             Ipsilon's General Switch Management Protocol Specification
                                   Version 2.0

Status of this Memo

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Abstract

   This memo specifies enhancements to the General Switch Management
   Protocol (GSMP) [RFC1987]. The major enhancement is the addition of
   Quality of Service (QoS) messages. Other improvements have been made
   to the protocol resulting from operational experience. GSMP is a
   general purpose protocol to control an ATM switch. It allows a
   controller to establish and release connections across the switch;
   add and delete leaves on a multicast connection; manage switch ports;
   request configuration information; and request statistics.

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1. Introduction

    The General Switch Management Protocol (GSMP), is a general purpose
    protocol to control an ATM switch. GSMP allows a controller to
    establish and release connections across the switch; add and delete
    leaves on a multicast connection; manage switch ports; request
    configuration information; and request statistics. It also allows the
    switch to inform the controller of asynchronous events such as a link
    going down. GSMP runs across an ATM link connecting the controller to
    the switch, on a control connection (virtual channel) established at
    initialization. GSMP operation across an Ethernet link is also
    specified. The GSMP protocol is asymmetric, the controller being the
    master and the switch being the slave. Multiple switches may be
    controlled by a single controller using multiple instantiations of
    the protocol over separate control connections.

    A switch is assumed to contain multiple "ports". Each port is a
    combination of one "input port" and one "output port". Some GSMP
    requests refer to the port as a whole whereas other requests are
    specific to the input port or the output port. ATM cells arrive at
    the switch from an external communication link on incoming virtual
    paths or virtual channels at an input port. ATM cells depart from the
    switch to an external communication link on outgoing virtual paths or
    virtual channels from an output port. Virtual paths on a port or link
    are referenced by their virtual path identifier (VPI). Virtual
    channels on a port or link are referenced by their virtual path and
    virtual channel identifiers (VPI/VCI).

A virtual channel connection across a switch is formed by connecting
an incoming virtual channel to one or more outgoing virtual channels.
Virtual channel connections are referenced by the input port on which
they arrive and the virtual path and virtual channel identifiers
(VPI/VCI) of their incoming virtual channel. A virtual path
connection across a switch is formed by connecting an incoming
virtual path to one or more outgoing virtual paths. Virtual path
connections are referenced by the input port on which they arrive and
their virtual path identifier (VPI). In a virtual path connection
the value of the VCI in each cell on that, connection is not used by
the switch and remains unchanged by the switch.

GSMP supports point-to-point and point-to-multipoint connections. A
multipoint-to-point connection is specified by establishing multiple
point-to-point connections each of them specifying the same output
branch. A multipoint-to-multipoint connection is specified by
establishing multiple point-to-multipoint trees each of them
specifying the same output branches.

In general a virtual channel is established with a certain quality of
service (QoS). A rich set of QoS messages is introduced in this
version of the protocol. However, implementation or operation of GSMP
without any of the messages defined in Section 9, "Quality of service
messages," is permitted. In this case each virtual channel
connection or virtual path connection may be assigned a priority when
it is established. It may be assumed that for virtual connections
that share the same output port, an ATM cell on a connection with a
higher priority is much more likely to exit the switch before an ATM
cell on a connection with a lower priority if they are both in the
switch at the same time. The number of priorities that each port of
the switch supports may be obtained from the port configuration
message.

GSMP contains an adjacency protocol. The adjacency protocol is used
to synchronize state across the link, to negotiate which version of
the GSMP protocol to use, to discover the identity of the entity at
the other end of a link, and to detect when it changes.

2. GSMP Packet Encapsulation

2.1 ATM Encapsulation

GSMP packets are variable length and for an ATM data link layer they
are encapsulated directly in an AAL-5 CPCS-PDU [I.363] with an
LLC/SNAP header as illustrated:

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                   LLC (0xAA-AA-03)            |               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+               +
   |                   SNAP (0x00-00-00-88-0C)                    |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                             |
   ~                   GSMP Message                              ~
   |                                                             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                   Pad (0 - 47 octets)                       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                             |
   +                   AAL-5 CPCS-PDU Trailer (8 octets)         +
   |                                                             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
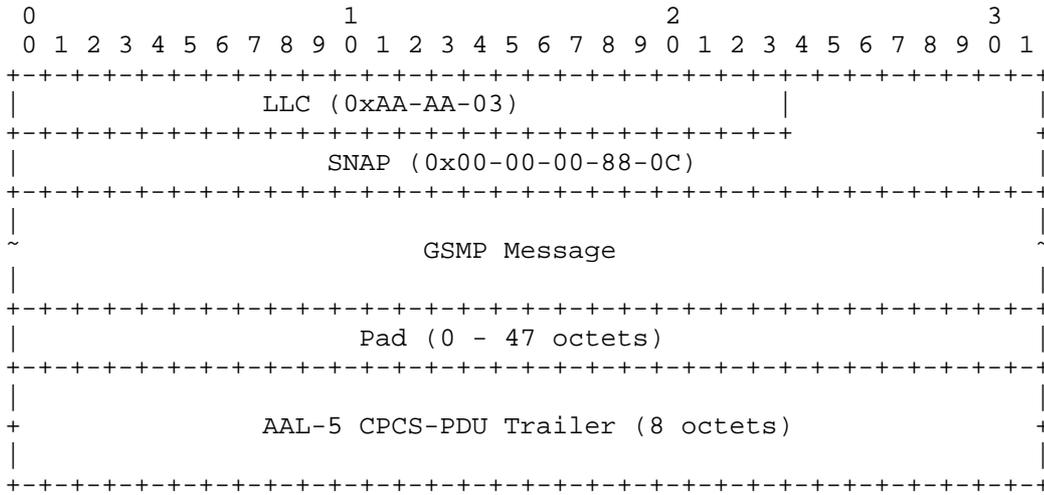
(The convention in the documentation of Internet Protocols [RFC1700]
is to express numbers in decimal. Numbers in hexadecimal format are
specified by prefacing them with the characters "0x". Data is
pictured in "big-endian" order. That is, fields are described left to
right, with the most significant octet on the left and the least
significant octet on the right. 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. This is the same coding
convention as is used in the ATM layer [I.361] and AAL-5 [I.363].)

The LLC/SNAP header contains the octets: 0xAA 0xAA 0x03 0x00 0x00
0x00 0x88 0x0C. (0x880C is the assigned Ethertype for GSMP.)

The maximum transmission unit (MTU) of the GSMP Message field is 1492
octets.

The virtual channel over which a GSMP session is established between
a controller and the switch it is controlling is called the GSMP
control channel. The default VPI and VCI of the GSMP control channel
for LLC/SNAP encapsulated GSMP messages on an ATM data link layer is:

     VPI = 0
     VCI = 15.

2.2 Ethernet Encapsulation

   GSMP packets may be encapsulated on an Ethernet data link as
   illustrated:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Destination Address                     |
|                       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       |                                       |
+-+-+-+-+-+-+-+-+-+-+-+-+                                       |
|                         Source Address                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Ethertype (0x88-0C)      |                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+                               |
|                                                               |
~                         GSMP Message                          ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Sender Instance                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Receiver Instance                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Pad                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Frame Check Sequence                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Destination Address
           For the SYN message of the adjacency protocol the
           Destination Address is the broadcast address
           0xFFFFFFFFFFFF. (Alternatively, it is also valid to
           configure the node with the unicast 48-bit IEEE MAC address
           of the destination. In this case the configured unicast
           Destination Address is used in the SYN message.) For all
           other messages the Destination Address is the unicast 48-
           bit IEEE MAC address of the destination. This address may
           be discovered from the Source Address field of messages
           received during synchronization of the adjacency protocol.

   Source Address
           For all messages the Source Address is the 48-bit IEEE MAC
           address of the sender.

   Ethertype
           The assigned Ethertype for GSMP is 0x880C.

    GSMP Message
            The maximum transmission unit (MTU) of the GSMP Message
            field is 1492 octets.

    Sender Instance
            The Sender Instance number for the link obtained from the
            adjacency protocol. This field is already present in the
            adjacency protocol message. It is appended to all non-
            adjacency GSMP messages in the Ethernet encapsulation to
            offer additional protection against the introduction of
            corrupt state.

    Receiver Instance
            The Receiver Instance number is what the sender believes is
            the current instance number for the link, allocated by the
            entity at the far end of the link. This field is already
            present in the adjacency protocol message. It is appended
            to all non-adjacency GSMP messages in the Ethernet
            encapsulation to offer additional protection against the
            introduction of corrupt state.

    Pad
            The minimum length of the data field of an Ethernet packet
            is 46 octets. If necessary, padding should be added such
            that it meets the minimum Ethernet frame size. This padding
            should be octets of zero and it is not considered to be
            part of the GSMP message.

    After the adjacency protocol has achieved synchronization, for every
    GSMP message received with an Ethernet encapsulation, the receiver
    must check the Source Address from the Ethernet MAC header, the
    Sender Instance, and the Receiver Instance. The incoming GSMP
    message must be discarded if the Sender Instance and the Source
    Address do not match the values of Sender Instance and Sender Name
    stored by the "Update Peer Verifier" operation of the GSMP adjacency
    protocol. The incoming GSMP message must also be discarded if it
    arrives over any port other than the port over which the adjacency
    protocol has achieved synchronization. In addition, the incoming
    message must also be discarded if the Receiver Instance field does
    not match the current value for the Sender Instance of the GSMP
    adjacency protocol.

3. Common Definitions and Procedures

    GSMP is a master-slave protocol. The controller issues request
    messages to the switch. Each request message indicates whether a
    response is required from the switch and contains a transaction

identifier to enable the response to be associated with the request.
The switch replies with a response message indicating either a
successful result or a failure. There are five classes of GSMP
request-response message: Connection Management, Port Management,
State and Statistics, Configuration, and Quality of Service. The
switch may also generate asynchronous Event messages to inform the
controller of asynchronous events. Event messages are not
acknowledged by the controller. There is also an adjacency protocol
message used to establish synchronization across the link and
maintain a handshake.

For the request-response messages, each message type has a format for
the request message and a format for the success response. Unless
otherwise specified a failure response message is identical to the
request message that caused the failure, with the Code field
indicating the nature of the failure. Event messages have only a
single format defined as they are not acknowledged by the controller.

Switch ports are described by a 32-bit port number. The switch
assigns port numbers and it may typically choose to structure the 32
bits into subfields that have meaning to the physical structure of
the switch (e.g. slot, port). In general, a port in the same physical
location on the switch will always have the same port number, even
across power cycles. The internal structure of the port number is
opaque to the GSMP protocol. However, for the purposes of network
management such as logging, port naming, and graphical
representation, a switch may declare the physical location (physical
slot and port) of each port. Alternatively, this information may be
obtained by looking up the product identity in a database.

Each switch port also maintains a port session number assigned by the
switch. A message, with an incorrect port session number must be
rejected. This allows the controller to detect a link failure and to
keep state synchronized.

Except for the adjacency protocol message, no GSMP messages may be
sent across the link until the adjacency protocol has achieved
synchronization, and all GSMP messages received on a link that does
not currently have state synchronization must be discarded.

3.1 GSMP Packet Format

All GSMP messages, except the adjacency protocol message, have the
following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    | Message Type  |    Result     |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                        Message Body                           ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
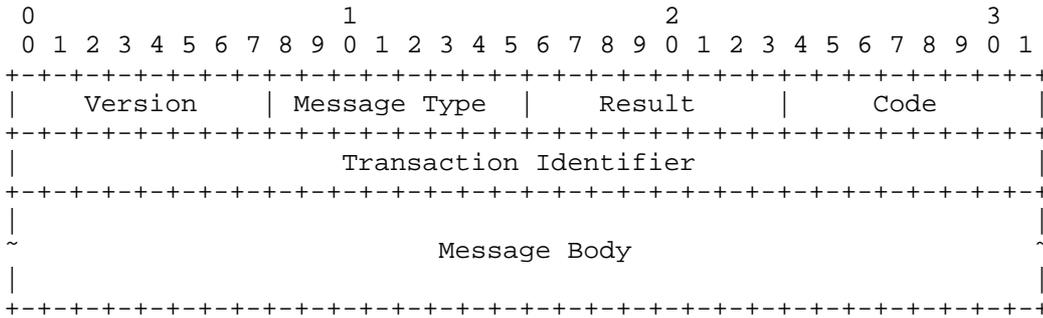
Version

>   The version number of the GSMP protocol being used in this
>   session. It should be set by the sender of the message to
>   the GSMP protocol version negotiated by the adjacency
>   protocol.

Message Type

>   The GSMP message type. GSMP messages fall into six classes:
>   Connection Management, Port Management, State and
>   Statistics, Configuration, Quality of Service, and Events.
>   Each class has a number of different message types. In
>   addition, one Message Type is allocated to the adjacency
>   protocol.

Result

>   Field in a Connection Management request message, a Port
>   Management request message, or a Quality of Service request
>   message is used to indicate whether a response is required
>   to the request message if the outcome is successful. A
>   value of "NoSuccessAck" indicates that the request message
>   does not expect a response if the outcome is successful,
>   and a value of "AckAll" indicates that a response is
>   expected if the outcome is successful. In both cases a
>   failure response must be generated if the request fails.
>   For Sate and Statistics, and Configuration request
>   messages, a value of "NoSuccessAck" in the request message
>   is ignored and the request message is handled as if the
>   field were set to "AckAll". (This facility was added to
>   reduce the control traffic in the case where the controller
>   periodically checks that the state in the switch is
>   correct. If the controller does not use this capability,
>   all request messages should be sent with a value of
>   "AckAll.")

In a response message the result field can have three
values: "Success," "More," and "Failure". The "Success" and
"More" results both indicate a success response. The "More"
result indicates that the success response exceeds the
maximum transmission unit of the data link and that one or
more further messages will be sent to complete the success
response. All messages that belong to the same success
response will have the same Transaction Identifier. The
"Success" result indicates a success response that may be
contained in a single message or the final message of a
success response spanning multiple messages.

The encoding of the result field is:

```
NoSuccessAck:  Result = 1
AckAll:        Result = 2
Success:       Result = 3
Failure:       Result = 4
More:          Result = 5.
```

The Result field is not used in an adjacency protocol
message.

Code

Field gives further information concerning the result in a
response message. It is mostly used to pass an error code
in a failure response but can also be used to give further
information in a success response message or an event
message. In a request message the code field is not used
and is set to zero. In an adjacency protocol message the
Code field is used to determine the function of the
message.

Transaction Identifier

Used to associate a request message with its response
message. For request messages the controller may select any
transaction identifier. For response messages the
transaction identifier is set to the value of the
transaction identifier from the message to which it is a
response. For event messages the transaction identifier
should be set to zero. The Transaction Identifier is not
used, and the field is not present, in the adjacency
protocol.

The following fields are frequently found in GSMP messages. They are
defined here to avoid repetition.

Port
          Gives the port number of the switch port to which the
          message applies.

Port Session Number
          Each switch port maintains a Port Session Number assigned
          by the switch. The port session number of a port remains
          unchanged while the port is continuously in the Available
          state and the link status is continuously Up. When a port
          returns to the Available state after it has been
          Unavailable or in any of the Loopback states, or when the
          line status returns to the Up state after it has been Down
          or in Test, or after a power cycle, a new Port Session
          Number must be generated. Port session numbers should be
          assigned using some form of random number.

          If the Port Session Number in a request message does not
          match the current Port Session Number for the specified
          port, a failure response message must be returned with the
          Code field indicating, "Invalid port session number." The
          current port session number for a port may be obtained
          using a Port Configuration or an All Ports Configuration
          message.

   Any field in a GSMP message that is unused or defined as "reserved"
   must be set to zero by the sender and ignored by the receiver.

   It is not an error for a GSMP message to contain additional data
   after the end of the Message Body. This is to support development and
   experimental purposes. However, the maximum transmission unit of the
   GSMP message, as defined by the data link layer encapsulation, must
   not be exceeded.

   A success response message must not be sent until the requested
   operation has been successfully completed.

3.2 Failure Response Messages

   A failure response message is formed by returning the request message
   that caused the failure with the Result field in the header
   indicating failure (Result = 4) and the Code field giving the failure
   code. The failure code specifies the reason for the switch being
   unable to satisfy the request message.

   If the switch issues a failure response in reply to a request
   message, no change should be made to the state of the switch as a
   result of the message causing the failure. (For request messages that
   contain multiple requests, such as the Delete Branches message, the

failure response message will specify which requests were successful
and which failed. The successful requests may result in changed
state.)

If the switch issues a failure response it must choose the most
specific failure code according to the following precedence:

> Invalid Message

> Failure specific to the particular message type (failure code
>   16). (The meaning of this failure is dependent upon the
>   particular message type and is specified in the text defining
>   the message.)

> A failure response specified in the text defining the message
>   type.

> Connection Failures

> Virtual Path Connection Failures

> Multicast Failures

> QoS Failures (QoS failures are specified in Section 9.7.)

