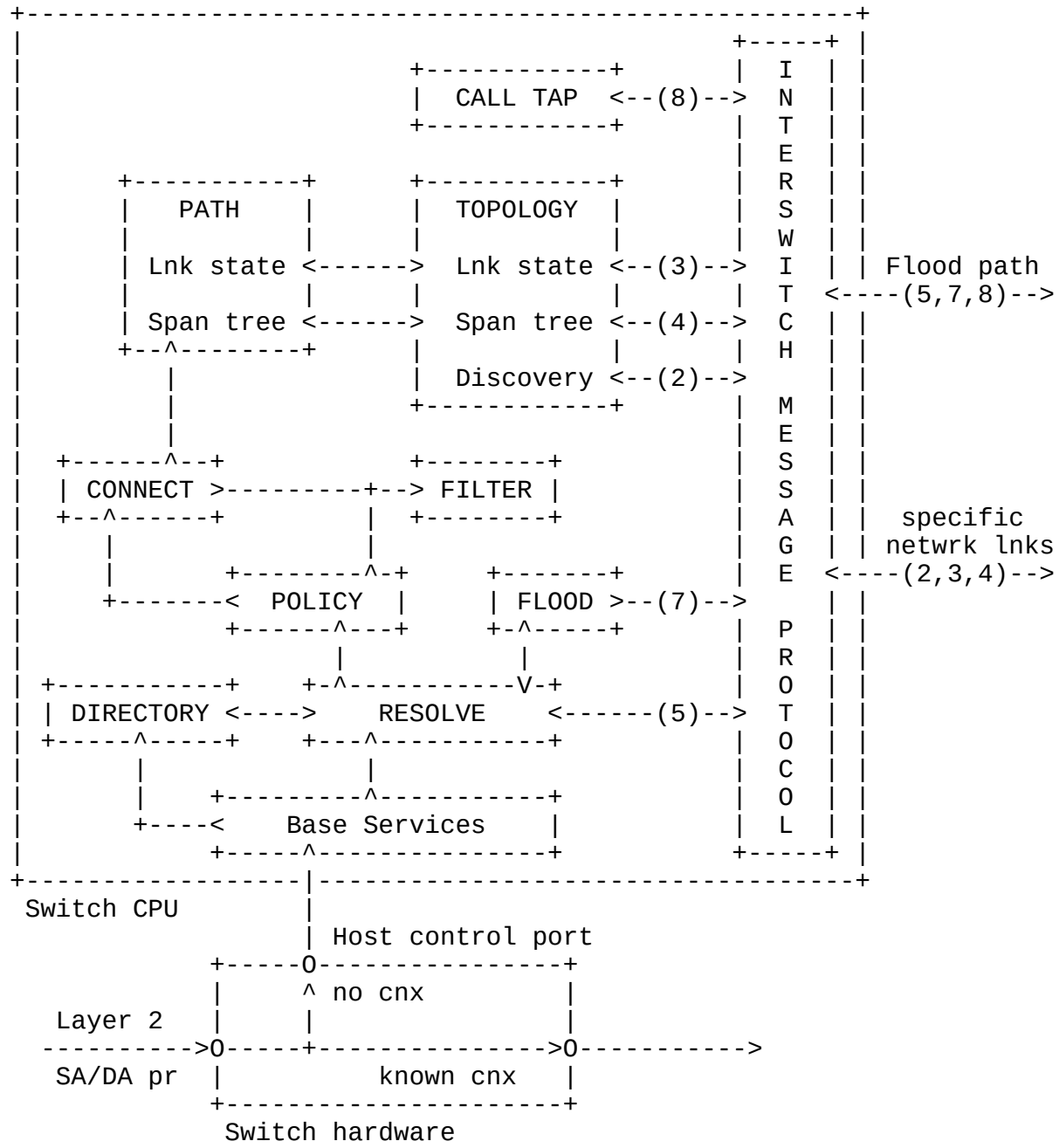


Figure 1: SFVLAN Architectural Overview

- Eight call processing service centers that provide the essential services required to process call connections. The call processing service centers are described in Section 4.

- A Call Tap module that supports the monitoring of call connections. The Call Tap module is described in Section 5.

- The InterSwitch Message Protocol (ISMP) that provides a consistent method of encapsulating and transmitting control messages exchanged between SFVLAN switches. (Note that ISMP is not a discrete software module. Instead, its functionality is distributed among those service centers and software modules that need to communicate with other switches in the fabric.) The Interswitch Message Protocol and the formats of the individual interswitch messages are described in Section 6.

3. Base Services

The SFVLAN base services act as the interface between the switch hardware and the SFVLAN service centers running on the switch CPU. This relationship is shown in Figure 2. This figure is a replication of the bottom portion of Figure 1.

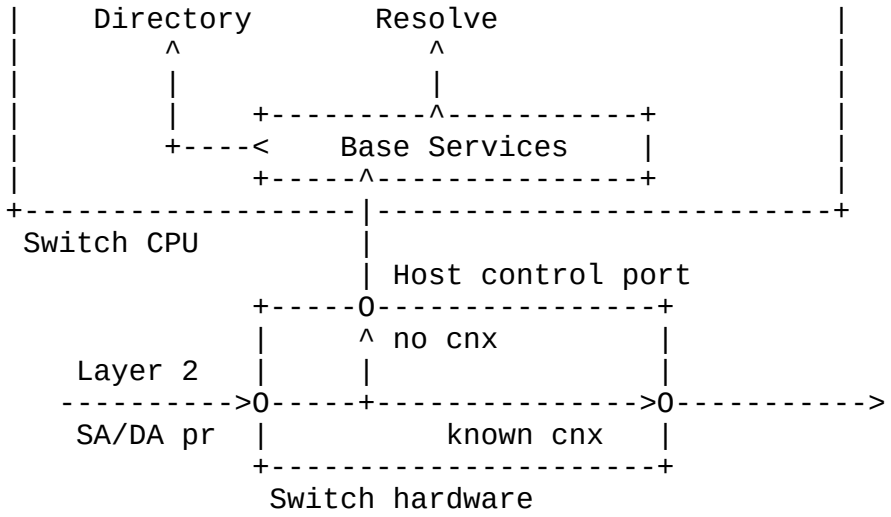


Figure 2: Base Services

During normal operation of the switch, data packets arriving at any one of the local switch ports are examined in the switch hardware. If the packet's source and destination address (SA/DA) pair match a known connection, the hardware simply forwards the packet out the outport specified by the connection.

If the SA/DA pair do not match any known connection, the hardware diverts the packet to the host control port where it is picked up by the SFVLAN base services. The base services generate a structure known as a state box that tracks the progress of the call connection request as the request moves through the call processing service centers.

After creating the call's state box, the base services check to determine if the call is a duplicate of a call already being processed. If not, a request is issued to the Directory Service Center (Section 4.1) to add the call's source address to the local Node and Alias Tables. The base services then hand the call off to the Resolve Service Center (Section 4.3) for further processing.

4. Call Processing

Call connection processing is handled by a set of eight service centers, each with one or more servers. The servers within a service center are called in a particular sequence. Each server records the results of its processing in the call connection request state box and passes the state box to the next server in the sequence.

In the sections that follow, servers are listed in the order in which they are called.

4.1 Directory Service Center

The Directory Service Center is responsible for cataloging the MAC addresses and alias information for both local and remote endstations. The information is stored in two tables -- the Node Table and the Alias Table.

- The Node Table contains the MAC addresses of endstations attached to the local switch. It also contains a cache of remote endstations detected by the Resolve Service Center (Section 4.3). Every entry in the Node Table has one or more corresponding entries in the Alias Table.

- The Alias Table contains protocol alias information for each endstation. An endstation alias can be a network address (such as an IP or IPX address), a VLAN identifier, or any other protocol identifier. Since every endstation is a member of at least one VLAN (the default VLAN for the port), there is always at least one entry in the Alias Table for each entry in the Node Table.

  Note:

  The Node and Alias Tables must remain synchronized. That is, when an endstation's final alias is removed from the Alias Table, the endstation entry is removed from the Node Table.

Note that the total collection of all Node Tables and Alias Tables across all switches is known as the "virtual" directory of the switch fabric. The virtual directory contains address mappings of all known endstations in the fabric.

4.1.1 Local Add Server

The Directory Local Add server adds entries to the local Node or Alias Tables. It is called by the base services (Section 3) to add a local endstation and by the Interswitch Resolve (Section 4.3.4) server to add an endstation discovered on a remote switch.

4.1.2 Inverse Resolve Server

The Directory Inverse Resolve server is invoked when a new endstation has been discovered on the local switch (that is, when the Local Add server was successful in adding the endstation). The server provides two functions:

- It populates the Node and Alias Tables with local entries during switch initialization.

- It processes a new endstation discovered after the fabric topology has converged to a stable state.

In both instances, the processing is identical.

When a new endstation is detected on one of the switch's local ports, the Inverse Resolve server sends an Interswitch New User request message (Section 6.5) over the switch flood path to all other switches in the fabric. The purpose of the Interswitch New User request is two-fold:

- It informs the other switches of the new endstation address. Any entries for that endstation in the local databases of other switches should be dealt with appropriately.

- It requests information about any static VLAN(s) to which the endstation has been assigned.

When a switch receives an Interswitch New User request message from one of its upstream neighbors, it first forwards the message to all its downstream neighbors. No actual processing or VLAN resolution is attempted until the message reaches the end of the switch flood path and begins its trip back along the return path. This ensures that all switches in the fabric receive notification of the new user and have synchronized their databases.

If a switch receives an Interswitch New User request message but has no downstream neighbors, it does the following:

- If the endstation was previously connected to one of the switch's local ports, the switch formulates an Interswitch New User Response message by loading the VLAN identifier(s) of the static VLAN(s) to which the endstation was assigned, along with its own MAC address. (VLAN identifiers are stored in Tag/Length/Value (TLV) format. See Section 2.3.) The switch then sets the message status field to NewUserAck, and returns the message to its upstream (requesting) neighbor.

  Otherwise, the switch sets the status field to NewUserUnknown and returns the message to its upstream neighbor.

- The switch then deletes the endstation from its local database, as well as any entries associated with the endstation in its connection table.

When a switch forwards an Interswitch New User request message to its downstream neighbors, it keeps track of the number of requests it has sent out and does not respond back to its upstream neighbor until all requests have been responded to.

- As each response is received, the switch checks the status field of the message. If the status is NewUserAck, the switch retains the information in that response. When all requests have been responded to, the switch returns the NewUserAck response to its upstream neighbor.