> General Failures

If multiple failures match in any of the following categories, the
one that is listed first should be returned. The following failure
response messages and failure codes are defined:

Invalid Message

> 3: The specified request is not implemented on this switch.
>   The Message Type field specifies a message that is not
>   implemented on the switch or contains a value that is not
>   defined in the version of the protocol running in this
>   session of GSMP.

> 5: One or more of the specified ports does not exist.
>   At least one of the ports specified in the message is
>   invalid. A port is invalid if it does not exist or if it
>   has been removed from the switch.

> 4: Invalid Port Session Number.
>   The value given in the Port Session Number field does not
>   match the current Port Session Number for the specified
>   port.

Connection Failures

    8: The specified connection does not exist.
        An operation that expects a connection to be specified,
        either a virtual channel or a virtual path connection,
        cannot locate the specified connection. A virtual channel
        connection is specified by the input port, input VPI, and
        input VCI on which it arrives. A virtual path connection
        is specified by the input port and input VPI on which it
        arrives.

    9: The specified branch does not exist.
        An operation that expects a branch of an existing
        connection to be specified, either a virtual channel or a
        virtual path connection, cannot locate the specified
        branch. A branch of a virtual channel connection is
        specified by the virtual channel connection it belongs to
        and the output port, output VPI, and output VCI on which
        it departs. A branch of a virtual path connection is
        specified by the virtual path connection it belongs to
        and the output port and output VPI on which it departs.

   18: One or more of the specified input VPIs is invalid.

   19: One or more of the specified input VCIs is invalid.

   20: One or more of the specified output VPIs is invalid.

   21: One or more of the specified output VCIs is invalid.

   22: Invalid Class of Service field in a Connection Management
        message.
        The value of the Class of Service field is invalid.

   23: Insufficient resources for QoS Profile.
        The resources requested by the QoS Profile in the Class
        of service field are not available.

Virtual Path Connections

   24: Virtual path switching is not supported on this input port.

   25: Point-to-multipoint virtual path connections are not
        supported on either the requested input port or the
        requested output port.
        One or both of the requested input and output ports is
        unable to support point-to-multipoint virtual path
        connections.

26: Attempt to add a virtual path connection branch to an
        existing virtual channel connection.
        It is invalid to mix branches switched as virtual channel
        connections with branches switched as virtual path
        connections on the same point-to-multipoint connection.

27: Attempt to add a virtual channel connection branch to an
        existing virtual path connection.
        It is invalid to mix branches switched as virtual channel
        connections with branches switched as virtual path
        connections on the same point-to-multipoint connection.

Multicast Failures

10: A branch belonging to the specified point-to-multipoint
        connection is already established on the specified output
        port and the switch cannot support more than a single
        branch of any point-to-multipoint connection on the same
        output port.

11: The limit on the maximum number of point-to-multipoint
        connections that the switch can support has been reached.

12: The limit on the maximum number of branches that the
        specified point-to-multipoint connection can support has
        been reached.

17: Cannot label each output branch of a point-to-multipoint tree
        with a different label.
        Some early designs, and some low-cost ATM switch designs,
        require all output branches of a multicast connection to
        use the same value of VPI/VCI.

28: Only point-to-point bidirectional connections may be
        established.
        It is an error to attempt to add an additional output
        branch to an existing connection with the bidirectional
        flag set.

13: Unable to assign the requested VPI/VCI value to the requested
        branch on the specified point-to-multipoint connection.
        Although the requested VPI and VCI are valid, the switch
        is unable to support the request using the specified
        values of VPI and VCI for some reason not covered by the
        above failure responses. This message implies that a
        valid value of VPI or VCI exists that the switch could

support. For example, some switch designs restrict the
number of distinct VPI/VCI values available to a point-
to-multipoint connection. (Most switch designs will not
require this message.)

14: General problem related to the manner in which point-to-
multipoint is supported by the switch.
Use this message if none of the more specific multicast
failure messages apply. (Most switch designs will not
require this message.)

General Failures

2: Invalid request message.
There is an error in one of the fields of the message not
covered by a more specific failure message.

6: One or more of the specified ports is down.
A port is down if its Port Status is Unavailable.
Connection Management, Connection State, Port Management,
and Configuration operations are permitted on a port that
is Unavailable. Connection Activity and Statistics
operations are not permitted on a port that is
Unavailable and will generate this failure response. A
Port Management message specifying a Take Down function
on a port already in the Unavailable state will also
generate this failure response.

15: Out of resources.
The switch has exhausted a resource not covered by a more
specific failure message, for example, running out of
memory.

1: Unspecified reason not covered by other failure codes.
The failure message of last resort.

The following failure response messages are only used by the Label
Range message.

29: Cannot support requested VPI range.

30: Cannot support requested VCI range on all requested VPIs.

The following failure response messages are only used by the Set
Transmit Cell Rate function of the Port Management
message.

31: The transmit cell rate of this output port cannot be changed.

          32: Requested transmit cell rate out of range for this output
                port.

4. Connection Management Messages

    Connection management messages are used by the controller to
    establish, delete, modify and verify virtual channel connections and
    virtual path connections across the switch. The Add Branch, Delete
    Tree, and Delete All connection management messages have the
    following format for both request and response messages:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    | Message Type  |    Result     |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Port Session Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Input Port                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|M|Q|B|C|     Input VPI        |           Input VCI            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Output Port                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x|     Output VPI       |           Output VCI           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Number of Branches       |        Class of Service        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
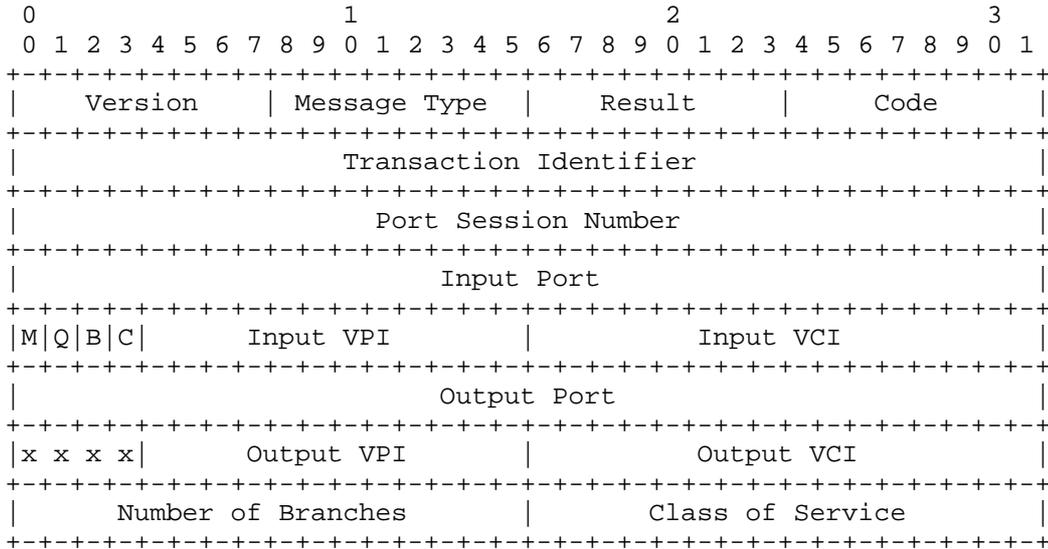
    Input Port
            Identifies a switch input port.

    Flags

        M: Multicast
            The Multicast flag is used as a hint for point-to-
            multipoint connections in the Add Branch message. It is not
            used in any other connection management messages and in
            these messages it should be set to zero. If set, it
            indicates that the virtual channel connection or the
            virtual path connection is very likely to be a point-to-
            multipoint connection. If zero, it indicates that this
            connection is very likely to be a point-to-point connection
            or is unknown.

The Multicast flag is only used in the Add Branch message
when establishing the first branch of a new connection. It
is not required to be set when establishing subsequent
branches of a point-to-multipoint connection and on such
connections it should be ignored by the receiver. (On
receipt of the second and subsequent Add Branch messages
the receiver knows that this is a point-to-multipoint
connection.) If it is known that this is the first branch
of a point-to-multipoint connection this flag should be
set. If it is unknown, or if it is known that the
connection is point-to-point this flag should be zero. The
use of this flag is not mandatory. It may be ignored by the
switch. If unused the flag should be set to zero. Some
switches use a different data structure for point-to-
multipoint connections than for point-to-point connections.
This flag avoids the switch setting up a point-to-point
structure for the first branch of a point-to-multipoint
connection which must immediately be deleted and
reconfigured as point-to-multipoint when the second branch
is established.

Q: QoS Profile
The QoS Profile flag, if set, indicates that the Class of
Service field contains a QoS Profile Identifier. If this
flag is zero, it indicates that the Class of Service field
contains a Priority or a Scheduler Identifier.

B: Bidirectional
The Bidirectional flag applies only to the Add Branch
message. In all other Connection Management messages it is
not used. It may only be used when establishing a point-
to-point connection. The Bidirectional flag in an Add
Branch message, if set, requests that two unidirectional
virtual channels or virtual paths be established, one in
the forward direction, and one in the reverse direction. It
is equivalent to two Add Branch messages, one specifying
the forward direction, and one specifying the reverse
direction. The forward direction uses the values of Input
Port, Input VPI, Input VCI, Output Port, Output VPI, and
Output VCI as specified in the Add Branch message. The
reverse direction is derived by exchanging the values
specified in the Input Port, Input VPI, and Input VCI
fields, with those of the Output Port, Output VPI, and
Output VCI fields respectively. Thus, a virtual connection
in the reverse direction arrives at the input port
specified by the Output Port field, on the VPI/VCI
specified by the Output VPI and Output VCI fields. It
departs from the output port specified by the Input Port

field, on the VPI/VCI specified by the Input VPI and Input
VCI fields.

The Bidirectional flag is simply a convenience to establish
two unidirectional virtual connections in opposite
directions between the same two ports, with identical
VPI/VCIs, using a single Add Branch message. In all future
messages the two unidirectional virtual connections must be
handled separately. There is no bidirectional delete
message. However, a single Delete Branches message with two
Delete Branch Elements, one for the forward connection and
one for the reverse, may be used.

C: Congestion Indication
The Congestion Indication flag, if set, requests that cells
on this connection be marked if congestion is experienced.
If this connection passes through a queue that the switch
considers to be congested, the Congestion Experienced bit
will be set in the Payload Type field of the cell header of
all cells on the connection. GSMP does not specify the
algorithm or any threshold by which the switch decides when
a queue is congested.

Input VPI
Identifies an ATM virtual path arriving at the switch input
port indicated by the Input Port field.

Input VCI
Identifies an ATM virtual channel arriving on the virtual
path indicated by the Input VPI field at the switch input
port indicated by the Input Port field. For virtual path
connections the Input VCI field is not used.

Output Port
Identifies a switch output port.

x: Unused

Output VPI
Identifies an outgoing virtual path departing from the
switch output port indicated in the Output Port field.

Output VCI
Identifies an outgoing virtual channel departing on the
virtual path indicated by the Output VPI field from the
switch output port indicated in the Output Port field. For
virtual path connections the Output VCI field is not used.

Number of Branches
         In a success response message and a failure response
         message, gives the number of output branches on a virtual
         channel connection or a virtual path connection after
         completion of the requested operation. (A point-to-point
         connection will have one branch, a point-to-multipoint
         connection will have two or more branches.) If the switch
         is unable to keep track of the number of branches on a
         virtual path connection or a virtual channel connection it
         must respond with the value 0xFFFF meaning: "number of
         branches unknown". This field is not used in the request
         message.

Class of Service
         This field can contain either a QoS Profile Identifier, a
         Priority, or a Scheduler Identifier. If the QoS Profile
         flag in the Flags field is set, the Class of Service field
         contains a QoS Profile. If the QoS Profile flag in the
         Flags field is zero, and the value of the Class of Service
         field is greater than or equal to 0x100, the Class of
         Service field contains a Scheduler Identifier. If the QoS
         Profile flag in the Flags field is zero, and the value of
         the Class of Service field is less than 0x100, the Class of
         Service field contains a Priority. (Values of Scheduler
         Identifier less than 0x100 are interpreted as priorities.)
         The Class of Service field is only used in the Add Branch
         and Move Branch messages.

         A QoS Profile Identifier is an opaque 16-bit value. It is
         used to identify a QoS profile in the switch which
         specifies the Quality of Service required by the
         connection. QoS profiles are established by a mechanism
         external to GSMP.

         A Scheduler Identifier is an alternative method of
         communicating the QoS requirements of a connection. The
         Scheduler Identifier is defined in Section 9, "Quality of
         Service Messages."

         A Priority specifies the priority of the connection for Add
         Branch and Move Branch messages that choose not to use a
         QoS profile, or the QoS capabilities defined in Section 9,
         "Quality of Service Messages." The highest priority is
         numbered zero and the lowest priority is numbered "Q-1"
         where "Q" is the number of priorities that the output port
         can support. The ability to offer different qualities of
         service to different connections based upon their priority
         is assumed to be a property of the output port of the

switch. It is assumed that for virtual path connections or
virtual channel connections that share the same output
port, an ATM cell on a connection with a higher priority is
much more likely to exit the switch before an ATM cell on a
connection with a lower priority, if they are both in the
switch at the same time. The number of priorities that each
output port can support is given in the Port Configuration
message.

For all connection management messages, except the Delete Branches
message, the success response message is a copy of the request
message returned with the Result field indicating success and the
Number of Branches field indicating the number of branches on the
connection after completion of the operation. The Code field is not
used in a connection management success response message.

The failure response message is a copy of the request message
returned with a Result field indicating failure and the Number of
Branches field indicating the number of branches on the connection.

Fundamentally, no distinction is made between point-to-point and
point-to-multipoint connections. By default, the first Add Branch
message for a particular Input Port, Input VPI, and Input VCI will
establish a point-to-point virtual connection. The second Add Branch
message with the same Input Port, Input VPI, and Input VCI fields
will convert the connection to a point-to-multipoint virtual
connection with two branches. (For virtual path connections the Input
VCI is not required.) However, to avoid possible inefficiency with
some switch designs, the Multicast Flag is provided. If the
controller knows that a new connection is point-to-multipoint when
establishing the first branch, it may indicate this in the Multicast
Flag. Subsequent Add Branch messages with the same Input Port, Input
VPI, and Input VCI fields will add further branches to the point-to-
multipoint connection. Use of the Delete Branch message on a point-
to-multipoint connection with two branches will result in a point-
to-point connection. However, the switch may structure this
connection as a point-to-multipoint connection with a single output
branch if it chooses. (For some switch designs this structure may be
more convenient.) Use of the Delete Branch message on a point-to-
point connection will delete the point-to-point connection. There is
no concept of a connection with zero output branches. All connections
are unidirectional, one input virtual path or virtual channel to one
or more output virtual paths or virtual channels.

GSMP supports point-to-point and point-to-multipoint connections. A
multipoint-to-point connection is specified by establishing multiple
point-to-point connections each of them specifying the same output
branch. (An output branch is specified by an output port and output

VPI for a virtual path connection and by an output port, output VPI,
and output VCI for a virtual channel connection.) A multipoint-to-
multipoint connection is specified by establishing multiple point-
to-multipoint trees each of them specifying the same output branches.

The connection management messages apply both to virtual channel
connections and virtual path connections. The Add Branch and Move
Branch connection management messages have two Message Types. One
Message Type indicates that a virtual channel connection is required,
and the other Message Type indicates that a virtual path connection
is required. The Delete Branches, Delete Tree, and Delete All
connection management messages have only a single Message Type
because they do not need to distinguish between virtual channel
connections and virtual path connections. For virtual path
connections, neither Input VCI fields nor Output VCI fields are
required. They should be set to zero by the sender and ignored by the
receiver. Virtual channel branches may not be added to an existing
virtual path connection. Conversely, virtual path branches may not
be added to an existing virtual channel connection. In the Port
Configuration message each switch input port may declare whether it
is capable of supporting virtual path switching (i.e. accepting
connection management messages requesting virtual path connections).

The connection management messages may be issued regardless of the
Port Status of the switch port. Connections may be established or
deleted when a switch port is in the Available, Unavailable, or any
of the Loopback states. However, all connection state on an input
port will be deleted when the port returns to the Available state
from any other state, i.e. when a Port Management message is received
for that port with the Function field indicating either Bring Up, or
Reset Input Port.

4.1 Add Branch Message

The Add Branch message is a connection management message used to
establish a virtual channel connection or a virtual path connection
or to add an additional branch to an existing virtual channel
connection or virtual path connection. It may also be used to check
the connection state stored in the switch. The connection is
specified by the Input Port, Input VPI, and Input VCI fields. The
output branch is specified by the Output Port, Output VPI, and Output
VCI fields. The quality of service requirements of the connection are
specified by the Class of Service field. To request a virtual channel
connection the Virtual Channel Connection (VCC) Add Branch message
is:

    Message Type = 16

To request a virtual path connection the Virtual Path Connection
(VPC) Add Branch message is:

    Message Type = 26

If a VPC Add Branch message is received and the switch input port
specified by the Input Port field does not support virtual path
switching, a failure response message must be returned indicating,
"Virtual path switching is not supported on this input port."

If the virtual channel connection specified by the Input Port, Input
VPI, and Input VCI fields; or the virtual path connection specified
by the Input Port and Input VPI fields; does not already exist, it
must be established with the single output branch specified in the
request message. If the Bidirectional Flag in the Flags field is set,
the reverse connection must also be established. The output branch
should have the QoS attributes specified by the Class of Service
field.

For the VCC Add Branch message, if a virtual path connection already
exists on the virtual path specified by the Input Port and Input VPI
fields, a failure response message must be returned indicating,
"Attempt to add a virtual channel connection branch to an existing
virtual path connection." For the VPC Add Branch message, if a
virtual channel connection already exists on any of the virtual
channels within the virtual path specified by the Input Port and
Input VPI fields, a failure response message must be returned
indicating, "Attempt to add a virtual path connection branch to an
existing virtual channel connection."

If the virtual channel connection specified by the Input Port, Input
VPI, and Input VCI fields; or the virtual path connection specified
by the Input Port and Input VPI fields; already exists, but the
specified output branch does not, the new output branch must be
added. The new output branch should have the QoS attributes
specified by the Class of Service field.

If the virtual channel connection specified by the Input Port, Input
VPI, and Input VCI fields; or the virtual path connection specified
by the Input Port and Input VPI fields; already exists and the
specified output branch also already exists, the QoS attributes of
the connection, specified by the Class of Service field, if different
from the request message, should be changed to that in the request
message. A success response message must be sent if the Result field
of the request message is "AckAll". This allows the controller to
periodically reassert the state of a connection or to change its
priority. If the result field of the request message is
"NoSuccessAck" a success response message should not be returned.

This may be used to reduce the traffic on the control link for
messages that are reasserting previously established state. For
messages that are reasserting previously established state, the
switch must always check that this state is correctly established in
the switch hardware (i.e. the actual connection tables used to
forward cells).

If the output branch specified by the Output Port, Output VPI, and
Output VCI fields for a virtual channel connection; or the output
branch specified by the Output Port and Output VPI fields for a
virtual path connection; is already in use by any connection other
than that specified by the Input Port, Input VPI, and Input VCI
fields, then the resulting output branch will have multiple input
branches. If multiple point-to-point connections share the same
output branch the result will be a multipoint-to-point connection. If
multiple point-to-multipoint trees share the same output branches the
result will be a multipoint-to-multipoint connection.

If the virtual channel connection specified by the Input Port, Input
VPI, and Input VCI fields, or the virtual path connection specified
by the Input Port and Input VPI fields, already exists, and the
Bidirectional Flag in the Flags field is set, a failure response must
be returned indicating: "Only point-to-point bidirectional
connections may be established."

It should be noted that different switches support multicast in
different ways. There will be a limit to the total number of point-
to-multipoint connections any switch can support, and possibly a
limit on the maximum number of branches that a point-to-multipoint
connection may specify. Some switches also impose a limit on the
number of different VPI/VCI values that may be assigned to the output
branches of a point-to-multipoint connection. Many switches are
incapable of supporting more than a single branch of any particular
point-to-multipoint connection on the same output port. Specific
failure codes are defined for some of these conditions.

4.2 Delete Tree Message

The Delete Tree message is a connection management message used to
delete an entire virtual channel connection or an entire virtual path
connection. All remaining branches of the connection are deleted. A
virtual channel connection is specified by the Input Port, Input VPI,
and Input VCI fields. A virtual path connection is specified by the
Input Port and Input VPI fields. The Output Port, Output VPI, and
Output VCI fields are not used in this message. The Delete Tree
message is:

     Message Type = 18

    If the Result field of the request message is "AckAll" a success
    response message must be sent upon successful deletion of the
    specified connection. The success message must not be sent until the
    delete operation has been completed and if possible, not until all
    data on the connection, queued for transmission, has been
    transmitted. The Number of Branches field is not used in either the
    request or response messages of the Delete Tree message.

4.3 Verify Tree Message

    The Verify Tree message has been removed from this version of GSMP.
    Its function has been replaced by the Number of Branches field in the
    success response to the Add Branch message which contains the number
    of branches on a virtual channel connection after successful
    completion of an add branch operation.

        Message Type = 19 is reserved.

    If a request message is received with Message Type = 19 a failure
    response must be returned with the Code field indicating: "The
    specified request is not implemented in this version of the
    protocol."

4.4 Delete All Message

    The Delete All message is a connection management message used to
    delete all connections on a switch input port. All connections that
    arrive at the specified input port must be deleted. On completion of
    the operation all dynamically assigned VPI/VCI values for the
    specified port must be unassigned, i.e. there must be no virtual
    connections established in the VPI/VCI space that GSMP controls on
    this port. The Input VPI, Input VCI, Output Port, Output VPI, and
    Output VCI fields are not used in this message. The Delete All
    message is:

        Message Type = 20

    If the Result field of the request message is "AckAll" a success
    response message must be sent upon completion of the operation. The
    Number of Branches field is not used in either the request or
    response messages of the Delete All message. The success response
    message must not be sent until the operation has been completed.

    The following failure response messages may be returned to a Delete
    All request.

        The specified request is not implemented on this switch.

        One or more of the specified ports does not exist.

        Invalid Port Session Number.

   If any field in a Delete All message not covered by the above failure
   codes is invalid, a failure response must be returned indicating:
   "Invalid request message." Else, the delete all operation must be
   completed successfully and a success message returned. No other
   failure messages are permitted.

4.5 Delete Branches Message

   The Delete Branches message is a connection management message used
   to request one or more delete branch operations. Each delete branch
   operation deletes a branch of a virtual channel connection or a
   virtual path connection, or in the case of the last branch of a
   connection, it deletes the connection. The Delete Branches message
   is:

      Message Type = 17

   The request message has the following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Version   | Message Type  |     Result    |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Reserved           |      Number of Elements       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                    Delete Branch Elements                     ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
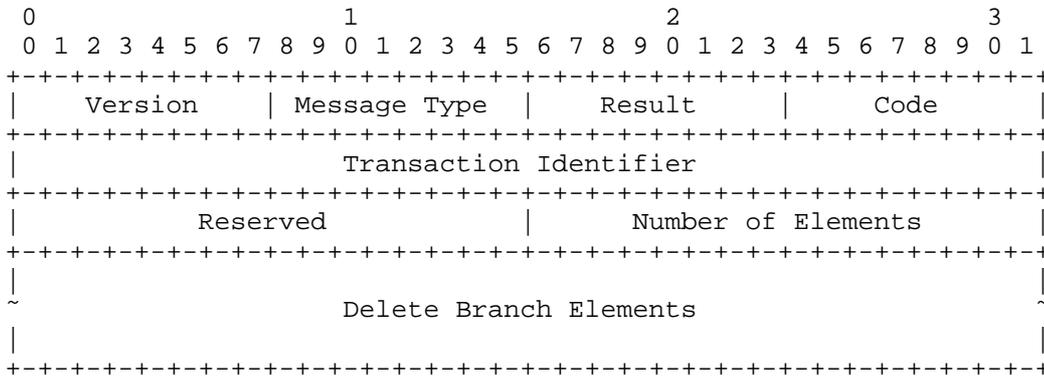
   Number of Elements
           Specifies the number of Delete Branch Elements to follow in
           the message. The number of Delete Branch Elements in a
           Delete Branches message must not cause the packet length to
           exceed the maximum transmission unit defined by the
           encapsulation.

   Each Delete Branch Element specifies an output branch to be deleted
   and has the following structure:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Port Session Number                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Input Port                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Error |      Input VPI        |           Input VCI           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Output Port                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x|      Output VPI       |           Output VCI          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Error

> Is used to return a failure code indicating the reason for
> the failure of a specific Delete Branch Element in a Delete
> Branches failure response message. The Error field is not
> used in the request message and must be set to zero. A
> value of zero is used to indicate that the delete operation
> specified by this Delete Branch Element was successful.
> Values for the other failure codes are specified in Section
> 3.2, "Failure Response Messages."

> All other fields of the Delete Branch Element have the same
> definition as specified for the other connection management
> messages.

In each Delete Branch Element, either a virtual channel connection is
specified by the Input Port, Input VPI, and Input VCI fields; or a
virtual path connection is specified by the Input Port and Input VPI
fields. The specific branch to be deleted is indicated by the Output
Port, Output VPI, and Output VCI fields for virtual channel
connections and by the Output Port and Output VPI for virtual path
connections.

If the Result field of the Delete Branches request message is
"AckAll" a success response message must be sent upon successful
deletion of the branches specified by all of the Delete Branch
Elements. The success response message must not be sent until all of
the delete branch operations have been completed. The success
response message is only sent if all of the requested delete branch
operations were successful. No Delete Branch Elements are returned in
a Delete Branches success response message and the Number of Elements
field must be set to zero.

If there is a failure in any of the Delete Branch Elements a Delete
Branches failure response message must be returned. The Delete
Branches failure response message is a copy of the request message
with the Code field of the entire message set to, "Failure specific

to the particular message type," and the Error field of each Delete
Branch Element indicating the result of each requested delete
operation. A failure in any of the Delete Branch Elements must not
interfere with the processing of any other Delete Branch Elements.

4.6 Move Branch Message

The Move Branch message is used to move a branch of an existing
connection from its current output port VPI/VCI to a new output port
VPI/VCI in a single atomic transaction. This operation occurs
frequently in IP switching, every time a flow is switched from hop-
by-hop forwarding to a dedicated virtual channel. The Move Branch
connection management message has the following format for both
request and response messages:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Version   | Message Type  |    Result     |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Transaction Identifier                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Port Session Number                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Input Port                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Flags |        Input VPI      |           Input VCI           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Old Output Port                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x|    Old Output VPI     |         Old Output VCI         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      New Output Port                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x|    New Output VPI     |         New Output VCI         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Number of Branches       |       Class of Service        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
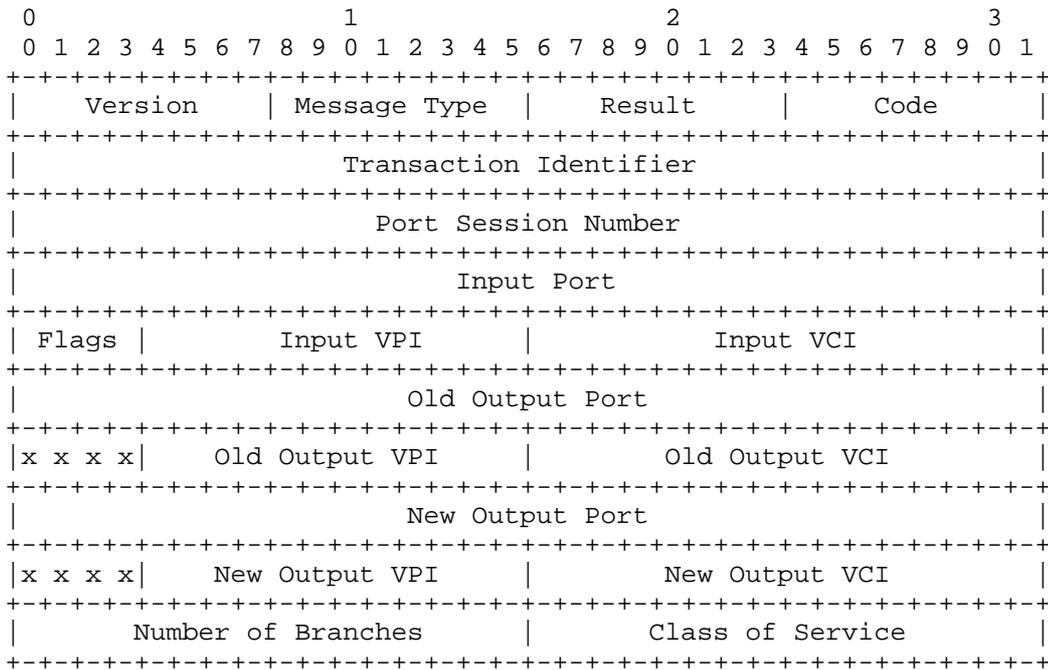
The VCC Move Branch message is a connection management message used
to move a single output branch of a virtual channel connection from
its current output port, output VPI, and output VCI, to a new output
port, output VPI, and output VCI on the same virtual channel
connection. None of the other output branches are modified. When the
operation is complete the original output VPI/VCI on the original
output port will be deleted from the connection. The VCC Move Branch
message is:

   Message Type = 22

For the VCC Move Branch message, if the virtual channel connection
specified by the Input Port, Input VPI, and Input VCI fields already
exists, and the output branch specified by the Old Output Port, Old
Output VPI, and Old Output VCI fields exists as a branch on that
connection, the output branch specified by the New Output Port, New
Output VPI, and New Output VCI fields is added to the connection and
the branch specified by the Old Output Port, Old Output VPI, and Old
Output VCI fields is deleted. If the Result field of the request
message is "AckAll" a success response message must be sent upon
successful completion of the operation. The success response message
must not be sent until the Move Branch operation has been completed.

For the VCC Move Branch message, if the virtual channel connection
specified by the Input Port, Input VPI, and Input VCI fields already
exists, but the output branch specified by the Old Output Port, Old
Output VPI, and Old Output VCI fields does not exist as a branch on
that connection, a failure response must be returned with the Code
field indicating, "The specified branch does not exist."

The VPC Move Branch message is a connection management message used
to move a single output branch of a virtual path connection from its
current output port and output VPI, to a new output port and output
VPI on the same virtual channel connection. None of the other output
branches are modified. When the operation is complete the original
output VPI on the original output port will be deleted from the
connection. The VPC Move Branch message is:

   Message Type = 27

For the VPC Move Branch message, if the virtual path connection
specified by the Input Port and Input VPI fields already exists, and
the output branch specified by the Old Output Port and Old Output VPI
fields exists as a branch on that connection, the output branch
specified by the New Output Port and New Output VPI fields is added
to the connection and the branch specified by the Old Output Port and
Old Output VPI fields is deleted. If the Result field of the request
message is "AckAll" a success response message must be sent upon
successful completion of the operation. The success response message
must not be sent until the Move Branch operation has been completed.

For the VPC Move Branch message, if the virtual path connection
specified by the Input Port and Input VPI fields already exists, but
the output branch specified by the Old Output Port and Old Output VPI
fields does not exist as a branch on that connection, a failure
response must be returned with the Code field indicating, "The
specified branch does not exist."

If the virtual channel connection specified by the Input Port, Input
VPI, and Input VCI fields; or the virtual path connection specified
by the Input Port and Input VPI fields; does not exist, a failure
response must be returned with the Code field indicating, "The
specified connection does not exist."

If the output branch specified by the New Output Port, New Output
VPI, and New Output VCI fields for a virtual channel connection; or
the output branch specified by the New Output Port and New Output VPI
fields for a virtual path connection; is already in use by any
connection other than that specified by the Input Port, Input VPI,
and Input VCI fields then the resulting output branch will have
multiple input branches. If multiple point-to-point connections share
the same output branch the result will be a multipoint-to-point
connection. If multiple point-to-multipoint trees share the same
output branches the result will be a multipoint-to-multipoint
connection.

5. Port Management Messages

5.1 Port Management Message

The Port Management message allows a port to be brought into service,
taken out of service, looped back, reset, or the transmit cell rate
changed. Only the Bring Up and the Reset Input Port functions change
the connection state (established connections) on the input port.
Only the Bring Up function changes the value of the Port Session
Number. If the Result field of the request message is "AckAll" a
success response message must be sent upon successful completion of
the operation. The success response message must not be sent until
the operation has been completed. The Port Management Message is:

    Message Type = 32

The Port Management message has the following format for the request
and success response messages:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Version   |  Message Type |     Result    |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Port                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Port Session Number                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Event Sequence Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Event Flags  |    Duration   |            Function           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transmit Cell Rate                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
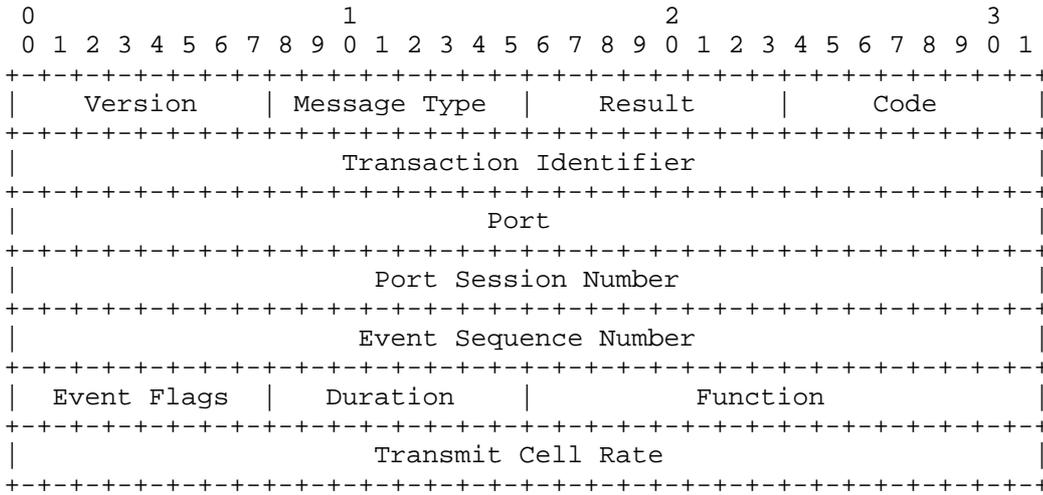
Event Sequence Number
          In the success response message gives the current value of
          the Event Sequence Number of the switch port indicated by
          the Port field. The Event Sequence Number is set to zero
          when the port is initialized. It is incremented by one each
          time the port detects an asynchronous event that the switch
          would normally report via an Event message. If the Event
          Sequence Number in the success response differs from the
          Event Sequence Number of the most recent Event message
          received for that port, events have occurred that were not
          reported via an Event message. This is most likely to be
          due to the flow control that restricts the rate at which a
          switch can send Event messages for each port. In the
          request message this field is not used.