- If all the Interswitch New User Request messages have been responded to with a status of NewUserUnknown, the switch checks to see if the endstation was previously connected to one of its local ports. If so, the switch formulates an Interswitch New User Response message by loading the VLAN identifier(s) of the static VLAN(s) to which the endstation was assigned, along with its own MAC address. The switch then sets the message status field to NewUserAck, and returns the message to its upstream (requesting) neighbor.

  Otherwise, the switch sets the status field to NewUserUnknown and returns the message to its upstream neighbor.

- The switch then deletes the endstation from its local database, as well as any entries associated with the endstation in its connection table.

When the originating switch has received responses to all the Interswitch New User Request messages it has sent, it does the following:

- If it has received a response message with a status of NewUserAck, it loads the new VLAN information into its local database.

- If all responses have been received with a status of NewUserUnknown, the originating switch assumes that the endstation was not previously connected anywhere in the network and assigns it to a VLAN according to the VLAN membership rules and order of precedence.

If any Interswitch New User Request message has not been responded to within a certain predetermined time (currently 5 seconds), the originating switch recalculates the switch flood path and resends the Interswitch New User Request message.

4.1.3 Local Delete Server

The Directory Local Delete server removes entries (both local and remote) from the local Node and Alias Tables. It is invoked when an endstation, previously known to be attached to one switch, has been moved and discovered on another switch.

Note also that remote entries are cached and are purged from the tables on a first-in/first-out basis as space is needed in the cache.

4.2 Topology Service Center

The Topology Service Center is responsible for maintaining three databases relating to the topology of the switch fabric:

- The topology table of SFVLAN switches that are physical neighbors to the local switch.

- The spanning tree that defines the loop-free switch flood path used for transmitting undirected interswitch messages.

- The directed graph that is used to calculate the best path(s) for call connections.

4.2.1 Neighbor Discovery Server

The Topology Neighbor Discovery server uses Interswitch Keepalive messages to detect the switch's neighbors and establish the topology of the switching fabric. Interswitch Keepalive messages are exchanged in accordance with Cabletron's VlanHello protocol, described in detail in [IDhello].

4.2.2 Spanning Tree Server

The Topology Spanning Tree server is invoked by the Topology Neighbor Discovery server when a neighboring SFVLAN switch is either discovered or lost -- that is, when the operational status of a network link changes.

The Spanning Tree server exchanges interswitch messages with neighboring SFVLAN switches to calculate the switch flood path over which undirected interswitch messages are sent. There are two parts to this process:

- Creating and maintaining the spanning tree
- Remote blocking

4.2.2.1 Creating and Maintaining the Spanning Tree

In a network with redundant network links, a packet traveling between switches can potentially be caught in an infinite loop -- an intolerable situation in a networking environment. However, it is possible to reduce a network topology to a single configuration (known as a spanning tree) such that there is, at most, one path between any two switches.

Within the SFVLAN product, the spanning tree is created and maintained using the Spanning Tree Algorithm defined by the IEEE 802.1d standard.

Note:

A detailed discussion of this algorithm is beyond the scope of this document. See [IEEE] for more information.

To implement the Spanning Tree Algorithm, SFVLAN switches exchange Interswitch BPDU messages (Section 6.2) containing encapsulated IEEE-compliant 802.2 Bridge Protocol Data Units (BPDUs). There are two types of BPDUs:

- Configuration (CFG) BPDUs are exchanged during the switch discovery process, following the receipt of an Interswitch Keepalive message. They are used to create the initial the spanning tree.

- Topology Change Notification (TCN) BPDUs are exchanged when changes in the network topology are detected. They are used to redefine the spanning tree to reflect the current topology.

See [IEEE] for detailed descriptions of these BPDUs.

4.2.2.2 Remote Blocking

After the spanning tree has been computed, each network port on an SFVLAN switch will be in one of two states:

- Forwarding. A port in the Forwarding state will be used to transmit all ISMP messages.

- Blocking. A port in the Blocking state will not be used to forward undirected ISMP messages. Blocking the rebroadcast of these messages on selected ports prevents message duplication arising from multiple paths that exist in the network topology. Note that all other types of ISMP message will be transmitted.

  Note:

  The IEEE 802.1d standard specifies other port states used during the initial creation of the spanning tree. These states are not relevant to the discussion here.

Note that although a port in the Blocking state will not forward undirected ISMP messages, it may still receive them. Any such message received will ultimately be discarded, but at the cost of CPU time necessary to process the packet.

To prevent the transmission of undirected messages to a port, the port's owner switch can set remote blocking on the link by sending an Interswitch Remote Blocking message (Section 6.3) out over the port. This notifies the switch on the other end of the link that undirected messages should not be sent over the link, regardless of the state of the sending port.

Each SFVLAN switch sends an Interswitch Remote Blocking message out over all its blocked network ports every 5 seconds. A flag within the message indicates whether remote blocking should be turned on or off over the link.

4.2.3 Link State Server

The Topology Link State server is invoked by any process that detects a change in the state of the network links of the local switch. These changes include (but are not limited to) changes in operational or administrative status of the link, path "cost" or bandwidth.

The Link State server runs Cabletron's Virtual LAN Link State (VLS) protocol which exchanges interswitch messages with neighboring SFVLAN switches to calculate the set of best paths between the local switch and all other switches in the fabric. (The VLS protocol is described in detail in [IDvlsp].)

The Link State server also notifies the Connect Service Center (Section 4.5) of any remote links that have failed, thereby necessitating potential tear-down of current connections.

4.3 Resolve Service Center

The Resolve Service Center is responsible for resolving the destination address of broadcast data packets (such as an IP ARP packet) to a unicast MAC address to be used in mapping the call connection. To do this, the Resolve Service Center attempts to resolve such broadcast packets directly at the access port of the ingress switch.

Address resolution is accomplished as follows:

1) First, an attempt is made to resolve the address from the switch's local databases by calling the following servers:

   - The Table server attempts to resolve the address from the Resolve Table (Section 4.3.1).

   - Next, the Local server attempts to resolve the address from the Node and Alias Tables (Section 4.3.2).

   - If the address is not found in these tables but is an IP address, the Resolve Subnet server (Section 4.3.3) is also called.

2) If the address cannot be resolved locally, the Interswitch Resolve server (Section 4.3.4) is called to access the "virtual directory" by sending an Interswitch Resolve request message out over the switch flood path.

3) If the address cannot be resolved either locally or via an Interswitch Resolve message -- that is, the destination endstation is unknown to any switch, perhaps because it has never transmitted a packet to its switch -- the following steps are taken:

   - The Unresolvable server (Section 4.3.5) is called to record the unresolved packet.

   - The Block server (Section 4.3.6) is called to determine whether the address should be added to the Block Table.

   - The Flood Service Center (Section 4.8) is called to broadcast the packet to other SFVLAN switches using a tag-based flooding mechanism.

4.3.1 Table Server

The Resolve Table server maintains the Resolve Table which contains a collection of addresses that might not be resolvable in the normal fashion. This table typically contains such things as the addresses of "quiet" devices that do not send data packets or special mappings of IP addresses behind a router. Entries can be added to or deleted from the Resolve Table via an external management application.

4.3.2 Local Server

The Resolve Local server checks the Node and Alias Tables maintained by the Directory Service Center (Section 4.1) to determine if it can resolve the address.

4.3.3 Subnet Server

If the address to be resolved is an IP address but cannot be resolved via the standard processing described above, the Resolve Subnet server applies the subnet mask to the IP address and then does a lookup in the Resolve Table.

4.3.4 Interswitch Resolve Server

If the address cannot be resolved locally, the Interswitch Resolve server accesses the "virtual directory" by sending an Interswitch Resolve request message (Section 6.4) out over the switch flood path. The Interswitch Resolve request message contains the destination address as it was received within the packet, along with a list of requested addressing information.

When a switch receives an Interswitch Resolve request message from one of its upstream neighbors, it checks to see if the destination endstation is connected to one of its local access ports. If so, it formulates an Interswitch Resolve response message by filling in the requested address information, along with its own MAC address. It then sets the message status field to ResolveAck, and returns the message to its upstream (requesting) neighbor.

If the receiving switch cannot resolve the address, it forwards the Interswitch Resolve request message to its downstream neighbors. If the switch has no downstream neighbors, it sets the message status field to Unknown, and returns the message to its upstream (requesting) neighbor.

When a switch forwards an Interswitch Resolve request message to its downstream neighbors, it keeps track of the number of requests it has sent out and received back. It will only respond back to its upstream (requesting) neighbor when one of the following conditions occurs:

- It receives any response with a status of ResolveAck

- All downstream neighbors have responded with a status of Unknown

Any Interswitch Resolve request message that is not responded to within a certain predetermined time (currently 5 seconds) is assumed to have a response status of Unknown.

When the Interswitch Resolve server receives a successful Interswitch Resolve response message, it records the resolved address information in the remote cache of its local directory for use in resolving later packets for the same endstation. Note that this process results in each switch building its own unique copy of the virtual directory containing only the endstation addresses in which it is interested.

4.3.5 Unresolvable Server

The Unresolvable server is called when a packet destination address cannot be resolved. The server records the packet in a table that can then be examined to determine which endstations are generating unresolvable traffic.

Also, if a particular destination is repeatedly seen to be unresolvable, the server calls the Block server (Section 4.3.6) to determine whether the address should be blocked.

4.3.6 Block Server

The Resolve Block server is called when a particular destination has been repeatedly seen to be unresolvable. This typically happens when, unknown to the packet source, the destination endstation is either not currently available or no longer exists.

If the Block server determines that the unresolved address has exceeded a configurable request threshold, the address is added to the server's Block Table. Interswitch Resolve request messages for addresses listed in the Block Table are sent less frequently, thereby reducing the amount of Interswitch Resolve traffic throughout the fabric.

If an address listed in the Block Table is later successfully resolved by and Interswitch Resolve request message, the address is removed from the table.

4.4 Policy Service Center

Once the destination address of the call packet has been resolved, the Policy Service Center is called to determine the validity of the requested call connection based on the VLAN policy of the source and destination VLANs.

4.4.1 Unicast Rules Server

The Policy Unicast Rules server recognizes two VLAN policy values: Open or Secure. The default policy for all VLANs is Open.

The policy value is used as follows when determining the validity of a requested call connection:

- If the VLAN policy of either the source or destination cannot be determined, the Filter Service Center is called to establish a filter (i.e., blocked) for the SA/DA pair.

- If the source and destination endstations belong to the same VLAN, then the connection is permitted regardless of the VLAN policy.