Event Flags
          Field in the request message is used to reset the Event
          Flags in the switch port indicated by the Port field. Each
          Event Flag in a switch port corresponds to a type of Event
          message. When a switch port sends an Event message it sets
          the corresponding Event Flag on that port. The port is not
          permitted to send another Event message of the same type
          until the Event Flag has been reset. If the Function field
          in the request message is set to "Reset Event Flags," for
          each bit that is set in the Event Flags field, the
          corresponding Event Flag in the switch port is reset.

          The Event Flags field is only used in a request message
          with the Function field set to "Reset Event Flags." For all
          other values of the Function field, the Event Flags field

is not used. In the success response message the Event
Flags field must be set to the current value of the Event
Flags for the port, after the completion of the operation
specified by the request message, for all values of the
Function field. Setting the Event Flags field to all zeros
in a "Reset Event Flags" request message allows the
controller to obtain the current state of the Event Flags
and the current Event Sequence Number of the port without
changing the state of the Event Flags.

The correspondence between the types of Event message and
the bits of the Event Flags field is as follows:

```
 0 1 2 3 4 5 6 7
+-+-+-+-+-+-+-+-+
|U|D|I|N|Z|x x x|
+-+-+-+-+-+-+-+-+

U: Port Up          Bit 0, (most significant bit)
D: Port Down        Bit 1,
I: Invalid VPI/VCI  Bit 2,
N: New Port         Bit 3,
Z: Dead Port        Bit 4,
x: Unused           Bits 5--7.
```

Duration

Is the length of time, in seconds, that any of the loopback
states remain in operation. When the duration has expired
the port will automatically be returned to service. If
another Port Management message is received for the same
port before the duration has expired, the loopback will
continue to remain in operation for the length of time
specified by the Duration field in the new message. The
Duration field is only used in request messages with the
Function field set to Internal Loopback, External Loopback,
or Bothway Loopback.

Function

Specifies the action to be taken. The specified action will
be taken regardless of the current status of the port
(Available, Unavailable, or any Loopback state). If the
specified function requires a new Port Session Number to be
generated, the new Port Session Number must be returned in
the success response message. The defined values of the
Function field are:

Bring Up:
     Function = 1. Bring the port into service. All

connections that arrive at the specified input port
must be deleted and a new Port Session Number must be
selected using some form of random number. On
completion of the operation all dynamically assigned
VPI/VCI values for the specified input port must be
unassigned, i.e. no virtual connections will be
established in the VPI/VCI space that GSMP controls on
this input port. The Port Status of the port
afterwards will be Available.

Take Down:
    Function = 2. Take the port out of service. Any cells
    received at this port will be discarded. No cells will
    be transmitted from this port. The Port Status of the
    port afterwards will be Unavailable.

    The behavior is undefined if the port is taken down
    over which the GSMP session that controls the switch
    is running. (In this case the most probable behavior
    would be for the switch either to ignore the message
    or to terminate the current GSMP session and to
    initiate another session, possibly with the backup
    controller, if any.) The correct method to reset the
    link over which GSMP is running is to issue an RSTACK
    message in the adjacency protocol.

Internal Loopback:
    Function = 3. Cells arriving at the output port from
    the switch fabric are looped through to the input port
    to return to the switch fabric. All of the ATM
    functions of the input port above the physical layer,
    e.g. header translation, are performed upon the looped
    back cells. The Port Status of the port afterwards
    will be Internal Loopback.

External Loopback:
    Function = 4. Cells arriving at the input port from
    the external communications link are immediately
    looped back to the communications link at the physical
    layer without entering the input port. None of the ATM
    functions of the input port above the physical layer
    are performed upon the looped back cells. The Port
    Status of the port afterwards will be External
    Loopback.

Bothway Loopback:
    Function = 5. Both internal and external loopback are

        performed. The Port Status of the port afterwards will
        be Bothway Loopback.

    Reset Input Port:
        Function = 6. All connections that arrive at the
        specified input port must be deleted and the input and
        output port hardware re-initialized. On completion of
        the operation all dynamically assigned VPI/VCI values
        for the specified input port must be unassigned, i.e.
        no virtual connections will be established in the
        VPI/VCI space that GSMP controls on this input port.
        The range of VPIs and VCIs that may be controlled by
        GSMP on this port will be set to the default values
        specified in the Port Configuration message. The
        transmit cell rate of the output port must be set to
        its default value. The Port Session Number is not
        changed by the Reset Input Port function. The Port
        Status of the port afterwards will be Unavailable.

    Reset Event Flags:
        Function = 7. For each bit that is set in the Event
        Flags field, the corresponding Event Flag in the
        switch port must be reset. The Port Status of the port
        is not changed by this function.

    Set Transmit Cell Rate:
        Function = 8. Sets the transmit cell rate of the
        output port as close as possible to the rate specified
        in the Transmit Cell Rate field. In the success
        response message the Transmit Cell Rate must indicate
        the actual transmit cell rate of the output port. If
        the transmit cell rate of the requested output port
        cannot be changed, a failure response must be returned
        with the Code field indicating: "The transmit cell
        rate of this output port cannot be changed." If the
        transmit cell rate of the requested output port can be
        changed, but the value of the Transmit Cell Rate field
        is beyond the range of acceptable values, a failure
        response must be returned with the Code field
        indicating: "Requested transmit cell rate out of range
        for this output port." In the failure response message
        the Transmit Cell Rate must contain the same value as
        contained in the request message that caused the
        failure. The transmit cell rate of the output port is
        not changed by the Bring Up, Take Down, or any of the
        Loopback functions. It is returned to the default
        value by the Reset Input Port function.

Transmit Cell Rate
> This field is only used in request and success response messages with the Function field set to "Set Transmit Cell Rate." It is used to set the output cell rate of the output port. It is specified in cells/s. If the Transmit Cell Rate field contains the value 0xFFFFFFFF the transmit cell rate of the output port should be set to the highest valid value.

5.2. Label Range Message

The default label range, Min VPI to Max VPI and Min VCI to Max VCI, is specified for each port by the Port Configuration or the All Ports Configuration messages. When the protocol is initialized, before the transmission of any Label Range messages, the label range of each port will be set to the default label range. (The default label range is dependent upon the switch design and configuration and is not specified by the GSMP protocol.) The Label Range message allows the range of VPIs supported by a specified port, or the range of VCIs supported by a specified VPI on a specified port, to be changed. Each switch port must declare whether it supports the Label Range message in the Port Configuration or the All Ports Configuration messages. The Label Range message is:

    Message Type = 33

The Label Range message has the following format for the request and success response messages:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    | Message Type  |    Result     |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Port                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Port Session Number                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Q|V|x x|     Min VPI        |x x x x|        Max VPI           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Min VCI          |          Max VCI                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Remaining VPIs      |         Remaining VCIs          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
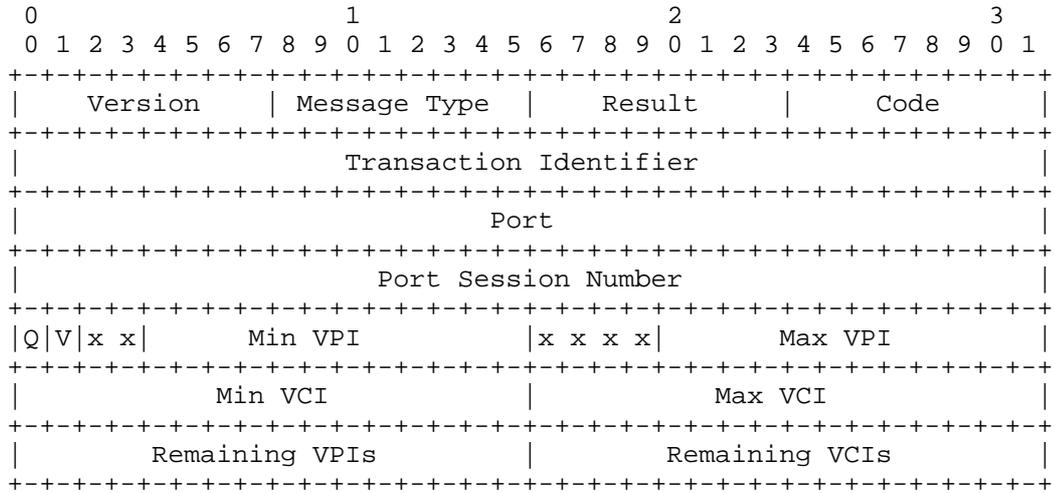
Flags

     Q: Query
          If the Query flag is set in a request message, the switch
          must respond with the current range of valid VPIs, or the
          current range of valid VCIs on a specified VPI, according
          to the VPI/VCI flag. The current label range is not changed
          by a request message with the Query flag set. If the Query
          flag is zero, the message is requesting a label change
          operation.

     V: VPI/VCI
          If the VPI/VCI flag is set, the message refers to a range
          of VPIs only. The Min VCI and Max VCI fields are unused. If
          the VPI/VCI flag is zero the message refers to a range of
          VCIs on either one VPI or on a range of VPIs.

     x: Unused

Min VPI
Max VPI
          Specify a range of VPI values, Min VPI to Max VPI
          inclusive. A single VPI may be specified with a Min VPI
          and a Max VPI having the same value. In a request message,
          if the value of the Max VPI field is less than or equal to
          the value of the Min VPI field, the requested range is a
          single VPI with a value equal to the Min VPI field. Zero is
          a valid value. In a request message, if the Query flag is
          set, and the VPI/VCI flag is zero, the Max VPI field
          specifies a single VPI and the Min VPI field is not used.
          The maximum valid value of these fields for both request
          and response messages is 0xFFF.

Min VCI
Max VCI
          Specify a range of VCI values, Min VCI to Max VCI
          inclusive. A single VCI may be specified with a Min VCI
          and a Max VCI having the same value. In a request message,
          if the value of the Max VCI field is less than or equal to
          the value of the Min VCI field, the requested range is a
          single VCI with a value equal to the Min VCI field. Zero is
          a valid value. (However, VPI=0, VCI=0 is not available as
          a virtual channel connection as it is used as a special
          value in ATM to indicate an unassigned cell.)

Remaining VPIs
Remaining VCIs
          These fields are unused in the request message. In the

success response message and in the failure response
message these fields give the maximum number of remaining
VPIs and VCIs that could be requested for allocation on the
specified port (after completion of the requested operation
in the case of the success response). It gives the switch
controller an idea of how many VPIs and VCIs it could
request. The number given is the maximum possible given the
constraints of the switch hardware. There is no implication
that this number of VPIs and VCIs is available to every
switch port.

If the Query flag and the VPI/VCI flag are set in the request
message, the switch must reply with a success response message
containing the current range of valid VPIs that are supported by the
port. The Min VPI and Max VPI fields are not used in the request
message.

If the Query flag is set and the VPI/VCI flag is zero in the request
message, the switch must reply with a success response message
containing the current range of valid VCIs that are supported by the
VPI specified by the Max VPI field. If the requested VPI is invalid,
a failure response must be returned indicating: "One or more of the
specified input VPIs is invalid." The Min VPI field is not used in
either the request or success response messages.

If the Query flag is zero and the VPI/VCI flag is set in the request
message, the Min VPI and Max VPI fields specify the new range of VPIs
to be allocated to the input port specified by the Port field.
Whatever the range of VPIs previously allocated to this port it
should be increased or decreased to the specified value.

If the Query flag and the VPI/VCI flag are zero in the request
message, the Min VCI and Max VCI fields specify the range of VCIs to
be allocated to each of the VPIs specified by the VPI range.
Whatever the range of VCIs previously allocated to each of the VPIs
within the specified VPI range on this port, it should be increased
or decreased to the specified value. The allocated VCI range must be
the same on each of the VPIs within the specified VPI range.

The success response to a Label Range message requesting a change of
label range is a copy of the request message with the Remaining VPIs
and Remaining VCIs fields updated to the new values after the Label
Range operation.

If the switch is unable to satisfy a request to change the VPI range,
it must return a failure response message with the Code field set to
"Cannot support requested VPI range." In this failure response

message the switch must use the Min VPI and Max VPI fields to suggest
a VPI range that it would be able to satisfy.

If the switch is unable to satisfy a request to change the VCI range
on all VPIs within the requested VPI range, it must return a failure
response message with the Code field set to "Cannot support requested
VCI range on all requested VPIs." In this failure response message
the switch must use the Min VPI, Max VPI, Min VCI, and Max VCI fields
to suggest a VPI and VCI range that it would be able to satisfy.

In all other failure response messages for the label range operation
the switch must return the values of Min VPI, Max VPI, Min VCI, and
Max VCI from the request message.

While switches can typically support all 256 or 4096 VPIs the VCI
range that can be supported is often more constrained. Often the Min
VCI must be 0 or 32. Typically all VCIs within a particular VPI must
be contiguous. The hint in the failure response message allows the
switch to suggest a label range that it could satisfy in view of its
particular architecture.

While the Label Range message is defined to specify both a range of
VPIs and a range of VCIs within each VPI, the most likely use is to
change either the VPI range or the range of VCIs within a single VPI.
It is possible for a VPI to be valid but to be allocated no valid
VCIs. Such a VPI could be used for a virtual path connection but to
support virtual channel connections it would need to be allocated a
range of VCIs.

A Label Range request message may be issued regardless of the Port
Status or the Line Status of the target switch port. If the Port
field of the request message contains an invalid port (a port that
does not exist or a port that has been removed from the switch) a
failure response message must be returned with the Code field set to,
"One or more of the specified ports does not exist."

6. State and Statistics Messages

   The state and statistics messages permit the controller to request
   the values of various hardware counters associated with the switch
   input and output ports, virtual path connections, virtual channel
   connections, and QoS Classes. They also permit the controller to
   request the connection state of a switch input port. The Connection
   Activity message is used to determine whether one or more specific
   virtual channel connections or virtual path connections have recently
   been carrying traffic. The Statistics message is used to query the
   various port, connection, and QoS class traffic and error counters.

   The Report Connection State message is used to request an input port
   to report the connection state for a single virtual channel
   connection, a single virtual path connection, or for the entire input
   port.