- If the source and destination endstations belong to different VLANs, but both VLANs are running with an Open policy, then the connection is permitted, providing cut-through switching between different VLAN(s).

- If the source and destination endstations belong to different VLANs and one or both of the VLANs are running with a Secure policy, then the Flood Service Center (Section 4.8) is called to broadcast the packet to other SFVLAN switches having ports or endstations that belong to the same VLAN as the packet source.

  Note that if any of the VLANs to which the source or destination belong has a Secure policy, then the policy used in the above algorithm is Secure.

4.5 Connect Service Center

Once the Policy Service Center (Section 4.4) has determined that a requested call connection is valid, the Connect Service Center is called to set up the connection. Note that connectivity between two endstations within the fabric is established on a switch-by-switch basis as the call progresses through the fabric toward its destination. No synchronization is needed between switches to establish an end-to-end connection.

The Connect Service Center maintains a Connection Table containing information for all connections currently active on the switch's local ports.

Connections are removed from the Connection Table when one of the endstations is moved to a new switch (Section 4.1.2) or when the Topology Link State server (Section 4.2.3) notifies the Connect Service Center that a network link has failed. Otherwise, connections are not automatically aged out or removed from the Connection Table until a certain percentage threshold (HiMark) of table capacity is reached and resources are needed. At that point, some number of connections (typically 100) are aged out and removed at one time.

4.5.1 Local Server

If the destination endstation resides on the local switch, the Connect Local server establishes a connection between the source and destination ports. Note that if the source and destination both reside on the same physical port, a filter connection is established by calling the Filter Service Center (Section 4.6).

4.5.2 Link State Server

The Connect Link State server is called if the destination endstation of the proposed connection does not reside on the local switch.

The server executes a call to the Path Link State server (Section 4.7.1) which returns up to three "best" paths of equal cost from the local switch to the destination switch. If more than one path is returned, the server chooses a path that provides the best load balancing of user traffic across the fabric.

4.5.3 Directory Server

The Connect Directory server is called if the Connect Link State server is unable to provide a path for some reason.

The server examines the local directory to determine on which switch the destination endstation resides. If the port of access to the destination switch is known, then a connection is established using that port as the outport of the connection.

4.6 Filter Service Center

The Filter Service Center is responsible for establishing filtered connections. This service center is called by the Connect Local server (Section 4.5.1) if the source and destination endstations reside on the same physical port, and by the Policy Service Center (Section 4.4) if the VLAN of either the source or destination is indeterminate.

A filter connection is programmed in the switch hardware with no specified outport. That is, the connection is programmed to discard any traffic for that SA/DA pair.

4.7 Path Service Center

The Path Service Center is responsible for determining the path from a source to a destination.

4.7.1 Link State Server

The Path Link State server is called by the Connect Link State server (Section 4.5.2) to return up to three best paths of equal cost between a source and destination pair of endstations. These best paths are calculated by the Topology Link State server (Section 4.2.3).

The Path Link State server is also called by the Connect Service Center to return a complete source-to-destination path consisting of a list of individual switch port names. A switch port name consists of the switch base MAC address and a port instance relative to the switch.

4.7.2 Spanning Tree Server

The Path Spanning Tree server is called by any server needing to forward an undirected message out over the switch flood path. The server returns a port mask indicating which local ports are currently enabled as outports of the switch flood path. The switch flood path is calculated by the Topology Spanning Tree server (Section 4.2.2).

4.8 Flood Service Center

If the Resolve Service Center (Section 4.3) is unable to resolve the destination address of a packet, it invokes the Flood Service Center to broadcast the unresolved packet.

4.8.1 Tag-Based Flood Server

The Tag-Based Flood server encapsulates the unresolved packet into an Interswitch Tag-Based Flood message (Section 6.6), along with a list of Virtual LAN identifiers specifying those VLANs to which the source endstation belongs. The message is then sent out over the switch flood path to all other switches in the fabric.

When a switch receives an Interswitch Tag-Based Flood message, it examines the encapsulated header to determine the VLAN(s) to which the packet should be sent. If any of the switch's local access ports belong to one or more of the specified VLANs, the switch strips off the tag-based header and forwards the original packet out the appropriate access port(s).

The switch also forwards the entire encapsulated packet along the switch flood path to its downstream neighboring switches, if any.

5. Monitoring Call Connections

The SecureFast VLAN product permits monitoring of user traffic moving between two endstations by establishing a call tap on the connection between the two stations. Traffic can be monitored in one or both directions along the connection path.

5.1 Definitions

In addition to the terms defined in Section 1.2, the following terms are used in this description of the call tap process.

Originating Switch

The originating switch is the switch that requests the call tap. Any switch along a call connection path may request a tap on that call connection.

Probe

The tap probe is the device to receive a copy of the call connection data. The probe is attached to a port on the probe switch.

Probe Switch

The probe switch (also known as the terminating switch) is the switch to which the probe is attached. The probe switch can be anywhere in the topology.

5.2 Tapping a Connection

A request to tap a call connection between two endstations can originate on any switch along the call connection path -- the ingress switch, the egress switch, or any of the intermediate switches. The call connection must have already been established before a call tap request can be issued. The probe device can be attached to any switch in the topology.

5.2.1 Types of Tap Connections

A call tap is enabled by setting up an auxiliary tap connection associated with the call being monitored. Since the tap must originate on a switch somewhere along the call connection path, the tap connection path will pass through one or more of the switches along the call path. However, since the probe switch can be anywhere in the switch fabric, the tap path and the call path may diverge at some point.

Therefore, on each switch along the tap path, the tap connection is established in one of three ways:

- The existing call connection is used with no modification.

  When both the call path and tap path pass through the switch, and the inport and outports of both connections are identical, the switch uses the existing call connection to route the tap.

- The existing call connection is modified.

When both the call path and tap path pass through the switch, but the call path outport is different from the tap path outport, the switch enables an extra outport in either one or both directions of the call connection, depending on the direction of the tap. This happens under two conditions.

- If the switch is also the probe switch, an extra outport is enabled to the probe.

- If the switch is the point at which the call path and the tap path diverge, an extra outport is enabled to the downstream neighbor on that leg of the switch flood path on which the probe switch is located.

- A new connection is established.

  If the call path does not pass through the switch (because the tap path has diverged from the call path), a completely new connection is established for the tap.

5.2.2 Locating the Probe and Establishing the Tap Connection

To establish a call tap, the originating switch formats an Interswitch Tap request message (Section 6.7) and sends it out over the switch flood path to all other switches in the topology.

Note:

If the originating switch is also the probe switch, no Interswitch Tap request message is necessary.

As the Interswitch Tap request message travels out along the switch flood path, each switch receiving the message checks to see if it is the probe switch and does the following:

- If the switch is the probe switch, it establishes the tap connection by either setting up a new connection or modifying the call connection, as appropriate (see Section 5.2.1). It then reformats the Tap request message to be a Tap response message with a status indicating that the probe has been found, and sends the message back to its upstream neighbor.

- If the switch is not the probe switch, it forwards the Tap request message to all its downstream neighbors (if any).

- If the switch is not the probe switch and has no downstream neighbors, it reformats the Tap request message to be a Tap response message with a status indicating that the probe is not

located on that leg of the switch flood path. It then sends the response message back to its upstream neighbor.

When a switch forwards an Interswitch Tap request message to its downstream neighbors, it keeps track of the number of requests it has sent out.

- If a response is received with a status indicating that the probe switch is located somewhere downstream, the switch establishes the appropriate type of tap connection (see Section 5.2.1). It then formats a Tap response message with a status indicating that the probe has been found and passes the message to its upstream neighbor.

- If no responses are received with a status indicating that the probe switch is located downstream, the switch formats a Tap response message with a status indicating that the probe has not been found and passes the message to its upstream neighbor.

5.2.3 Status Field

The status field of the Interswitch Tap request/response message contains information about the state of the tap. Some of these status values are transient and are merely used to track the progress of the tap request. Other status values are stored in the tap table of each switch along the tap path for use when the tap is torn down. The possible status values are as follows:

- StatusUnassigned. This is the initial status of the Interswitch Tap request message.

- OutportDecisionUnknown. The tap request is still moving downstream along the switch flood path. The probe switch had not yet been found.

- ProbeNotFound. The probe switch is not located on this leg of the switch flood path.

- DisableOutport. The probe switch is located on this leg of the switch flood path, and the switch has had to either modify the call connection or establish a new connection to implement the tap (see Section 5.2.1). When the tap is torn down, the switch will have to disable any additional outports that have been enabled for the tap.

- KeepOutport. The probe switch is located on this leg of the switch flood path, and the switch was able to route the tap over the existing call path (see Section 5.2.1). Any ports used for

the tap will remain enabled when the tap is torn down.

5.3 Untapping a Connection

A request to untap a call connection must be issued on the tap originating switch -- that is, the same switch that issued the tap request.

To untap a call connection, the originating switch sends an Interswitch Untap request message (Section 6.7) out over the switch flood path to all other switches in the topology. The message is sent over the switch flood path, rather than the tap connection path, to ensure that all switches that know of the tap are properly notified, even if the switch topology has changed since the tap was established.

When a switch receives an Interswitch Untap request message, it checks to see if it is handling a tap for the specified call connection. If so, the switch disables the tap connection, as follows:

- If a new connection was added for the tap, the connection is deleted from the connection table.

- If additional outports were enabled on the call connection, they are disabled.

The switch then forwards the Interswitch Untap request message to its downstream neighbor (if any). If the switch has no downstream neighbors, it formats an untap response and sends the message back to its upstream neighbor.

When a switch forwards an Interswitch Untap request message to its downstream neighbors, it keeps track of the number of requests it has sent out and does not respond back to its upstream neighbor until all untap requests have been responded to. Once all responses have been received, the switch handles any final cleanup for the tap and then sends a single Interswitch Untap response message to its upstream neighbor.

6. Interswitch Message Protocol (ISMP)

The InterSwitch Message protocol (ISMP) provides a consistent method of encapsulating and transmitting messages exchanged between switches to create and maintain the databases and provide other control services and functionality required by the SFVLAN product.

6.1 General Packet Structure

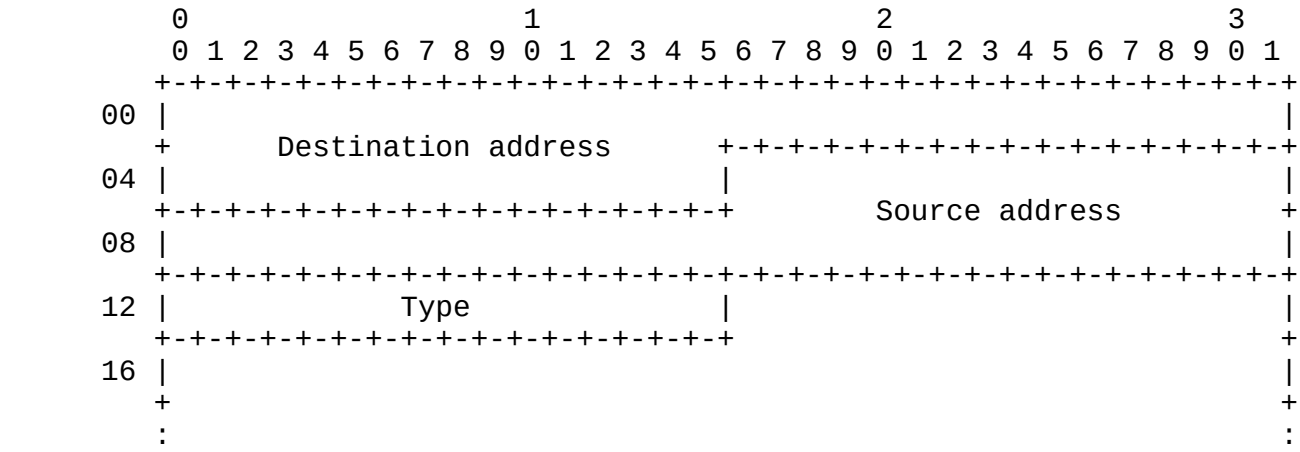
ISMP packets are of variable length and have the following general structure:

- Frame header
- ISMP packet header
- ISMP message body

Each of these packet segments is discussed separately in the following subsections.

6.1.1 Frame Header

ISMP packets are encapsulated within an IEEE 802-compliant frame using a standard header as shown below:



Destination address

This 6-octet field contains the Media Access Control (MAC) address of the multicast channel over which all switches in the fabric receive ISMP packets. Except where otherwise noted, this field

contains the multicast address of the control channel over which all switches in the fabric receive ISMP packets -- a value of 01-00-1D-00-00-00.

Source address

Except where otherwise noted, this 6-octet field contains the physical (MAC) address of the switch originating the ISMP packet.

Type

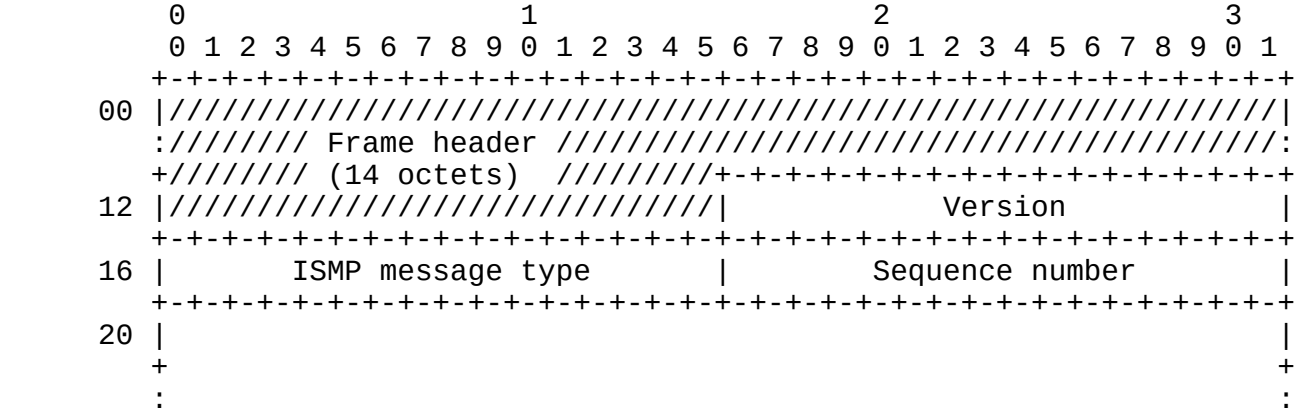
This 2-octet field identifies the type of data carried within the frame. Except where otherwise noted, the type field of ISMP packets contains the value 0x81FD.

6.1.2 ISMP Packet Header

There are two versions of the ISMP packet header in use by the SecureFast VLAN product.

6.1.2.1 Version 2

The version 2 ISMP packet header consists of 6 octets, as shown below:



Frame header

This 14-octet field contains the frame header (Section 6.1.1).

Version

This 2-octet field contains the version number of the InterSwitch Message Protocol to which this ISMP packet adheres. This document describes ISMP Version 2.0.

ISMP message type

This 2-octet field contains a value indicating which type of ISMP message is contained within the message body. The following table lists each ISMP message, along with its message type and the section within this document that describes the message in detail:

Message Name	Type	Description
Interswitch Link State message	3	See note below
Interswitch BPDU message	4	Section 6.2
Interswitch Remote Blocking message	4	Section 6.3
Interswitch Resolve message	5	Section 6.4
Interswitch New User message	5	Section 6.5
Interswitch Tag-Based Flood message	7	Section 6.6
Interswitch Tap/Untap message	8	Section 6.7

Note:

The Link State messages used by the VLS Protocol are not described in this document. For a detailed description of these messages, see [IDvlsp].

Sequence number

This 2-octet field contains an internally generated sequence number used by the various protocol handlers for internal synchronization of messages.

6.1.2.2 Version 3

The version 3 ISMP packet header is used only by the Interswitch Keepalive message. That message is not described in this document. For a detailed description of the version 3 ISMP packet header, see [IDhello].

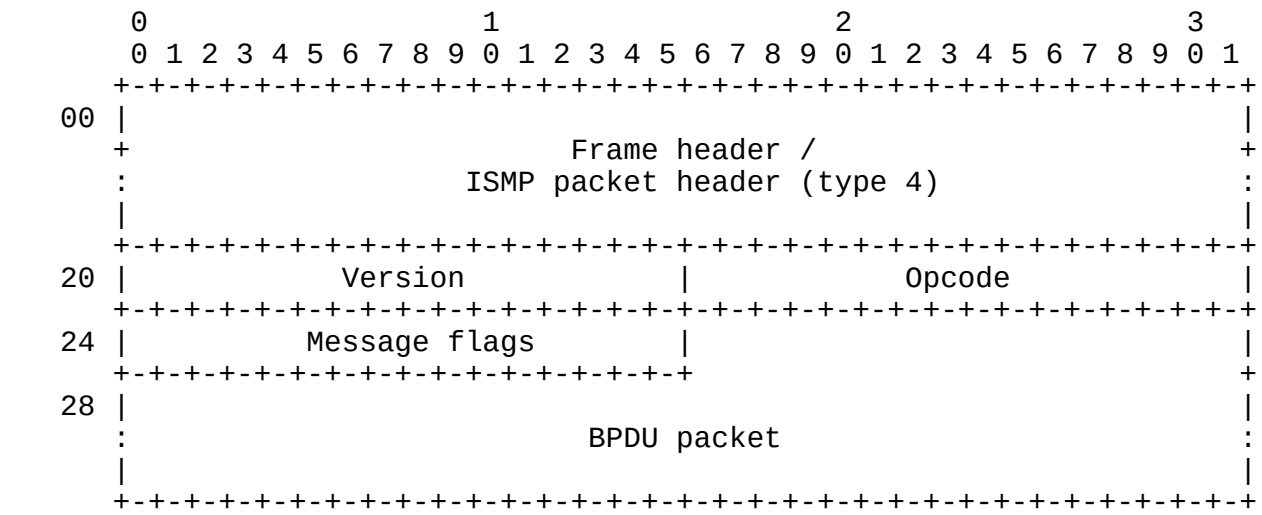
6.1.3 ISMP Message Body

The ISMP message body is a variable-length field containing the actual data of the ISMP message. The length and content of this field are determined by the value found in the message type field.

See the following sections for the exact format of each message type.

6.2 Interswitch BPDU Message

The Interswitch BPDU message consists of a variable number of octets, as shown below:



Frame header/ISMP packet header

This 20-octet field contains the frame header and the ISMP packet header.

Version

This 2-octet field contains the version number of the message type. This document describes ISMP message type 4, version 1.

Opcode

This 2-octet field contains the operation type of the message. For an Interswitch BPDU message, the value should be 1.

Message flags

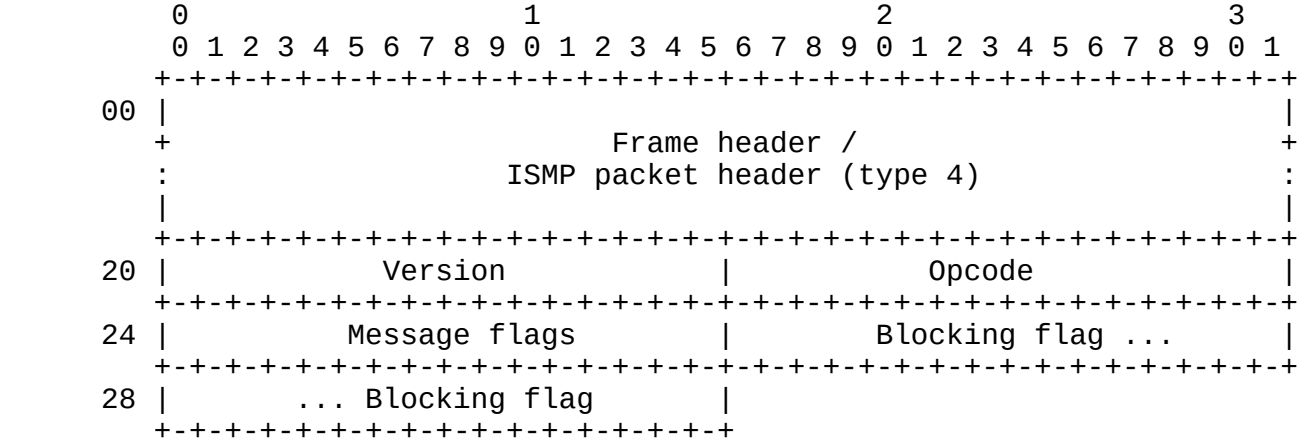
This 2-octet field is currently unused. It is reserved for future use.

BPDU packet

This variable-length field contains an IEEE-compliant 802.2 Bridge Protocol Data Unit. See [IEEE] for a detailed description of the contents of this field.

6.3 Interswitch Remote Blocking Message

The Interswitch Remote Blocking message consists of 30 octets, as shown below:



Frame header/ISMP packet header

This 20-octet field contains the frame header and the ISMP packet header.