6.1 Connection Activity Message

   The Connection Activity message is used to determine whether one or
   more specific virtual channel connections or virtual path connections
   have recently been carrying traffic. The Connection Activity message
   contains one or more Activity Records. Each Activity Record is used
   to request and return activity information concerning a single
   virtual channel connection or virtual path connection. Each virtual
   channel connection is specified by its input port, input VPI, and
   input VCI. Each virtual path connection is specified by its input
   port and input VPI. These are specified in the Input Port, Input VPI,
   and Input VCI fields of each Activity Record. Two forms of activity
   detection are supported. If the switch supports per connection
   traffic accounting, the current value of the traffic counter for each
   specified virtual channel connection or virtual path connection must
   be returned. The units of traffic counted are not specified but will
   typically be either cells or frames. The controller must compare the
   traffic counts returned in the message with previous values for each
   of the specified connections to determine whether each connection has
   been active in the intervening period. If the switch does not
   support per connection traffic accounting, but is capable of
   detecting per connection activity by some other unspecified means,
   the result may be indicated for each connection using the Flags
   field. The Connection Activity message is:

      Message Type = 48

   The Connection Activity request and success response messages have
   the following format:

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Version    | Message Type  |    Result     |     Code      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                    Transaction Identifier                     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |       Number of Records       |            Reserved           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   ~                      Activity Records                        ~
   |                                                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
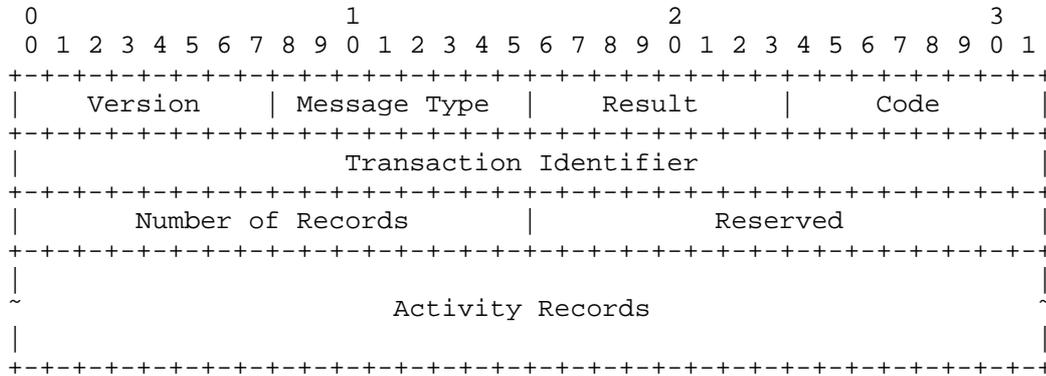
Number of Records
         Field specifies the number of Activity Records to follow.
         The number of Connection Activity records in a single
         Connection Activity message must not cause the packet
         length to exceed the maximum transmission unit defined by
         the encapsulation.

Each Activity Record has the following format:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Input Port                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|V|C|A|x|      Input VPI        |         Input VCI             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                              |
+                       Traffic Count                          +
|                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
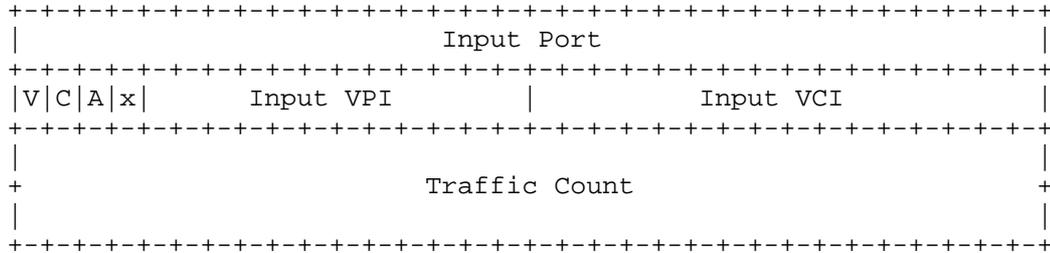
Input Port
         Identifies the port number of the input port on which the
         connection of interest arrives in order to identify the
         connection (regardless of whether the traffic count for the
         connection is maintained on the input port or the output
         port).

Input VPI
Input VCI
         Fields identify the specific virtual path connection or
         virtual channel connection for which statistics are being
         requested. For a virtual path connection the Input VCI
         field is not used.

Flags

    V: Valid Record
         In the success response message the Valid Record flag is
         used to indicate an invalid Activity Record. The flag must
         be zero if any of the fields in this Activity Record are
         invalid, if the input port specified by the Input Port
         field does not exist, or if the specified connection does
         not exist. If the Valid Record flag is zero in a success
         response message, the Counter flag, the Activity flag, and
         the VC Traffic Count field are undefined. If the Valid
         Record flag is set, the Activity Record is valid, and the
         Counter and Activity flags are valid. The Valid Record flag
         is not used in the request message.

   C: Counter
        In a success response message, if the Valid Record flag is
        set, the Counter flag, if zero, indicates that the value in
        the VC Traffic Count field is valid. If set, it indicates
        that the value in the Activity flag is valid. The Counter
        flag is not used in the request message.

   A: Activity
        In a success response message, if the Valid Record and
        Counter flags are set, the Activity flag, if set, indicates
        that there has been some activity on this connection since
        the last Connection Activity message for this connection.
        If zero, it indicates that there has been no activity on
        this connection since the last Connection Activity message
        for this connection. The Activity flag is not used in the
        request message.

   x: Unused

Traffic Count
        Field is not used in the request message. In the success
        response message, if the switch supports per connection
        traffic counting, the Traffic Count field must be set to
        the value of a free running, connection specific, 64-bit
        traffic counter counting traffic flowing across the
        specified connection. The value of the traffic counter is
        not modified by reading it. If per connection traffic
        counting is supported, the switch must report the
        Connection Activity result using the traffic count rather
        than using the Activity flag.

The format of the failure response is the same as the request message
with the Number of Records field set to zero and no VC Activity
records returned in the message. If the switch is incapable of
detecting per connection activity, a failure response must be
returned indicating, "The specified request is not implemented on
this switch."

6.2 Statistics Messages

The Statistics messages are used to query the various port,
connection, and QoS class traffic and error counters.

The Statistics request messages have the following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Version   |  Message Type |     Result    |      Code     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Port                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| zero  |         VPI           |              VCI              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      QoS Class Identifier                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
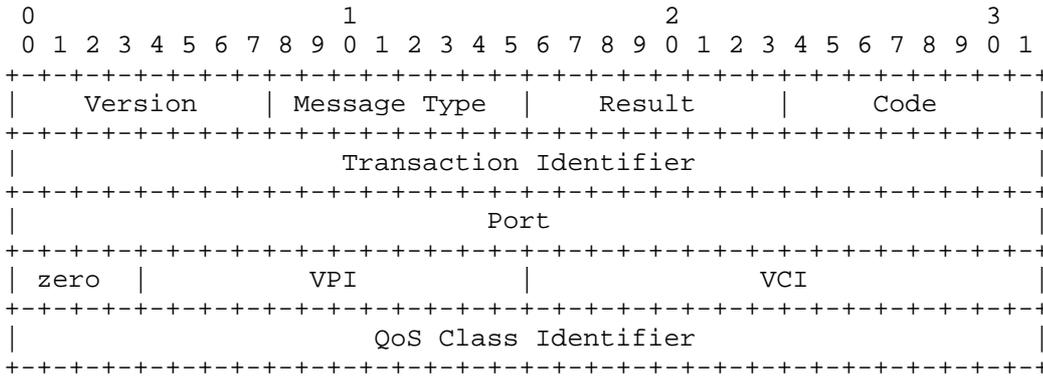
VPI
VCI

        Fields identify the specific virtual path connection or
        virtual channel connection for which statistics are being
        requested. For a virtual path connection the Input VCI
        field is not used. For requests that do not require a
        virtual path connection or virtual channel connection to be
        specified, the VPI and VCI fields are not used.

QoS Class Identifier
        Field identifies the QoS class for which statistics are
        being requested. This field is only used if the QoS Class
        Establishment message defined in section 9.4 is
        implemented.

The success response for the Statistics message has the following
format:

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Version   |  Message Type |     Result    |     Code      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                      Transaction Identifier                   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                            Port                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | zero  |          VPI          |              VCI              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                      QoS Class Identifier                     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   +                      Input Cell Count                        +
   |                                                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   +                      Input Frame Count                       +
   |                                                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   +                   Input Cell Discard Count                   +
   |                                                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   +                  Input Frame Discard Count                   +
   |                                                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   +                   Input HEC Error Count                      +
   |                                                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   +                 Input Invalid VPI/VCI Count                  +
   |                                                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   +                     Output Cell Count                        +
   |                                                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   +                    Output Frame Count                        +
   |                                                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   +                 Output Cell Discard Count                    +
   |                                                              |
```

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                    Output Frame Discard Count                 +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Port
VPI/VCI
QoS Class Identifier
        Fields are the same as those of the request message.

Input Cell Count
Output Cell Count
        Give the value of a free running 64-bit counter counting
        cells arriving at the input or departing from the output
        respectively.

Input Frame Count
Output Frame Count
        Give the value of a free running 64-bit counter counting
        frames (packets) arriving at the input or departing from
        the output respectively.

Input Cell Discard Count
Output Cell Discard Count
        Give the value of a free running 64-bit counter counting
        cells discarded due to queue overflow on an input port or
        on an output port respectively.

Input Frame Discard Count
Output Frame Discard Count
        Give the value of a free running 64-bit counter counting
        frames discarded due to congestion on an input port or on
        an output port respectively.

HEC Error Count
        Gives the value of a free running 64-bit counter counting
        cells discarded due to header checksum errors on arrival at
        an input port.

Invalid VPI/VCI Count
        Gives the value of a free running 64-bit counter counting
        cells discarded because their VPI/VCI is invalid on arrival
        at an input port. For a virtual channel connection an
        incoming VPI/VCI is invalid if no connection is currently
        established having that value of VPI/VCI. For a virtual
        path connection an incoming VPI is invalid if no connection
        is currently established having that value of VPI.

6.2.1 Port Statistics Message

   The Port Statistics message requests the statistics for the switch
   port specified in the Port field. The contents of the VPI/VCI and the
   QoS Class Identifier fields in the Port Statistics request message
   are ignored. All of the count fields in the success response message
   refer to per-port counts regardless of the connection or QoS class to
   which the cells belong. Any of the count fields in the success
   response message not supported by the port must be set to zero. The
   Port Statistics message is:

      Message Type = 49

6.2.2 Connection Statistics Message

   The Connection Statistics message requests the statistics for the
   virtual channel connection specified in the VPI/VCI field, or the
   virtual path connection specified in the VPI field, that arrives on
   the switch input port specified in the Port field, regardless of the
   QoS class to which the cells belong. All of the count fields in the
   success response message refer only to the specified connection. The
   HEC Error Count and Invalid VPI/VCI Count fields are not connection
   specific and must be set to zero. Any of the other count fields not
   supported on a per connection basis must be set to zero in the
   success response message. The Connection Statistics message is:

      Message Type = 50

6.2.3 QoS Class Statistics Message

   The QoS Class Statistics message requests the statistics for the QoS
   class specified by the QoS Class Identifier field that arrives on the
   switch input port specified in the Port field, regardless of the
   connection to which the cells belong. The QoS Statistics message is
   only used if the QoS Class Establishment message defined in section
   9.4 is implemented. The contents of the VPI/VCI fields in the QoS
   Class Statistics request message are ignored. All of the count fields
   in the success response message refer only to the specified QoS
   class. The HEC Error Count and Invalid VPI/VCI Count fields are not
   specific to a QoS class and must be set to zero. Any of the other
   count fields not supported on a per QoS class basis must be set to
   zero in the success response message. The QoS Class Statistics
   message is:

      Message Type = 51

6.3 Report Connection State Message

   The Report Connection State message is used to request an input port
   to report the connection state for a single virtual channel
   connection, a single virtual path connection, or for the entire input
   port. The Report Connection State message is:

      Message Type = 52

   The Report Connection State request message has the following format:
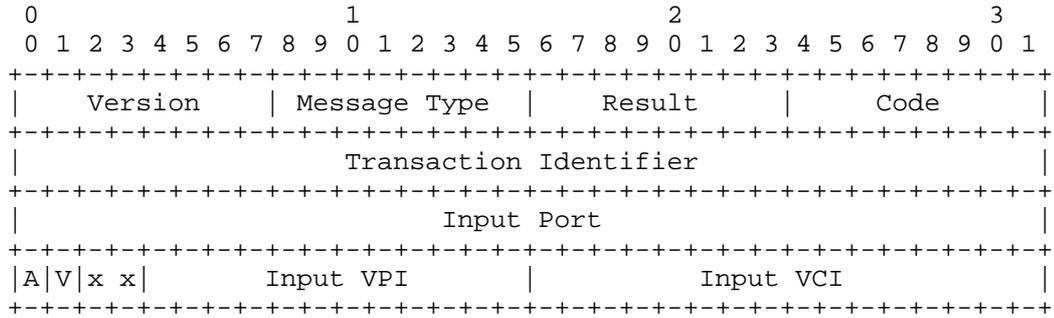
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    | Message Type  |    Result     |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Input Port                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|A|V|x x|      Input VPI        |          Input VCI            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Input Port
           Identifies the port number of the input port for which the
           connection state is being requested.

   Flags

       A: All Connections
           If the All Connections flag is set, the message requests
           the connection state for all virtual path connections and
           virtual channel connections that arrive at the input port
           specified by the Input Port field. In this case the Input
           VPI and Input VCI fields and the VPI/VCI flag are unused.

       V: VPI/VCI
           If the All Connections flag is zero and the VPI/VCI flag is
           set, the message requests the connection state for the
           virtual path connection that arrives at the input port
           specified by the Input Port and Input VPI fields. If the
           specified Input VPI identifies a virtual path connection
           (i.e. a single switched virtual path) the state for that
           connection is requested. If the specified Input VPI
           identifies a virtual path containing virtual channel
           connections, the message requests the connection state for
           all virtual channel connections that belong to the
           specified virtual path. The Input VCI field is not used.

          If the All Connections flag is zero and the VPI/VCI flag is
          also zero, the message requests the connection state for
          the virtual channel connection that arrives at the input
          port specified by the Port, Input VPI and Input VCI fields.

          x: Unused.

  Input VPI
  Input VCI
          Fields identify the specific virtual path connection, the
          specific virtual path, or the specific virtual channel
          connection for which connection state is being requested.
          For a virtual path connection (switched as a single virtual
          path connection) or a virtual path (switched as one or more
          virtual channel connections within the virtual path) the
          Input VCI field is not used. For requests that do not
          require a virtual path connection or virtual channel
          connection to be specified, the Input VPI and Input VCI
          fields are not used.

  The Report Connection State success response message has the
  following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    | Message Type  |    Result     |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Input Port                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Sequence Number                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                      Connection Records                       ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

  Input Port
          Is the same as the Input Port field in the request message.
          It identifies the port number of the input port for which
          the connection state is being reported.

  Sequence Number
          In the case that the requested connection state cannot be
          reported in a single success response message, each
          successive success response message in reply to the same

        request message must increment the Sequence Number. The
        Sequence Number of the first success response message, in
        response to a new request message, must be zero.

    Connection Records
        Each success response message must contain one or more
        Connection Records. Each Connection Record specifies a
        single point-to-point or point-to-multipoint virtual path
        connection or virtual channel connection. The number of
        Connection Records in a single Report Connection State
        success response must not cause the packet length to exceed
        the maximum transmission unit defined by the encapsulation.
        If the requested connection state cannot be reported in a
        single success response message, multiple success response
        messages must be sent. All success response messages that
        are sent in response to the same request message must have
        the same Input Port and Transaction Identifier fields as
        the request message. A single Connection Record must not be
        split across multiple success response messages. The More
        flag of the last Connection Record in a success response
        message indicates whether the response to the request has
        been completed or whether one or more further success
        response messages should be expected in response to the
        same request message.

    Each Connection Record has the following format:

    +-+
    |A|V|P|M| Input VPI | Input VCI |
    +-+
    | |
    ~   Output Branch Records   ~
    | |
    +-+
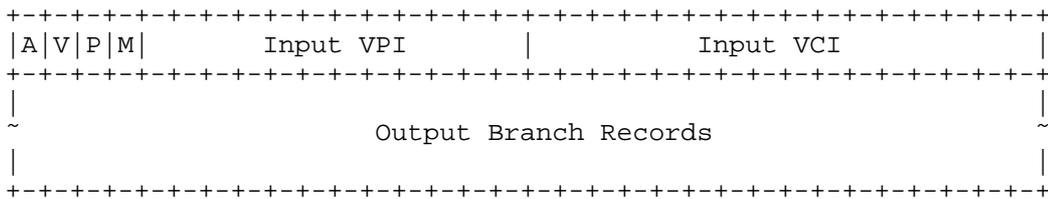
    Flags

        A: All Connections
        V: VPI/VCI
            For the first Connection Record in each success response
            message the All Connections and the VPI/VCI flags must be
            the same as those of the request message. For successive
            Connection Records in the same success response message
            these flags are not used.

        P: VPC
            The VPC flag, if set, indicates that the Connection Record
            refers to a virtual path connection. If zero, it indicates

that the Connection Record refers to a virtual channel
connection.

  M: More
        If the More flag is set, it indicates that another
        Connection Record, in response to the same request message,
        will follow either in the same success response message or
        in a successive success response message. If the More flag
        is zero it indicates that this is the last Connection
        record in this success response message and that no further
        success response messages will be sent in response to the
        current request message. It indicates that the response to
        the request message is now complete.

Input VPI
Input VCI
        The input VPI and VCI of the connection specified in this
        Connection Record. If this Connection Record specifies a
        virtual path connection (the VPC flag is set) the Input VCI
        field is unused.

Output Branch Records
        Each Connection Record must contain one or more Output
        Branch Records. Each Output Branch Record specifies a
        single output branch belonging to the connection identified
        by the Input VPI and Input VCI fields of the Connection
        Record. A point-to-point connection will require only a
        single Output Branch Record. A point-to-multipoint
        connection will require multiple Output Branch Records. The
        last Output Branch Record of each Connection Record is
        indicated by the Last Branch flag of the Output Branch
        Record. If a point-to-multipoint connection has more output
        branches than can fit in a single Connection Record
        contained within a single success response message, that
        connection may be reported using multiple Connection
        Records in multiple success response messages.

Each Output Branch Record has the following format:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Output Port                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|L|x x x|       Output VPI       |          Output VCI          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Output Port
        The output port of the switch to which this output branch
        is routed.

Flags

L: Last Branch
The Last Branch flag, if set, indicates that this is the
last Output Branch Record of this Connection Record. If
zero, it indicates that one or more further Output Branch
Records are to follow. If this is the last Output Branch
Record in the message and the Last Branch flag is zero,
further output branches belonging to the same connection
will be given in another Connection Record. This Connection
Record will be the first Connection Record in the next
success response message. This Connection Record must have
the same Input VPI and Input VCI values as the current
Connection Record.

x: Unused.

Output VPI
Output VCI
The output VPI and VCI of the output branch specified in
this Output Branch Record. If this Output Branch Record is
part of a Connection Record that specifies a virtual path
connection (the VPC flag is set) the Output VCI field is
unused.

A Report Connection State request message may be issued regardless of
the Port Status or the Line Status of the target switch port.

If the Input Port of the request message is valid, and the All
Connections flag is set, but there are no connections established on
that port, a failure response message must be returned with the code
field set to, "Failure specific to the particular message type." For
the Report Connection State message, this failure code indicates that
no connections matching the request message were found. This failure
message should also be returned if the Input Port of the request
message is valid, the All Connections flag is zero, and no
connections are found on that port matching the specified virtual
path connection, virtual path, or virtual channel connection.

7. Configuration Messages

The configuration messages permit the controller to discover the
capabilities of the switch. Three configuration request messages have
been defined: Switch, Port, and All Ports.

All configuration request messages have the following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    |  Message Type |      Result     |     Code     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            Port                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

7.1 Switch Configuration Message

The Switch Configuration message requests the global (non port-
specific) configuration for the switch. The Switch Configuration
message is:

    Message Type = 64

The Port field is not used in the request message.

The Switch Configuration success response message has the following
format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    |  Message Type |      Result     |     Code     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Firmware Version Number   |         Window Size           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Switch Type          |                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+                               +
|                         Switch Name                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Firmware Version Number
           The version number of the switch control firmware
           installed.

   Window Size
           The maximum number of unacknowledged request messages that
           may be transmitted by the controller without the
           possibility of loss. This field is used to prevent request
           messages being lost in the switch because of overflow in
           the receive buffer. The field is a hint to the controller.
           If desired, the controller may experiment with higher and

        lower window sizes to determine heuristically the best
        window size.

    Switch Type
        A 16-bit field allocated by the manufacturer of the switch.
        (For these purposes the manufacturer of the switch is
        assumed to be the organization identified by the OUI in the
        Switch Name field.) The Switch Type identifies the product.
        When the Switch Type is combined with the OUI from the
        Switch Name the product is uniquely identified. Network
        Management may use this identification to obtain product
        related information from a database.

    Switch Name
        A 48-bit quantity that is unique within the operational
        context of the device. A 48-bit IEEE 802 MAC address, if
        available, may be used as the Switch Name. The most
        significant 24 bits of the Switch Name must be an
        Organizationally Unique Identifier (OUI) that identifies
        the manufacturer of the switch.

7.2 Port Configuration Message

   The Port Configuration message requests the switch for the
   configuration information of a single switch port. The Port field in
   the request message specifies the port for which the configuration is
   requested. The Port Configuration message is:

      Message Type = 65.

   The Port Configuration success response message has the following
   format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Version     |   Message Type  |     Result      |    Code     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Port                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Port Session Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|V|M|L|R|      Min VPI        |Q|x x x|        Max VPI           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Min VCI           |            Max VCI               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Receive Cell Rate                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Transmit Cell Rate                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Port Status  |   Port Type   |  Line Status  |   Priorities  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Physical Slot Number     |    Physical Port Number         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Port

        The switch port to which the configuration information
        refers. Configuration information relating to both the
        input and the output sides of the switch port is given.
        Port numbers are 32 bits wide and allocated by the switch.
        The switch may choose to structure the 32 bits into
        subfields that have meaning to the physical structure of
        the switch hardware (e.g. physical slot and port). This
        structure may be indicated in the Physical Slot Number and
        Physical Port Number fields.

Flags

    V: VP Switching
        The VP Switching flag, if set, indicates that this input
        port is capable of supporting virtual path switching. Else,
        if zero, it indicates that this input port is only capable
        of virtual channel switching.

    M: Multicast Labels
        The Multicast Labels flag, if set, indicates that this
        output port is capable of labelling each output branch of a
        point-to-multipoint tree with a different label. If zero,
        it indicates that this output port is not able to label

each output branch of a point-to-multipoint tree with a
different label.

L: Logical Multicast
The Logical Multicast flag, if set, indicates that this
output port is capable of supporting more than a single
branch from any point-to-multipoint connection. This
capability is often referred to as logical multicast. If
zero, it indicates that this output port can only support a
single output branch from each point-to-multipoint
connection.

R: Label Range
The Label Range flag, if set, indicates that this switch
port is capable of reallocating its VPI label range or its
VCI label range and therefore accepts the Label Range
message. Else, if zero, it indicates that this port does
not accept Label Range messages.

Q: QoS
The QoS flag, if set, indicates that this switch port is
capable of handling the Quality of Service messages defined
in section 9 of this specification. Else, if zero, it
indicates that this port does not accept the Quality of
Service messages.

x: Unused

Min VPI
The default minimum value of dynamically assigned incoming
VPI that the connection table on the input port supports
and that may be controlled by GSMP. This value is not
changed as a result of the Label Range message.

Max VPI
The default maximum value of dynamically assigned incoming
VPI that the connection table on the input port supports
and that may be controlled by GSMP. This value is not
changed as a result of the Label Range message.

At power-on, after a hardware reset, and after the Reset
Input Port function of the Port Management message, the
input port must handle all values of VPI within the range
Min VPI to Max VPI inclusive and GSMP must be able to
control all values within this range. It should be noted
that the range Min VPI to Max VPI refers only to the
incoming VPI range that can be supported by the associated
port. No restriction is placed on the values of outgoing

VPIs that may be written into the cell header. If the
switch does not support virtual paths it is acceptable for
both Min VPI and Max VPI to specify the same value, most
likely zero.

Use of the Label Range message allows the range of VPIs
supported by the port to be changed. However, the Min VPI
and Max VPI fields in the Port Configuration and All Ports
Configuration messages always report the same default
values regardless of the operation of the Label Range
message.

Min VCI

The default minimum value of dynamically assigned incoming
VCI that the connection table on the input port can support
and may be controlled by GSMP. This value is not changed as
a result of the Label Range message.

Max VCI

The default maximum value of dynamically assigned incoming
VCI that the connection table on the input port can support
and may be controlled by GSMP. This value is not changed as
a result of the Label Range message.

At power-on, after a hardware reset, and after the Reset
Input Port function of the Port Management message, the
input port must handle all values of VCI within the range
Min VCI to Max VCI inclusive, for each of the virtual paths
in the range Min VPI to Max VPI inclusive, and GSMP must be
able to control all values within this range. It should be
noted that the range Min VCI to Max VCI refers only to the
incoming VCI range that can be supported by the associated
port on each of the virtual paths in the range Min VPI to
Max VPI. No restriction is placed on the values of outgoing
VCIs that may be written into the cell header.

Use of the Label Range message allows the range of VCIs to
be changed on each VPI supported by the port. However, the
Min VCI and Max VCI fields in the Port Configuration and
All Ports Configuration messages always report the same
default values regardless of the operation of the Label
Range message.

For a port over which the GSMP protocol is operating, the
VCI of the GSMP control channel may or may not be reported
as lying within the range Min VCI to Max VCI. A switch
should honor a connection request message that specifies

the VCI value of the GSMP control channel even if it lies
outside the range Min VCI to Max VCI.

Receive Cell Rate
        The maximum rate of cells that may arrive at the input port
        in cells/s.

Transmit Cell Rate
        The maximum rate of cells that may depart from the output
        port in cells/s. (The transmit cell rate of the output port
        may be changed by the Set Transmit Cell Rate function of
        the Port Management message.)

Port Status
        Gives the administrative state of the port. The defined
        values of the Port Status field are:

        Available:
             Port Status = 1. The port is available to both send
             and receive cells. When a port changes to the
             Available state from any other administrative state,
             all dynamically assigned virtual connections must be
             cleared and a new Port Session Number must be
             generated.

        Unavailable:
             Port Status = 2. The port has intentionally been taken
             out of service. No cells will be transmitted from this
             port. No cells will be received by this port.

        Internal Loopback:
             Port Status = 3. The port has intentionally been taken
             out of service and is in internal loopback: cells
             arriving at the output port from the switch fabric are
             looped through to the input port to return to the
             switch fabric. All of the ATM functions of the input
             port above the physical layer, e.g. header
             translation, are performed upon the looped back cells.

        External Loopback:
             Port Status = 4. The port has intentionally been taken
             out of service and is in external loopback: cells
             arriving at the input port from the external
             communications link are immediately looped back to the
             communications link at the physical layer without
             entering the input port. None of the ATM functions of
             the input port above the physical layer are performed
             upon the looped back cells.

Bothway Loopback:
    Port Status = 5. The port has intentionally been taken
    out of service and is in both internal and external
    loopback.

The Port Status of the port over which the GSMP session
controlling the switch is running, must be declared
Available. The controller will ignore any other Port status
for this port. The Port Status of switch ports after
power-on initialization is not defined by GSMP.

Port Type
        The type of physical transmission interface for this port.
        The values for this field are defined by the atmIfType
        object specified in the Ipsilon IP Switch MIB [IpsilonMIB].

Line Status
        The status of the physical transmission medium connected to
        the port. The defined values of the Line Status field are:

        Up:
            Line Status = 1. The line is able to both send and
            receive cells. When the Line Status changes to Up
            from either the Down or Test states, a new Port
            Session Number must be generated.

        Down:
            Line Status = 2. The line is unable either to send or
            receive cells or both.

        Test:
            Line Status = 3. The port or line is in a test mode,
            for example, power-on test.

Priorities
        The number of different priority levels that this output
        port can assign to virtual connections. Zero is invalid in
        this field. If an output port is able to support "Q"
        priorities, the highest priority is numbered zero and the
        lowest priority is numbered "Q-1". The ability to offer
        different qualities of service to different connections
        based upon their priority is assumed to be a property of
        the output port of the switch. It may be assumed that for
        connections that share the same output port, an ATM cell on
        a connection with a higher priority is much more likely to
        exit the switch before an ATM cell on a connection with a
        lower priority if they are both in the switch at the same
        time.

Physical Slot Number
          The physical location of the slot in which the port is
          located. It is an unsigned 16-bit integer that can take any
          value except 0xFFFF. The value 0xFFFF is used to indicate
          "unknown." The Physical Slot Number is not used by the GSMP
          protocol. It is provided to assist network management in
          functions such as logging, port naming, and graphical
          representation.

Physical Port Number
          The physical location of the port within the slot in which
          the port is located. It is an unsigned 16-bit integer that
          can take any value except 0xFFFF. The value 0xFFFF is used
          to indicate "unknown." The Physical Port Number is not used
          by the GSMP protocol. It is provided to assist network
          management in functions such as logging, port naming, and
          graphical representation.

          There must be a one to one mapping between Port Number and
          the Physical Slot Number and Physical Port Number
          combination. Two different Port Numbers must not yield the
          same Physical Slot Number and Physical Port Number
          combination. The same Port Number must yield the same
          Physical Slot Number and Physical Port Number within a
          single GSMP session. If both Physical Slot Number and
          Physical Port Number indicate "unknown" the physical
          location of switch ports may be discovered by looking up
          the product identity in a database to reveal the physical
          interpretation of the 32-bit Port Number.

7.3 All Ports Configuration Message

   The All Ports Configuration message requests the switch for the
   configuration information of all of its ports. The All Ports
   Configuration message is:

      Message Type = 66

   The Port field is not used in the request message.

   The All Ports Configuration success response message has the
   following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Version   |  Message Type |     Result    |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Number of Records        |      Port Record Length       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                        Port Records                           ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
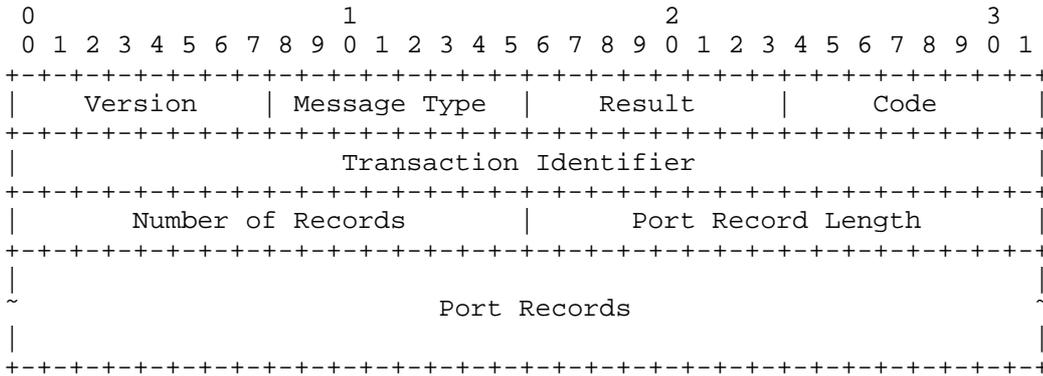
Number of Records
        Field gives the total number of Port Records to be returned
        in response to the All Ports Configuration request message.
        The number of port records in a single All Ports
        Configuration success response must not cause the packet
        length to exceed the maximum transmission unit defined by
        the encapsulation. If a switch has more ports than can be
        sent in a single success response message it must send
        multiple success response messages. All success response
        messages that are sent in response to the same request
        message must have the same Transaction Identifier as the
        request message and the same value in the Number of Records
        field. All success response messages that are sent in
        response to the same request message, except for the last
        message, must have the result field set to "More." The last
        message, or a single success response message, must have
        the result field set to "Success." All Port records within
        a success response message must be complete, i.e. a single
        Port record must not be split across multiple success
        response messages.

   Port Record Length
        Field gives the length of each port record in bytes. This
        is currently 32 but the Port Record Length field allows for
        the future definition of further fields at the end of the
        port record while preserving compatibility with earlier
        versions of the protocol.

   Port Records
        Follow in the remainder of the message. Each port record
        has the following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            Port                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Port Session Number                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|V|M|L|R|      Min VPI      |Q|x x x|        Max VPI            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Min VCI          |            Max VCI                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Receive Cell Rate                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Transmit Cell Rate                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Port Status  |   Port Type   |  Line Status  |  Priorities  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Physical Slot Number      |    Physical Port Number       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The definition of the fields in the Port Record is exactly the same
as that of the Port Configuration message.

8. Event Messages

   Event messages allow the switch to inform the controller of certain
   asynchronous events. Event messages are not acknowledged. The Result
   field and the Code field in the message header are not used and
   should be set to zero. Event messages are not sent during
   initialization. Event messages have the following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version     | Message Type  |    Result     |     Code     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            Port                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Port Session Number                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Event Sequence Number                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| zero  |        VPI         |              VCI                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Event Sequence Number
          The current value of the Event Sequence Number for the
          specified port. The Event Sequence Number is set to zero
          when the port is initialized. It is incremented by one each
          time the port detects an asynchronous event that the switch
          would normally report via an Event message. The Event
          Sequence Number must be incremented each time an event
          occurs even if the switch is prevented from sending an
          Event message due to the action of the flow control.

VPI/VCI
          Field gives the VPI/VCI to which the event message refers.
          If this field is not required by the event message it is
          set to zero.

Each switch port must maintain an Event Sequence Number and a set of
Event Flags, one Event Flag for each type of Event message. When a
switch port sends an Event message it must set the Event Flag on that
port corresponding to the type of the event. The port is not
permitted to send another Event message of the same type until the
Event Flag has been reset. Event Flags are reset by the "Reset Event
Flags" function of the Port Management message. This is a simple flow
control preventing the switch from flooding the controller with event
messages. The Event Sequence Number of the port must be incremented
every time an event is detected on that port even if the port is
prevented from reporting the event due to the action of the flow
control. This allows the controller to detect that it has not been
informed of some events that have occurred on the port due to the
action of the flow control.

8.1 Port Up Message

The Port Up message informs the controller that the Line Status of a
port has changed from either the Down or Test state to the Up state.
When the Line Status of a switch port changes to the Up state from
either the Down or Test state a new Port Session Number must be
generated, preferably using some form of random number. The new Port
Session Number is given in the Port Session Number field. The VPI/VCI
field is not used and is set to zero. The Port Up message is:

     Message Type = 80

8.2 Port Down Message

The Port Down message informs the controller that the Line Status of
a port has changed from the Up state to the Down state. This message
will be sent to report link failure if the switch is capable of
detecting link failure. The port session number that was valid before

the port went down is reported in the Port Session Number field. The
VPI/VCI field is not used and is set to zero. The Port Down message
is:

     Message Type = 81

8.3 Invalid VPI/VCI Message

   The Invalid VPI/VCI message is sent to inform the controller that one
   or more cells have arrived at an input port with a VPI/VCI that is
   currently not allocated to an assigned connection. The input port is
   indicated in the Port field, and the VPI/VCI in the VPI/VCI field.
   The Invalid VPI/VCI message is:

     Message Type = 82

8.4 New Port Message

   The New Port message informs the controller that a new port has been
   added to the switch. The port number of the new port is given in the
   Port field. A new Port Session Number must be assigned, preferably
   using some form of random number. The new Port Session Number is
   given in the Port Session Number field. The state of the new port is
   undefined so the VPI/VCI field is not used and is set to zero. The
   New Port message is:

     Message Type = 83

8.5 Dead Port Message

   The Dead Port message informs the controller that a port has been
   removed from the switch. The port number of the port is given in the
   Port field. The Port Session Number that was valid before the port
   was removed is reported in the Port Session Number field. The
   VPI/VCI fields are not used and are set to zero. The Dead Port
   message is:

     Message Type = 84

9. Quality of Service Messages

   The GSMP Quality of Service (QoS) messages allow a controller to
   group virtual path connections and virtual channel connections into
   QoS classes, and to allocate QoS resources to both QoS classes and to
   individual connections. At initialization, the switch describes its
   QoS capabilities to the controller, in terms of the abstract switch
   model, using the QoS Configuration message. The controller issues

Scheduler Establishment messages to configure the scheduler on each
switch output port. It also issues QoS Class Establishment messages
to configure QoS classes. Connections may be added to, or deleted
from, a QoS class using the QoS Connection Management message. QoS
resources may also be assigned to individual connections using the
QoS Connection Management message. Connections that only require the
scheduler may use the simple connection management messages defined
in Section 3, "Connection Management Messages."

9.1 Abstract Switch Model

   The abstract switch model, fig. 1, is the means by which a switch can
   describe its fundamental QoS capabilities to a controller. It
   consists of four main functions: a policer, a classifier, a
   regulator, and a scheduler. The classifier groups multiple
   connections (VPCs or VCCs) together into a QoS class such that QoS
   resources may be shared by the QoS class as a whole. Within a QoS
   class there is no differentiation between members of the class in
   terms of QoS resources received. However, the ordering of cells
   within each constituent VPC or VCC must be preserved on exit from the
   switch. Connections are not required to be aggregated into a QoS
   class with other connections; they may be allocated individual QoS
   resources.