Version

This 2-octet field contains the version number of the message type. This document describes ISMP message type 4, version 1.

Opcode

This 2-octet field contains the operation type of the message. Valid values are as follows:

2 Enable/disable remote blocking
3 Acknowledge previously received Remote Blocking message

Message flags

This 2-octet field is currently unused. It is reserved for future use.

Blocking flag

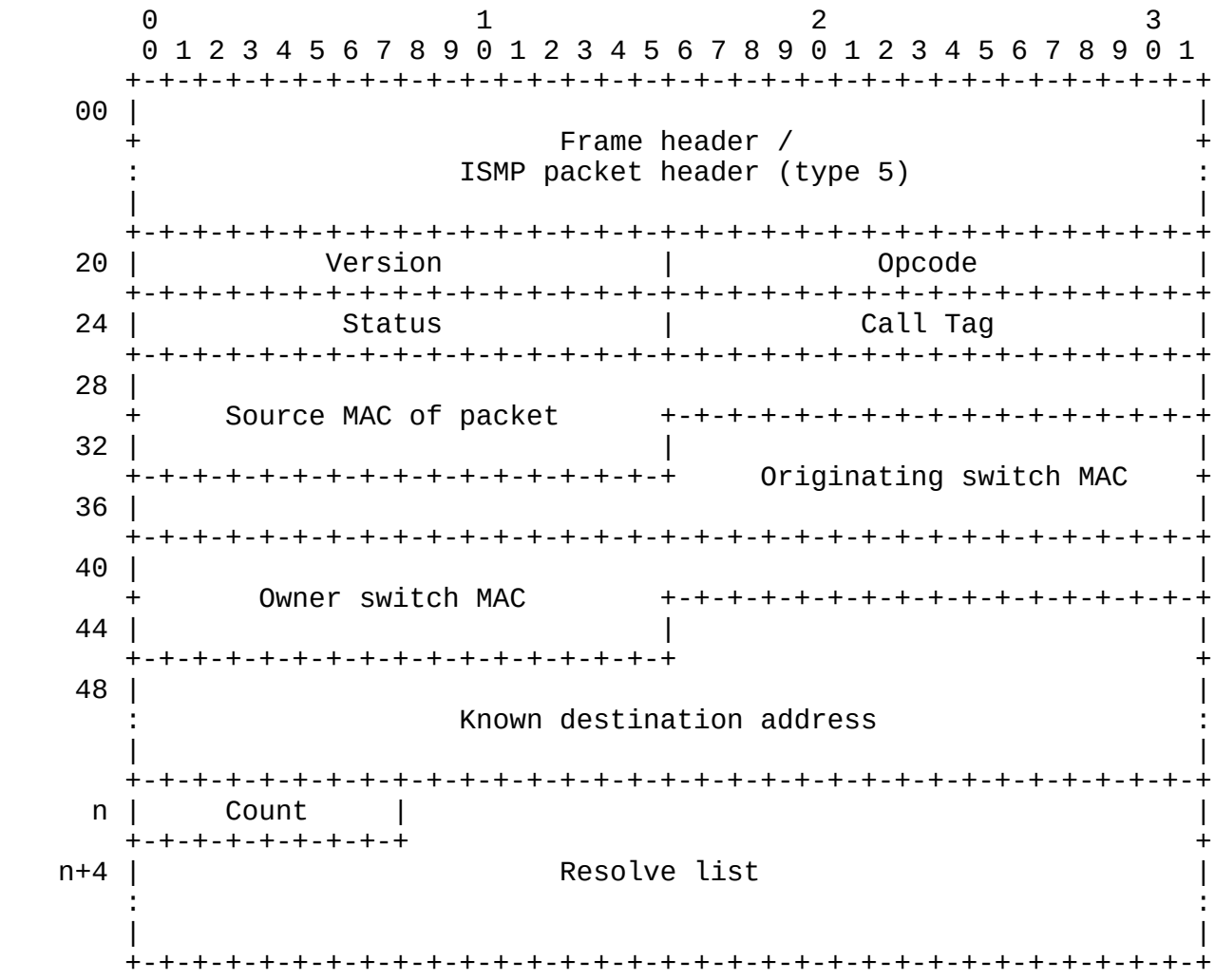
This 4-octet field contains a flag indicating the state of remote blocking on the link over which the message was received. A value of 1 indicates remote blocking is on and no undirected ISMP messages should be sent over the link. A value of 0 indicates remote blocking is off. This flag is irrelevant if the operation type (Opcode) of the message has a value of 3.

6.4 Interswitch Resolve Message

There are two versions of the Interswitch Resolve message used by the SecureFast VLAN product.

6.4.1 Prior to Version 1.8

The Interswitch Resolve message used by SFVLAN prior to version 1.8 consists of a variable number of octets, as shown below:



n = 46 + length of known address TLV

In the following description of the message fields, the term "originating" switch refers to the switch that issued the original Interswitch Resolve request. The term "owner" switch refers to that switch to which the destination endstation is attached. And the term "responding" switch refers to either the "owner" switch or to a switch at the end of the switch flood path that does not own the endstation but issues an Interswitch Resolve response because it has no downstream neighbors.

With the exception of the resolve list (which has a different size and format in a Resolve response message), all fields of an Interswitch Resolve message are allocated by the originating switch, and unless otherwise noted below, are written by the originating switch.

Frame header/ISMP packet header

This 20-octet field contains the frame header and the ISMP packet header.

Version

This 2-octet field contains the version number of the message type. This document describes ISMP message type 5, version 1.

Opcode

This 2-octet field contains the operation code of the message. Valid values are as follows:

1 The message is a Resolve request.
2 The message is a Resolve response.
3 (unused in Resolve messages)
4 (unused in Resolve messages)

The originating switch writes a value of 1 to this field, while the responding switch writes a value of 2.

Status

This 2-octet field contains the status of a Resolve response message. Valid values are as follows:

0 The Resolve request succeeded (ResolveAck).
1 (unused)
2 The Resolve request failed (Unknown).

This field is written by the responding switch.

Call tag

This 2-octet field contains the call tag of the endstation packet for which this Resolve request is issued. The call tag is a 16-bit value (generated by the originating switch) that uniquely identifies the packet.

Source MAC of packet

This 6-octet field contains the physical (MAC) address of the endstation that originated the packet identified by the call tag.

Originating switch MAC

This 6-octet field contains the physical (MAC) address of the switch that issued the original Resolve request.

Owner switch MAC

This 6-octet field contains the physical (MAC) address of the switch to which the destination endstation is attached -- that is, the switch that was able to resolve the requested addressing information. This field is written by the owner switch.

If the status of the response is Unknown, this field is irrelevant.

Known destination address

This variable-length field contains the known attribute of the destination endstation address. This address is stored in Tag/Length/Value format. (See Section 2.3.)

Count

This 1-octet field contains the number of address attributes requested or returned. This is the number of items in the resolve list.

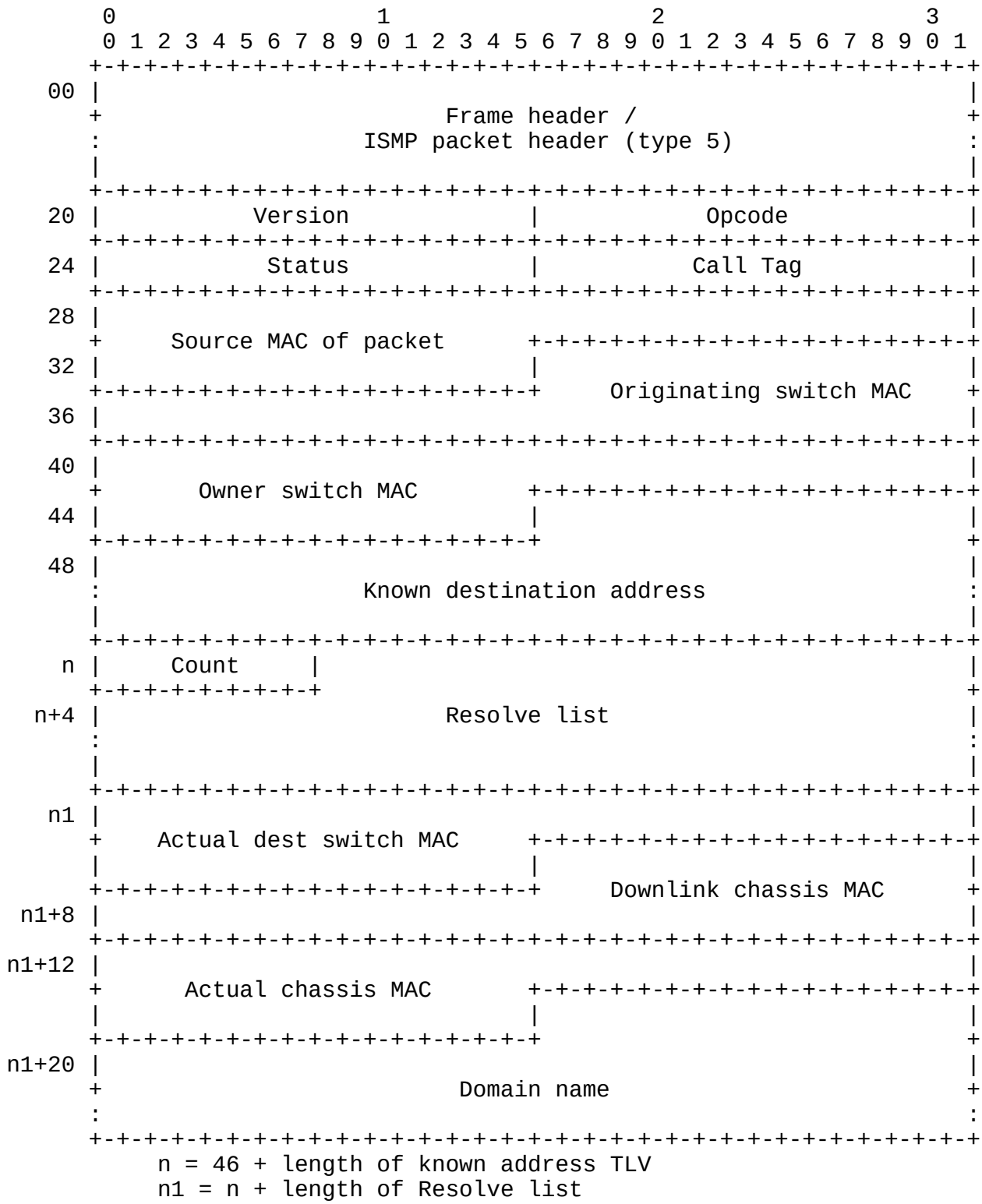
Resolve list

This variable-length field contains a list of the address attributes either requested by the originating switch or returned by the owner switch. Note that in a Resolve request message, this list contains only the tags of the requested address attributes (see Section 2.3). On the other hand, a Resolve response message with a status of ResolveAck contains the full TLV of each resolved address attribute. The number of entries in the list is specified in the count field.

In an Interswitch Resolve response message, this field is irrelevant if the status of the response is Unknown.

6.4.2 Version 1.8

The Interswitch Resolve message used by SFVLAN version 1.8 consists of a variable number of octets, as shown below:


0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
00
Frame header /
ISMP packet header (type 5)
20
Version
Opcode
24
Status
Call Tag
28
Source MAC of packet
32
Originating switch MAC
36
40
Owner switch MAC
44
48
Known destination address
n
Count
n+4
Resolve list
n1
Actual dest switch MAC
Downlink chassis MAC
n1+8
n1+12
Actual chassis MAC
n1+20
Domain name
n = 46 + length of known address TLV
n1 = n + length of Resolve list

In the following description of the message fields, the term "originating" switch refers to the switch that issued the original Interswitch Resolve request. The term "owner" switch refers to that switch to which the destination endstation is attached. And the term "responding" switch refers to either the "owner" switch or to a switch at the end of the switch flood path that does not own the endstation but issues an Interswitch Resolve response because it has no downstream neighbors.

With the exception of the resolve list (which has a different size and format in a Resolve response message) and the four fields following the resolve list, all fields of an Interswitch Resolve message are allocated by the originating switch, and unless otherwise noted below, are written by the originating switch.

Frame header/ISMP packet header

This 20-octet field contains the frame header and the ISMP packet header.

Version

This 2-octet field contains the version number of the message type. This section describes version 3 of the Interswitch Resolve message.

Opcode

This 2-octet field contains the operation code of the message. Valid values are as follows:

1 The message is a Resolve request.
2 The message is a Resolve response.
3 (unused in Resolve messages)
4 (unused in Resolve messages)

The originating switch writes a value of 1 to this field, while the responding switch writes a value of 2.

Status

This 2-octet field contains the status of a Resolve response message. Valid values are as follows:

0 The Resolve request succeeded (ResolveAck).
1 (unused)
2 The Resolve request failed (Unknown).

This field is written by the responding switch.

Call tag

This 2-octet field contains the call tag of the endstation packet for which this Resolve request is issued. The call tag is a 16-bit value (generated by the originating switch) that uniquely identifies the packet.

Source MAC of packet

This 6-octet field contains the physical (MAC) address of the endstation that originated the packet identified by the call tag.

Originating switch MAC

This 6-octet field contains the physical (MAC) address of the switch that issued the original Resolve request.

Owner switch MAC

This 6-octet field contains the physical (MAC) address of the switch to which the destination endstation is attached -- that is, the switch that was able to resolve the requested addressing information. This field is written by the owner switch.

If the status of the response is Unknown, this field is irrelevant.

Known destination address

This variable-length field contains the known attribute of the destination endstation address. This address is stored in Tag/Length/Value format.

Count

This 1-octet field contains the number of address attributes requested or returned. This is the number of items in the resolve list.

Resolve list

This variable-length field contains a list of the address attributes either requested by the originating switch or returned by the owner switch. Note that in a Resolve request message, this list contains only the tags of the requested address attributes. On the other hand, a Resolve response message with a status of ResolveAck contains the full TLV of each resolved address attribute. The number of entries in the list is specified in the count field.

In an Interswitch Resolve response message, this field is irrelevant if the status of the response is Unknown.

Actual destination switch MAC

This 6-octet field contains the physical (MAC) address of the actual switch within the chassis to which the endstation is attached. If the status of the response is Unknown, this field is irrelevant.

Downlink chassis MAC

This 6-octet field contains the physical (MAC) address of the downlink chassis. If the status of the response is Unknown, this field is irrelevant.

Actual chassis MAC

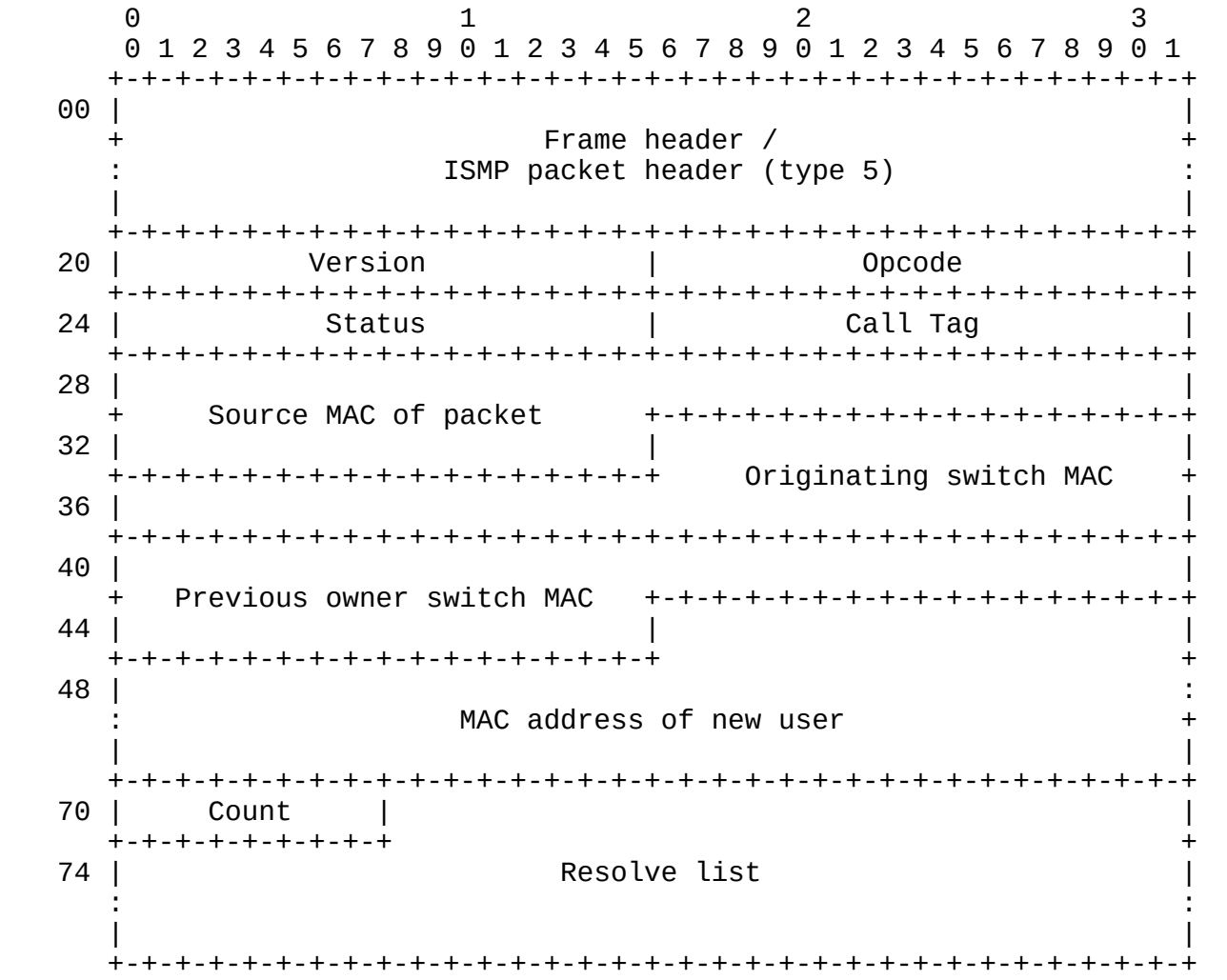
This 6-octet field contains the physical (MAC) address of the uplink chassis. If the status of the response is Unknown, this field is irrelevant.

Domain name

This 16-octet field contains the ASCII name of the domain. If the status of the response is Unknown, this field is irrelevant.

6.5 Interswitch New User Message

The Interswitch New User message consists of a variable number of octets, as shown below:



In the following description of the message fields, the term "originating" switch refers to the switch that issued the original Interswitch New User request. The term "previous owner" switch refers to that switch to which the endstation was previously attached. And the term "responding" switch refers to either the "previous owner" switch or to a switch at the end of the switch flood path that did not own the endstation but issues an Interswitch New User response because it has no downstream neighbors.

With the exception of the resolve list, all fields of an Interswitch New User message are allocated by the originating switch, and unless otherwise noted below, are written by the originating switch.

Frame header/ISMP packet header

This 20-octet field contains the frame header and the ISMP packet header.

Version

This 2-octet field contains the version number of the message type. This document describes ISMP message type 5, version 1.

Opcode

This 2-octet field contains the operation code of the message. Valid values are as follows:

1	(unused in a New User message)
2	(unused in a New User message)
3	The message is a New User request.
4	The message is a New User response.

The originating switch writes a value of 3 to this field, while the responding switch writes a value of 4.

Status

This 2-octet field contains the status of a New User response message. Valid values are as follows:

0	VLAN resolution successful (NewUserAck)
1	(unused)
2	VLAN resolution unsuccessful (NewUserUnknown)

This field is written by the responding switch.

Call tag

This 2-octet field contains the call tag of the endstation packet for which this New User request is issued. The call tag is a 16-bit value (generated by the originating switch) that uniquely identifies the packet that caused the switch to identify the endstation as a new user.

Source MAC of packet

This 6-octet field contains the physical (MAC) address of the endstation that originated the packet identified by the call tag.

Originating switch MAC

This 6-octet field contains the physical (MAC) address of the switch that issued the original New User request.

Previous owner switch MAC

This 6-octet field contains the physical (MAC) address of the switch to which the endstation was previously attached -- that is, the switch that was able to resolve the VLAN information. This field is written by the previous owner switch.

If the status of the response is Unknown, this field is irrelevant.

MAC address of new user

This 24-octet field contains the physical (MAC) address of the new user endstation, stored in Tag/Length/Value format.

Count

This 1-octet field contains the number of VLAN identifiers returned. This is the number of items in the resolve list. This field is written by the previous owner switch.

If the status of the response is Unknown, this field and the resolve list are irrelevant.

Resolve list

This variable-length field contains a list of the VLAN identifiers of all static VLANs to which the endstation belongs, stored in Tag/Length/Value format (see Section 2.3). The number of entries in the list is specified in the count field. This list is written by the previous owner switch.