```
   VPC/VCCs  Policer  Classifier    Regulator       Scheduler

               +--+      +----+                   +--------+
    -------->|  |---->|    |                   |        |
               +--+      |    |                   |        |
                         |    |                   |        |
               +--+      |    |      +----+       |        |
    -------->|  |---->|    |      |    |    |-------->|        |
               +--+      |    |      |    |    |conforming|        |
                         |    |------>|    |    |        |
               +--+      |    |  QoS |    |    |-------->|        |
    -------->|  |---->|    | Class|    |    |        |        |
               +--+      |    |      +----+    excess |        |
                         |    |                   |        |
               +--+      |    |                   |        |
    -------->|  |---->|    |                   |        |
               +--+      +----+                   |        |
                                                  |        |
                                                  |        |
                                                  |        |  Output
                                                  |        |    Port
                                                  |        |---------->
                                                  |        |
                                                  |        |
               +--+      +----+                   |        |
    -------->|  |---->|    |                   |        |
               +--+      |    |                   |        |
                         |    |                   |        |
               +--+      |    |      +----+       |        |
    -------->|  |---->|    |      |    |    |-------->|        |
               +--+      |    |      |    |    |conforming|        |
                         |    |------>|    |    |        |
               +--+      |    |  QoS |    |    |-------->|        |
    -------->|  |---->|    | Class|    |    |        |        |
               +--+      |    |      +----+    excess |        |
                         |    |                   |        |
               +--+      |    |                   |        |
    -------->|  |---->|    |                   |        |
               +--+      +----+                   +--------+
```
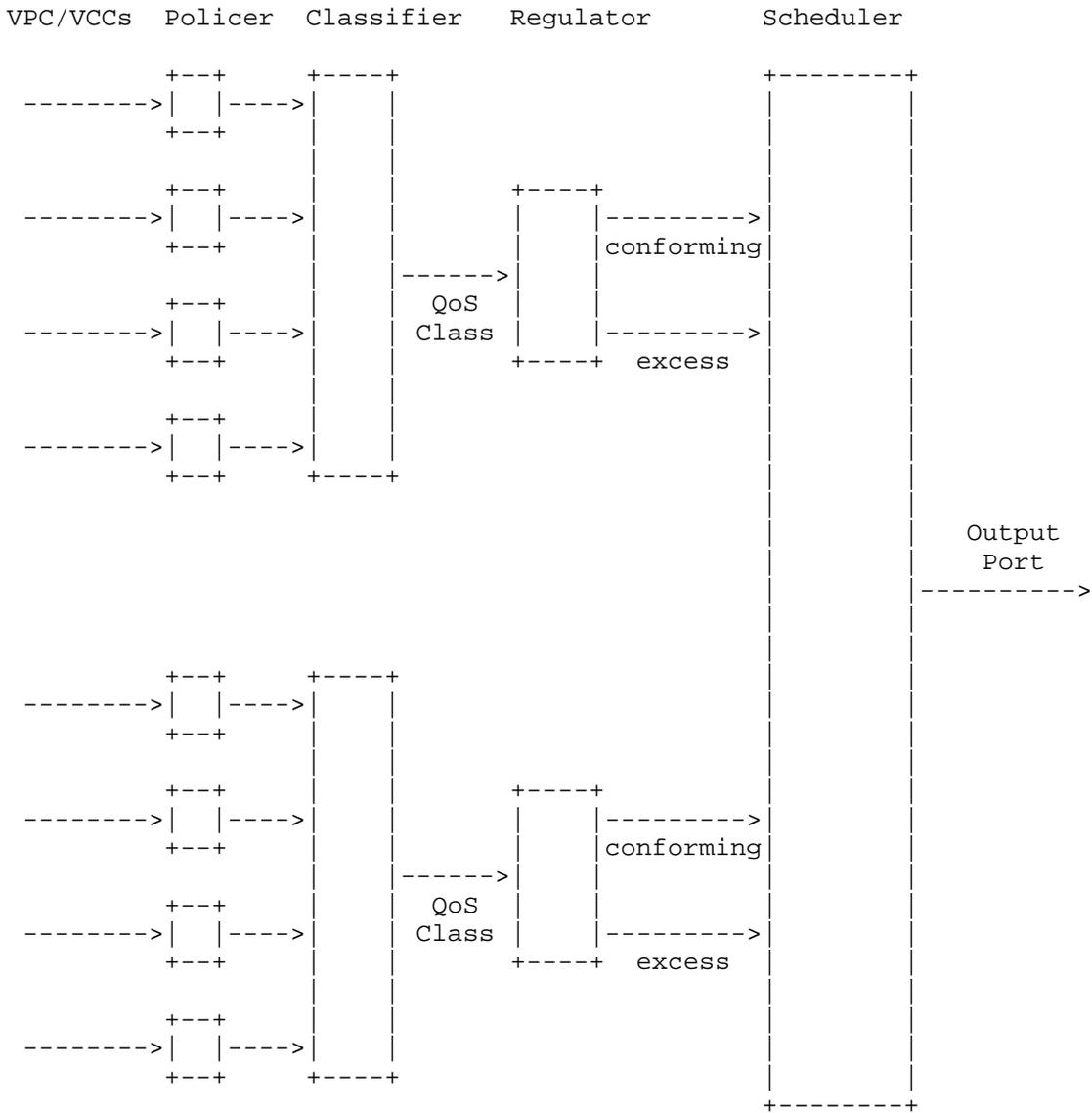
                   Fig. 1: Abstract Switch Model

   The policer is a single input, single output device that can discard
   or tag cells. A policer may be applied to police each individual
   connection. A policer may also be applied to police the aggregate
   traffic of a QoS class. The policer is used to enforce an upper
   bound on the traffic on a connection or on a QoS class.

The regulator follows the policer and classifier. It offers either a
policing function or a shaping function. The policing function
evaluates cells as conforming to the rate specified by the regulator
parameters or as being in excess of that rate. One of three actions
can be specified to be taken for each cell as a result of this
evaluation: tagging, discard or differentiated scheduling. Tagging
sets the CLP bit of cells deemed to be in excess of the rate defined
by the regulator parameters. The discard function discards excess
cells. The differentiated scheduling function allows conforming cells
and excess cells to be scheduled for service at different points in
the scheduler. This would allow conforming cells, for example, to
receive service with a QoS guarantee, whereas excess cells receive
best-effort service. The implementation of differentiated
scheduling, however, is complicated by the requirement not to reorder
cells within each connection.

The shaping function of the regulator paces cells out, on each QoS
class or individual connection, at the rate specified by the
regulator parameters. No jitter requirement may be specified, nor is
any specific guarantee of jitter given. If traffic arrives on any QoS
class or individual connection at a greater rate than the output rate
specified, that traffic will be delayed. If the delayed traffic for
any QoS class or individual connection exceeds a bound, discard will
occur. Differentiated scheduling is supported by the shaper but its
application to shaping is somewhat different than its application to
policing. Conforming traffic is that traffic which leaves the shaper
as a result of the shaping process. The conforming pointer specifies
the point in the scheduler structure where such traffic is scheduled
for output. (This is typically the highest priority of the scheduler
but the GSMP specification permits other priorities to be specified.)
If an excess pointer is also enabled for a particular QoS class or
individual connection, traffic in excess of the rate specified by the
shaper may also be transmitted. The position of the excess pointer
in the scheduler structure determines the undefined amount of
additional traffic that will be supported. The excess traffic may be
tagged if required, if tagging is supported. The excess pointer will
receive the same share of bandwidth that a best-effort class or
connection would receive at the same location in the scheduler
structure.

The location of the classifier and regulator functions in the switch
is important. If the classifier is located on an input port, only
virtual connections that arrive at that input port may be aggregated
into a QoS class. If the classifier is centralized, or located on an
output port, virtual connections that arrive at any input port may be
aggregated into the same QoS class. If the regulator is located on an
output port all virtual connections within a QoS class passing
through that regulator must exit the switch at that output port.

However, if the regulator is centralized, or located on an input
port, virtual connections that are part of the same QoS class may be
switched to different output ports. Each switch port must specify
the location of its classifier and regulator functions.

The scheduler is located on the output port, fig. 2. It distributes
the bandwidth of the output link between the QoS classes and
individual connections. It is a two-level scheduler: a priority
scheduler at one level and a FIFO or a weighted scheduler at the
other. Up to 255 strict priority levels may be supported. Traffic in
any specific priority level may only be transmitted if no traffic is
queued for transmission in any higher priority level. Within each
priority level a weighted scheduler may be defined. Each leaf of the
scheduler tree is connected to a waiting room. The waiting room has
two functions. When it receives service from the scheduler, it must
select a QoS class or individual connection for transmission. When it
is notified of traffic arrival on a QoS class or connection, it must
decide whether there is enough room left in the waiting room to
accept the traffic, else that traffic must be discarded. The waiting
room has a size parameter indicating how much traffic may be
accepted. Other queueing parameters may be attached to the waiting
room. Multiple conforming and excess pointers from the regulators may
point to each waiting room. Within a waiting room, the scheduling of
multiple connections sharing that waiting room may support weighted
sharing between the connections.

```
           From        Waiting       FIFO/Weighted      Priority
          Regulator     Room           Scheduler        Scheduler

                              Net       +---+
                   +------+ Weight      |   |
          ---------->|      |-%-------->| 0 |------\
                   +------+            |   |        \
                                       +---+         \