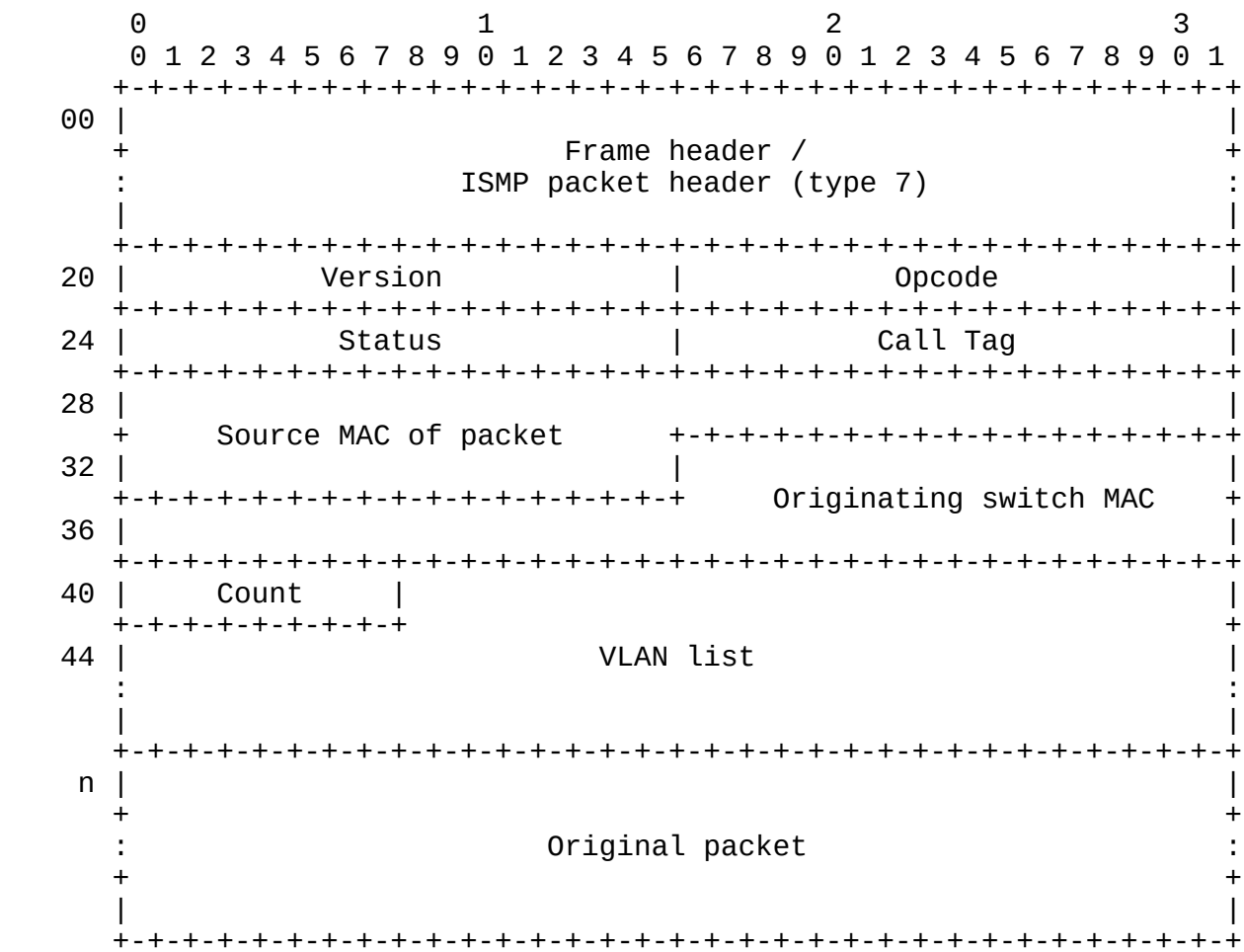
If the status of the response is Unknown, this field is irrelevant.

6.6 Interswitch Tag-Based Flood Message

There are two versions of the Interswitch Tag-Based Flood message used by the SecureFast VLAN product.

6.6.1 Prior to Version 1.8

The Interswitch Tag-Based Flood message used by SFVLAN prior to version 1.8 consists of a variable number of octets, as shown below:



n = 41 + length of VLAN list

Frame header/ISMP packet header

This 20-octet field contains the frame header and the ISMP packet header.

Version

This 2-octet field contains the version number of the message type. This document describes ISMP message type 7, version 1.

Opcode

This 2-octet field contains the operation code of the message. The value here should be 1, indicating the message is a flood request.

Status

This 2-octet field is currently unused. It is reserved for future use.

Call tag

This 2-octet field contains the call tag of the endstation packet encapsulated within this tag-based flood message. The call tag is a 16-bit value (generated by the originating switch) that uniquely identifies the packet.

Source MAC of packet

This 6-octet field contains the physical (MAC) address of the endstation that originated the packet identified by the call tag.

Originating switch MAC

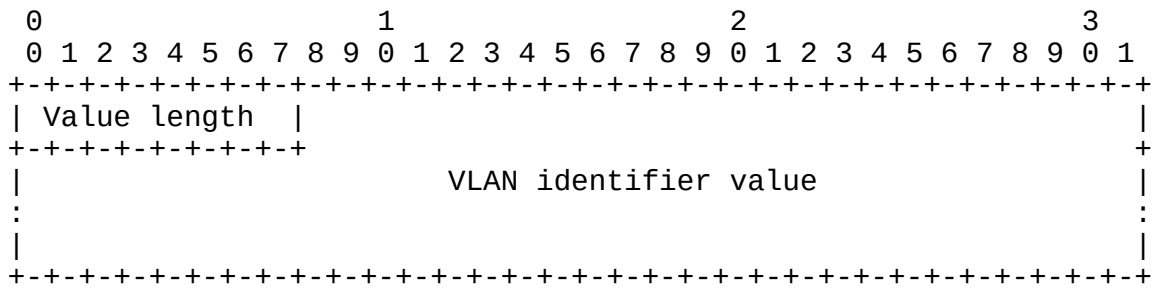
This 6-octet field contains the physical (MAC) address of the switch that issued the original tag-based flooded message.

Count

This 1-octet field contains the number of VLAN identifiers included in the VLAN list.

VLAN list

This variable-length field contains a list of the VLAN identifiers of all VLANs to which the source endstation belongs. Each entry in this list has the following format:



The 1-octet value length field contains the length of the VLAN identifier. VLAN identifiers can be from 1 to 16 characters long.

Original packet

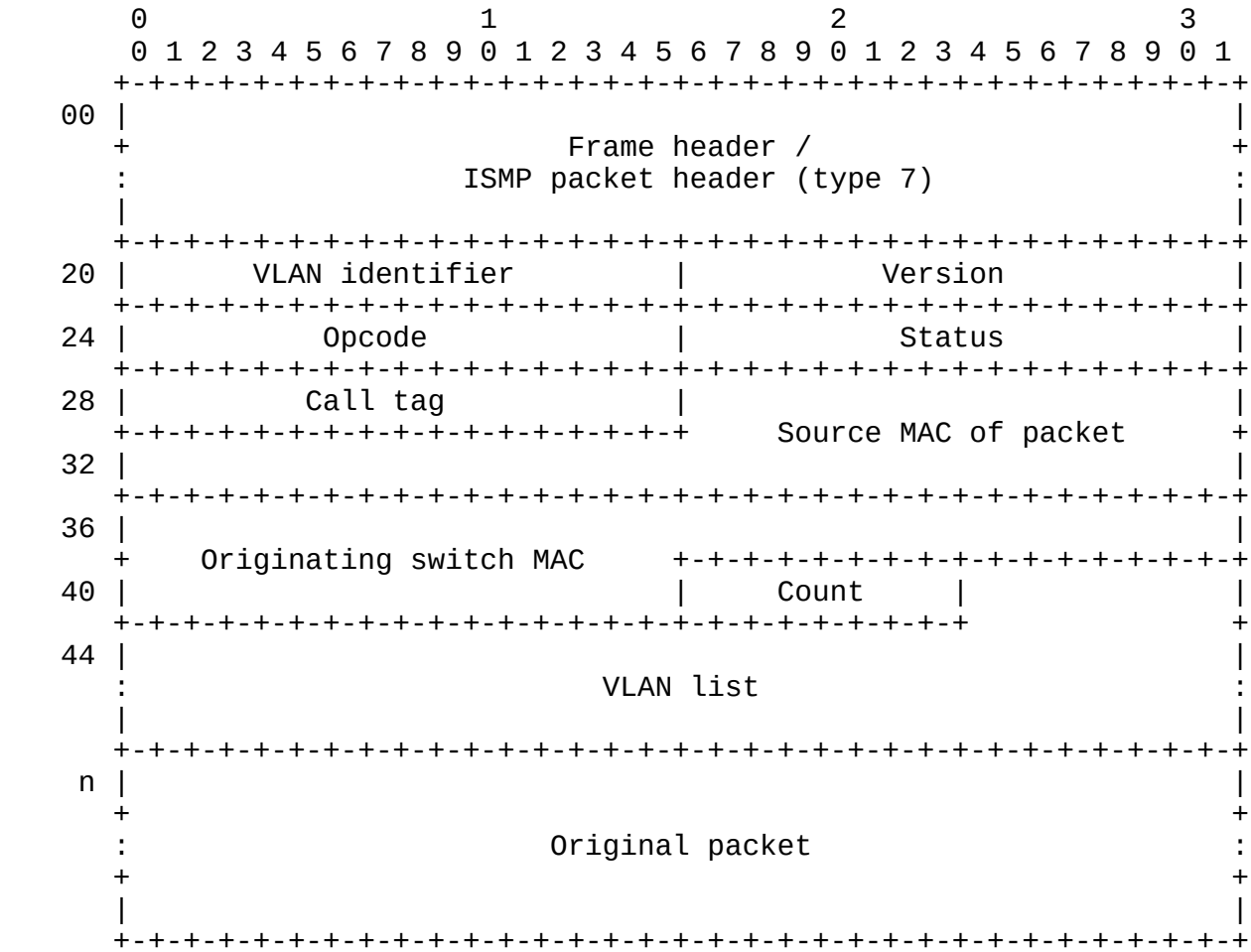
This variable-length field contains the original packet as sent by the source endstation.

6.6.2 Version 1.8

The Interswitch Tag-Based Flood message used by SFVLAN version 1.8 consists of a variable number of octets, as shown below:

Note:

SFVLAN version 1.8 also recognizes the Interswitch Tag-Based Flood message as described in Section 6.6.1.



n = 41 + length of VLAN list

Frame header/ISMP packet header

This 20-octet field contains the frame header and the ISMP packet header.

- The frame header source address contains a value of 02-00-1D-00-xx-yy, where xx-yy is a value set by the VLAN Manager application to tag the frame header with the VLAN identifier. This value ranges from 2 to 4095. For example, a value of 100 would be set as 00-64.

- The frame header type field contains a value of 0x81FF. Note that this differs from all other ISMP messages.

VLAN identifier

This 2-octet field contains the VLAN identifier of the packet source.

Version

This 2-octet field contains the version number of the message type. This section describes version 2 of the Interswitch Tag-Based Flood message.

Opcode

This 2-octet field contains the operation code of the message. Valid values here are as follows:

1 The message is a flood request. The original packet is complete within this message.

2 The message is a fragmented flood request. The first portion of the original packet is contained in this message.

3 The message is a fragmented flood request. The second portion of the original packet is contained in this message.

Status

This 2-octet field is currently unused. It is reserved for future use.

Call tag

This 2-octet field contains the call tag of the endstation packet encapsulated within this tag-based flood message. The call tag is a 16-bit value (generated by the originating switch) that uniquely identifies the packet.

Source MAC of packet

This 6-octet field contains the physical (MAC) address of the endstation that originated the packet identified by the call tag.

Originating switch MAC

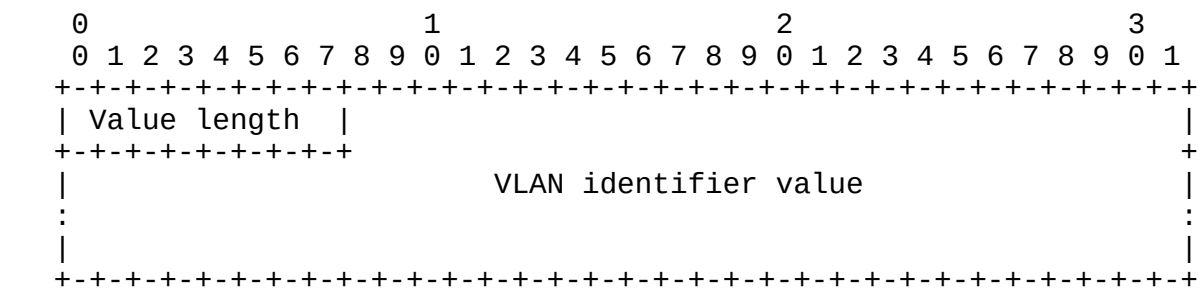
This 6-octet field contains the physical (MAC) address of the switch that issued the original tag-based flooded message.

Count

This 1-octet field contains the number of VLAN identifiers included in the VLAN list.

VLAN list

This variable-length field contains a list of the VLAN identifiers of all VLANs to which the source endstation belongs. Each entry in this list has the following format:



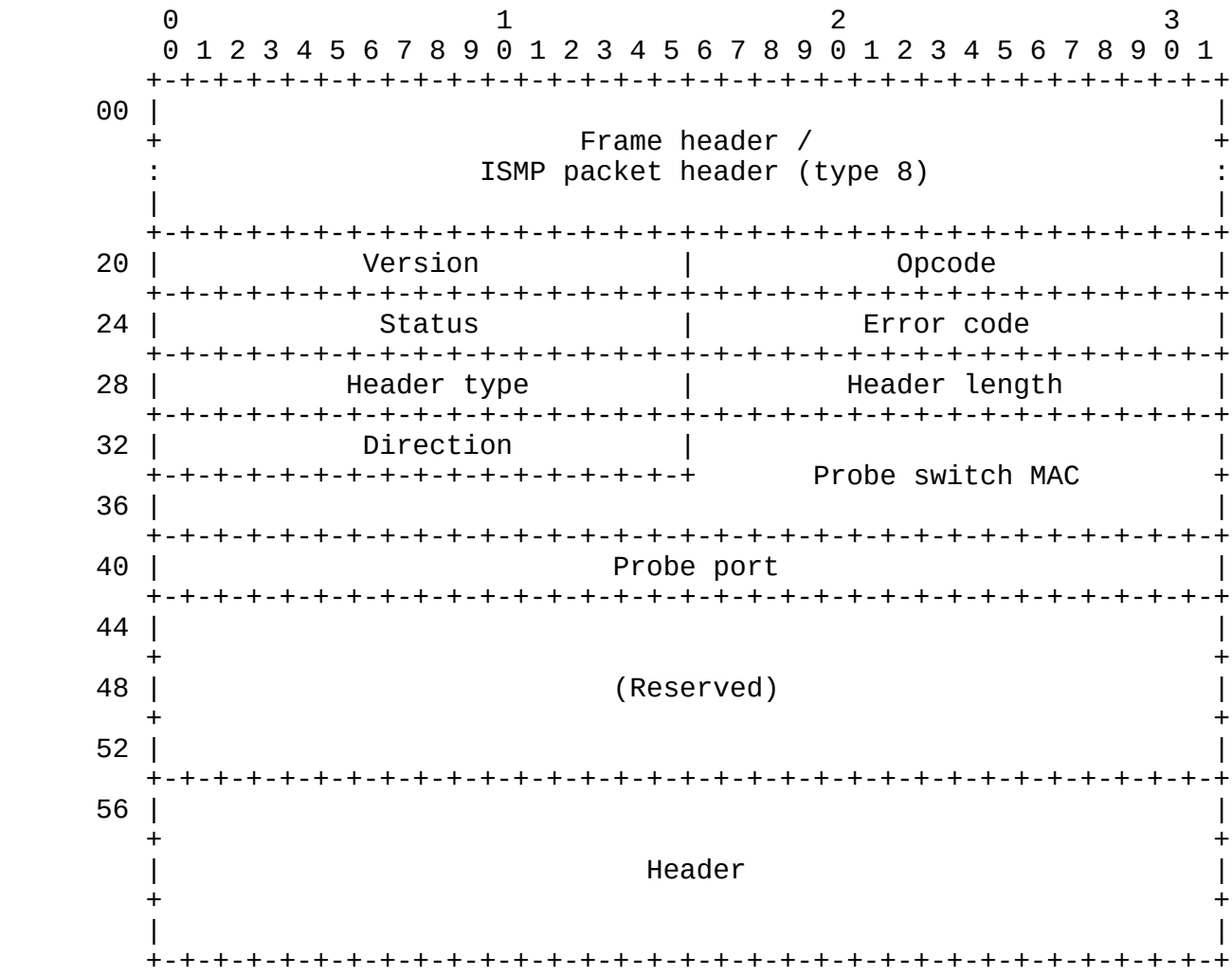
The 1-octet value length field contains the length of the VLAN identifier. VLAN identifiers can be from 1 to 16 characters long.

Original packet

This variable-length field contains the original packet as sent by the source endstation.

6.7 Interswitch Tap/Untap Message

The Interswitch Tap/Untap message consists of a variable number of octets, as shown below:



Frame header/ISMP packet header

This 20-octet field contains the frame header and the ISMP packet header.

Version

This 2-octet field contains the version number of the message type. This document describes ISMP message type 8, version 1.

Opcode

tet field contains the operation type of the message. ues are as follows:

1 The message is a Tap request.
2 The message is a Tap response.
3 The message is an Untap request.
4 The message is an Untap response.

Status

This 2-octet field contains the current status of the tap request. Valid values are as follows:

1 Switch must disable outport on untap. (DisableOutport)
2 Switch must keep outports on untap. (KeepOutport)
3 Probe not found this leg of spanning tree. (ProbeNotFound)
4 Still searching for probe switch. (OutportDecisionUnknown)
5 Unassigned. (StatusUnassigned)
6 (reserved)
7 (reserved)
8 (reserved)
9 (reserved)

See Section 5.2.3 for details on the use of this field.

Error code

This 2-octet field contains the response message error code of the requested operation. Valid values are as follows:

1 Operation successful. (NoError)
2 No response heard from downstream neighbor. (Timeout)
3 Port does not exist on probe switch. (BadPort)
4 Message invalid. (InvalidMessage)
5 Version number invalid. (IncompatibleVersions)

Header type

This 2-octet field contains the type of information contained in the header field. Currently, valid values are as follows:

1 (reserved) 2 Header contains destination and source endstation MAC addresses.

Header length

This 2-octet field contains the length of the header field. Currently, this field always contains a value of 12.

Direction

This 2-octet field contains a value indicating the type of tap. Valid values are as follows:

1 (reserved)
2 Tap is bi-directional and data should be captured flowing in either direction over the connection.
3 Tap is uni-directional and data should be captured only when it flows from the source to the destination.

Probe switch MAC

This 6-octet field contains the physical (MAC) address of the switch to which the probe is attached.

Probe port

This 4-octet field contains the logical port number (on the probe switch) to which the probe is attached.

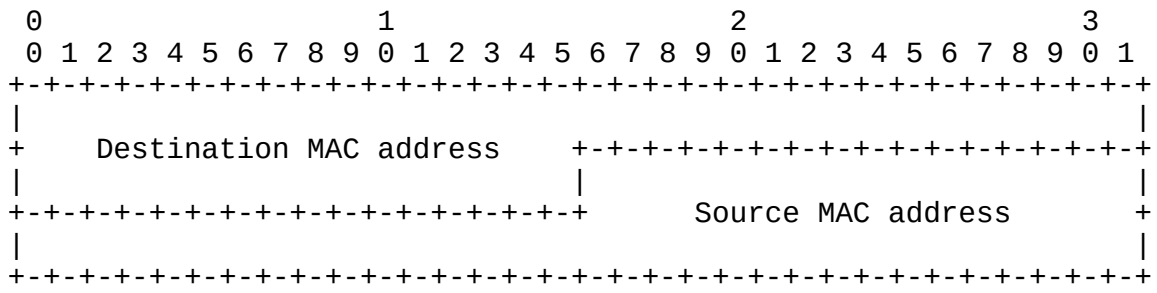
Reserved

These 12 octets are reserved.

Header

This variable-length field contains the header that identifies the connection being tapped. The length of the header is stored in the length field.

Currently, this field is 12 octets long and contains the 6-octet physical address of the connection's destination endstation, followed by the 6-octet physical address of the connection's source endstation, as shown below:



7. Security Considerations

Requested call connections are established or denied based on the VLAN policy of the source and destination addresses specified within the packet. Section 4.4.1 discusses this process in detail.

8. References

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[IEEE] "IEEE Standard 802.1d -- 1990"

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