          --------->+------+                          |
                   |      |-%--\        +---+         |
          --------->+------+     \---->|   |         |
                                       | 1 |---\     |
                   +------+     /---->|   |    \    \
          --------->|      |-%--/      +---+     \    \    +---+
                   +------+                       \    \-->|   |
                                                   \----->|   |--------->
                                                   /-->|   | Output
          --------->+------+                      /     +---+  Port
          --------->|      |-%-\                 /
          --------->+------+     \        +---+  /
                                  \      |   | /
                   +------+        \--->|   |/
          --------->|      |-%-------->| 2 |-----/
                   +------+      /--->|   |
                                /     +---+
                   +------+    /
          --------->|      |-%-/
                   +------+
```
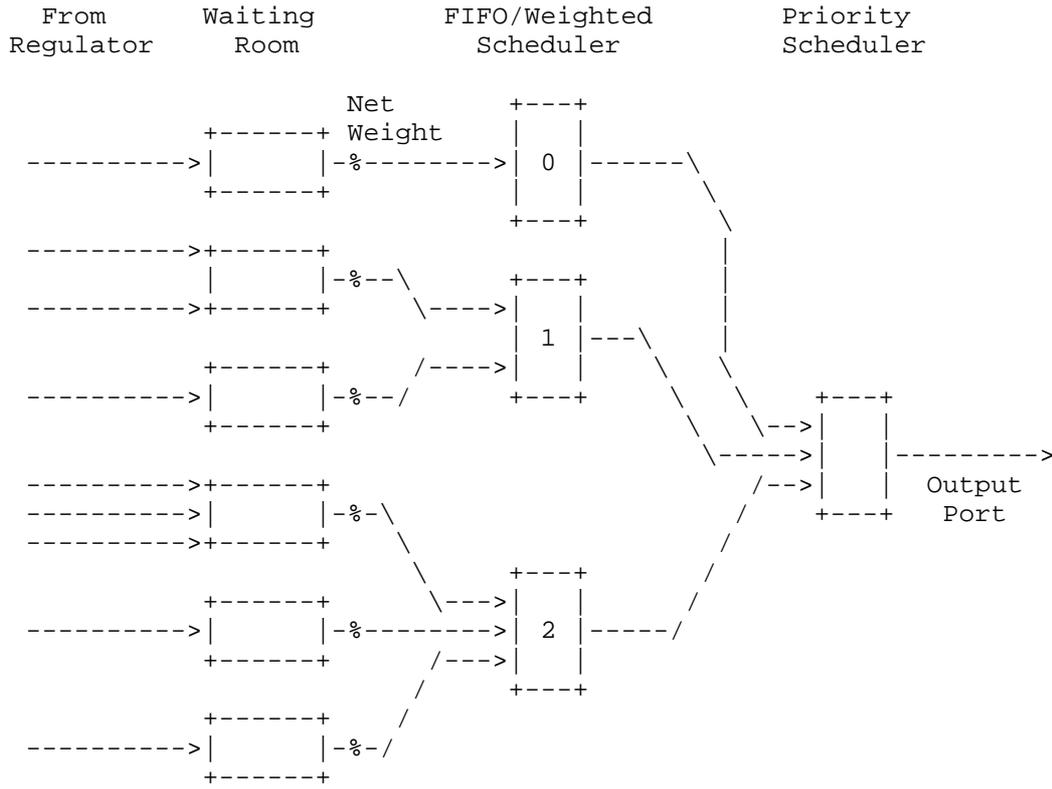
                        Fig. 2: The Scheduler

9.2 QoS Configuration Message

     The QoS Configuration message permits the controller to discover the
     QoS capabilities of each switch port in terms of the abstract switch
     model. The QoS Configuration message is:

        Message Type = 96

     The QoS Configuration request message has the following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Version   |  Message Type |     Result    |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Port                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The QoS Configuration success response message has the following
format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Version   |  Message Type |     Result    |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Transaction Identifier                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Port                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Port Session Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       Scheduler Flags         |        Regulator Flags        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Excess Capabilities       |           Reserved            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Hi Sharing   |  Lo Sharing   |          Max Classes          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Default Size                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Default Discard Threshold                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Max Buffer                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Max Shaper Buffer                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Scaling Factor                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Port

        The switch port to which the QoS configuration information
        refers. QoS configuration information relating to both the
        input and the output sides of the switch port is given.

   Scheduler Flags

          0   1
          0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         |W|Q|S|G|D|F|M|B|I|x x x x x x|
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

         W: Weighted Connections
              Bit 0 of the Scheduler Flags field, if set, indicates that
              a weighted service algorithm (such as weighted round-robin)
              is available for allocation of service to individual
              connections within at least some waiting rooms. It means
              that a Connection Weight parameter can be attached to a QoS
              Connection Management message. Not all waiting rooms at all
              priority levels may be able to support this function.
              Whether a particular waiting room can support this function
              will be discovered when a QoS Connection Management message
              is issued.

         Q: Weighted QoS Classes
              Bit 1 of the Scheduler Flags field, if set, indicates that
              a weighted service algorithm (such as weighted round-robin)
              is available for allocation of service to QoS classes
              within at least some waiting rooms. It means that a QoS
              Class Weight parameter can be attached to a QoS Class
              Establishment message. Not all waiting rooms at all
              priority levels may be able to support this function.
              Whether a particular waiting room can support this function
              will be discovered when a QoS Class Establishment message
              is issued.

         S: Shared Waiting Room
              Bit 2 of the Scheduler Flags field, if set, indicates that
              multiple QoS classes and multiple connections may be
              scheduled within a single waiting room. This is expected to
              be the normal case. If Bit 2 of the Scheduler Flags field
              is zero, it indicates that only a single QoS class or a
              single connection may be directed to any single waiting
              room.

         G: Global Max Classes
              Bit 3 of the Scheduler Flags field, if set, indicates that
              the Max Classes field gives the maximum number of QoS
              classes that may be supported by the entire switch. If
              zero, it indicates that the Max Classes field gives the
              maximum number of QoS classes that may be supported by this
              switch port.

D: Packet Discard
     Bit 4 of the Scheduler Flags field, if set, indicates that
     the scheduler on this output port is capable of packet
     discard. Packet discard indicates a discard algorithm that
     is aware of AAL-5 packet boundaries and attempts to discard
     whole packets. No specific algorithm is indicated though
     Early Packet Discard (EPD) is likely to be the most common.
     Other algorithms such as "push from front" schemes, dynamic
     threshold, or Random Early Detection (RED) are also
     examples of possible packet discard algorithms. The only
     parameters available to the packet discard algorithm, via
     GSMP, are the Size and Discard Threshold of the waiting
     room.

F: Frame-Based Scheduling
     Bit 5 of the Scheduler Flags field, if set, indicates that
     the scheduler on this output port is capable of frame-based
     scheduling. In frame-based scheduling, a connection is only
     scheduled for transmission when a complete AAL-5 packet is
     available. When a connection is scheduled for
     transmission, all cells belonging to one or more complete
     packets from that connection will be transmitted without
     being interleaved with any other cells on that output port
     (regardless of their priority). Frame-based scheduling is
     a property of the waiting room and is requested in the
     Scheduler Establishment message. A QoS class may be routed
     through a waiting room configured with frame-based
     scheduling. In this case each component connection of the
     QoS class will receive frame based scheduling. For correct
     distribution of bandwidth, each QoS class that requires
     frame-based scheduling should have its own waiting room.

M: VC Merging
     Bit 6 of the Scheduler Flags field, if set, indicates that
     the scheduler on this output port is capable of VC merging
     by a mechanism other than frame-based scheduling. VC
     merging indicates that the switch is capable of the
     multipoint-to-point merging of two or more incoming virtual
     connections onto a single outgoing virtual connection
     without interleaving cells from different AAL-5 packets
     that bear the same VPI/VCI. VC merging differs from frame-
     based scheduling in that cells with a different VPI/VCI may
     be interleaved with those of a multipoint-to-point VC
     merging connection. Thus, higher priority cells may be
     interleaved during the transmission of a packet on a lower
     priority VC merging connection. Most switches achieve VC
     merging by using frame-based scheduling. VC merging is a
     property of the waiting room and is requested in the

          Scheduler Establishment message. A QoS class may be routed
          through a waiting room configured with VC merging. In this
          case each component connection of the QoS class will
          receive VC merging.

     B: Shared Buffer
          Bit 7 of the Scheduler Flags field, if set, indicates that
          at least some of the buffer space specified by the Max
          Buffer field is shared with other ports. If zero, it
          indicates that the buffer space specified by the Max Buffer
          field is not shared with other ports.

     I: Identical Ports
          Bit 8 of the Scheduler Flags field, if set, indicates that
          all ports of the switch have identical QoS capabilities. If
          this bit is set the controller does not have to request the
          QoS configuration of each port individually as all ports
          have the same capability.

     x: Bits 9--15 of the Scheduler Flags field are not used.

  Regulator Flags

     0   1
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |C|Q|I O|P|S|H|M|x x x x x x x x|
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

     C: Connection Policing
          Bit 0 of the Regulator Flags field indicates that this
          input port supports the policing of individual incoming
          connections. The parameters for the policer are specified
          in the QoS Connection Management message when the
          connection is established.

     Q: QoS Class Policing
          If bit 1 of the Regulator Flags field is set, a policer
          function is available to police each QoS class on output
          from the classifier. The parameters for this policer are
          specified in the QoS Class Establishment message. If this
          bit is zero, no policer function is available to police a
          QoS class.

     IO: QoS Class Location
          Bits 2 and 3 of the Regulator Flags field specify the
          location of the classifier and regulator functions. If both

bits 2 and 3 of the Regulator Flags field are zero, no
classifier or regulator function is available to this port.

If bit 2 of the Regulator Flags field is set and bit 3 is
zero, the classifier and regulator functions are available
on the input port. This implies that only virtual
connections arriving at this input port may be grouped into
QoS classes by this classifier. However, connections in a
QoS class output from this regulator may be switched to any
output port.

If bit 2 of the Regulator Flags field is zero and bit 3 is
set, the classifier and regulator functions are available
on the output port. This implies that virtual connections
arriving at any input port may be grouped into QoS classes
by this classifier. However, all connections in any QoS
class output from this regulator may only be switched to
this output port.

If both bits 2 and 3 of the Regulator Flags field are set,
this switch port has access to centralized classifier and
regulator functions. This implies that virtual connections
arriving at any input port may be grouped into a QoS class
by this classifier. Also, connections in a QoS class output
from this regulator may be switched to any output port.

Regulator Function

P: If bit 4 of the Regulator Flags field is set, the regulator
   is able to support the policing function.

S: If bit 5 of the Regulator Flags field is set, the regulator
   is able to support the shaping function on all priority
   levels of the scheduler.

H: If bit 5 of the Regulator Flags field is zero and bit 6 is
   set, the regulator is able to support the shaping function
   but only on the highest priority level of the scheduler.
   All connections and QoS classes using this regulator must
   be routed to a waiting room at the highest priority level
   of the scheduler.

M: QoS Multicast
   If bit 7 of the Regulator Flags field is set, any point-
   to-multipoint connection arriving on this input port, with
   QoS parameters established by the GSMP Quality of Service
   messages, must use the same QoS parameters for all output
   branches.

x: Bits 8--15 of the Regulator Flags field are not used.

Excess Capabilities

```
 0                   1
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|D|T|S|A|B|x x x x x x x x x x x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
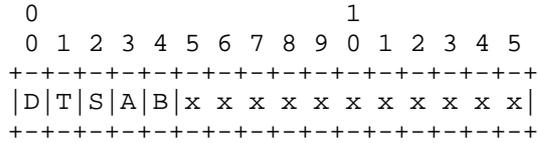
Policer:

D: If bit 0 of the Excess Capabilities field is set, the policer
   function of the regulator is able to support discard.

T: If bit 1 of the Excess Capabilities field is set, the policer
   function of the regulator is able to support tagging.

S: If bit 2 of the Excess Capabilities field is set, the policer
   function of the regulator is able to support differentiated
   scheduling.

Shaper:

A: If bit 3 of the Excess Capabilities field is set, the shaper
   function of the regulator is able to support tagging.

B: If bit 4 of the Excess Capabilities field is set, the shaper
   function of the regulator is able to support differentiated
   scheduling.

x: Bits 5--15 of the Excess Capabilities field are not used.

Hi Sharing
Lo Sharing
        Defines a range of priority levels that support weighted
        sharing. Each priority level in the range Lo Sharing to Hi
        Sharing inclusive, supports weighted sharing. A priority
        level that supports weighted sharing offers a weighted
        sharing algorithm (for example, weighted round-robin)
        between waiting rooms within that priority level. This
        permits the output link bandwidth available at that
        priority level, to be shared between the waiting rooms
        allocated to that priority level, according to the Net
        Weight parameter of each waiting room. The value 0xFF for
        both parameters indicates that this output port does not
        support weighted sharing in any priority level.

Max Classes
            If bit 3 of the Scheduler Flags field is zero, Max Classes
            gives the maximum number of QoS classes that may be
            supported by this switch port. In this case the maximum
            number of QoS classes that may be supported by this switch
            port is not affected by the number of QoS classes in use by
            other switch ports. If bit 3 of the Scheduler Flags field
            is set, Max Classes gives the maximum number of QoS classes
            that may be supported by the entire switch. In this case it
            is assumed that use of these QoS classes may be distributed
            among the various switch ports.

Default Size
            The size of waiting room that this output port allocates by
            default. The actual size of waiting room may be specified
            in the Scheduler Establishment message. The size of a
            waiting room specifies the maximum number of cells
            permitted to wait for transmission via that waiting room.
            Any further cells arriving at that waiting room beyond this
            number will be discarded.

Default Discard Threshold
            The value of discard threshold that this output port
            allocates by default. The actual value of discard threshold
            may be specified in the Scheduler Establishment message.
            The discard threshold specifies the number of cells waiting
            for transmission via a waiting room after which further
            arriving cells will be subject to a discard mechanism.

Max Buffer
            The maximum amount of buffer space, measured in cells,
            available to this port. If bit 7 of the Scheduler Flags
            field is zero this, buffer space is not shared with other
            ports. If bit 7 of the Scheduler Flags field is set, at
            least some of this buffer space is shared with other ports.

Max Shaper Buffer
            The maximum amount of buffer space, measured in cells,
            available to a QoS connection or a QoS class within the
            shaper function of the regulator. This shaper buffer space
            is likely to be shared among all QoS classes and QoS
            connections using the shaper, so there is no guarantee that
            the amount of buffer space defined by the Max Shaper Buffer
            field will be available to any particular QoS class or QoS
            connection.

Scaling Factor

> The QoS Class Establishment and QoS Connection Management
> messages require parameters that describe cell rates in
> cells per second or their reciprocal, cell interarrival
> periods, in seconds per cell. In order that these
> parameters may be specified with a 32-bit unsigned integer,
> the switch defines a Scaling Factor to be used in defining
> such parameters. By appropriate choice of the Scaling
> Factor the switch can select the range and granularity of
> rate or time that can be specified with the 32-bit unsigned
> integer. Further details are given in the discussion of
> the UPC Parameters field of the QoS Connection Management
> message.

9.3 Scheduler Establishment Message

The Scheduler Establishment message is used to configure the
scheduler on a specified output port. It is used to configure a
waiting room, attach it to a leaf of the scheduler tree, and return a
Scheduler Identifier to reference the waiting room. The Scheduler
Establishment message may also be used to modify the parameters of an
already established waiting room.

Scheduler Identifiers in the range 0--255 represent default values.
They are used for the priority levels that may be specified in the
Class of Service field of Connection Management messages without
requiring explicit establishment via a Scheduler Establishment
message. Each of these default values specifies a single waiting
room with default parameters, configured as a FIFO queue, on each of
the valid scheduler priority levels. (This permits Connection
Management messages to continue to specify QoS requirements as a
priority without requiring the use of any of the QoS messages.) The
number of priority levels available to the scheduler is specified in
the Priorities field of the Port Configuration and All Ports
Configuration messages.

The Scheduler Establishment Message is:

    Message Type = 97

The Scheduler Establishment request and success response messages
have the following format:

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Version     |   Message Type  |     Result      |    Code     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                     Transaction Identifier                     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                             Port                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                      Port Session Number                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      Scheduler Identifier      |          Net Weight           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Reserved            |D|F|M|W|x x x x|    Priority     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                      Waiting Room Size                        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                      Discard Threshold                        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
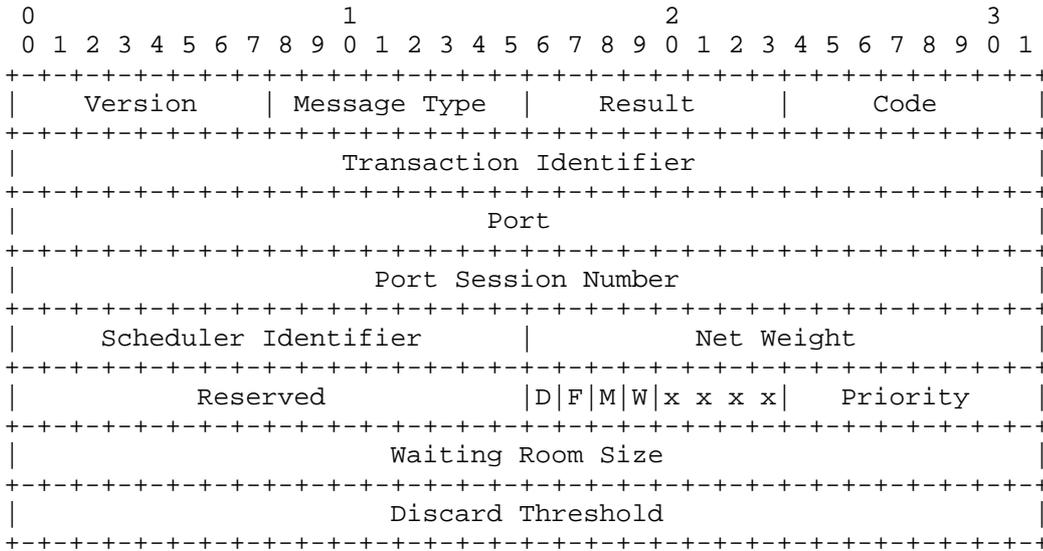
Scheduler Identifier
        The Scheduler Identifier is selected by the controller. It
        is used to identify the waiting room being established or
        modified in future messages. The Scheduler Identifier is
        taken from a namespace that is local to the switch port. A
        Scheduler Identifier in the Scheduler Establishment message
        must be greater than 0x00FF but less than 0xFFFF. The
        values 0 -- 0x00FF are reserved for use as default values.
        The default values of the Scheduler Identifier are used to
        specify the default settings for the scheduler. Each of the
        default values maps directly to one of the scheduler
        priority levels. The value 0xFFFF is reserved for use in
        the QoS Connection Management message.

  Net Weight
        The Net Weight specifies the share of the bandwidth
        available to the priority level, specified by the Priority
        field, that should be given to this waiting room. The Net
        Weight parameter is only valid if the priority level
        specified by the Priority field supports weighted sharing.

        The Net Weight is an unsigned 16-bit field specifying a
        binary fraction. I.e. the bandwidth share, as a fraction
        of the bandwidth available to the priority level, is given
        by:

        Bandwidth share = Net Weight * 2**(-16)

A Net Weight of zero indicates equal sharing between all
waiting rooms sharing this priority level that request a
Net Weight of zero. While a 16-bit field is used to
specify the Net Weight it is understood that the accuracy
of the bandwidth sharing is hardware dependent and is not
specified.

If weighted sharing is not required at a particular
priority level, a waiting room with a Net Weight value of
0xFFFF must be specified for that priority level. A
priority level that does not support weighted sharing can
only support a single waiting room.

Flags

  D: Packet Discard
     Bit 0 of the Flags field, if set, indicates that packet
     discard is required on all connections and QoS classes
     routed through this waiting room.

  F: Frame-Based Scheduling
     Bit 1 of the Flags field, if set, indicates that frame-
     based scheduling is required on all connections and QoS
     classes routed through this waiting room. In frame-based
     scheduling, a connection is only scheduled for transmission
     when a complete AAL-5 packet is available. When a
     connection is scheduled for transmission, all cells
     belonging to one or more complete packets from that
     connection will be transmitted without being interleaved
     with any other cells on that output port. A QoS class may
     be routed through a waiting room configured with frame-
     based scheduling. In this case each component connection
     of the QoS class will receive frame based scheduling. For
     correct distribution of bandwidth, each QoS class that
     requires frame-based scheduling should have its own waiting
     room.

  M: VC Merging
     Bit 2 of the Scheduler Flags field, if set, indicates that
     VC merging is required on all connections and QoS classes
     routed through this waiting room. VC merging enables the
     multipoint-to-point merging of two or more incoming virtual
     connections onto a single outgoing virtual connection,
     without interleaving cells from different AAL-5 packets
     that bear the same VPI/VCI. VC merging differs from frame-
     based scheduling in that cells with a different VPI/VCI may
     be interleaved with those of a multipoint-to-point VC
     merging connection. Most switches achieve VC merging by

using frame-based scheduling. A QoS class may be routed
through a waiting room configured with VC merging. In this
case each component connection of the QoS class will
receive VC merging.

    W: Weighted Scheduling
        Bit 3 of the Flags field, if set, indicates that weighted
        scheduling is required on all connections and QoS classes
        routed through this waiting room. All connections and QoS
        classes routed through this waiting room will require a
        Connection Weight or a QoS Class Weight respectively. The
        Connection Weight is specified in the QoS Connection
        Management message. The QoS Class Weight is specified in
        the QoS Class Establishment message. If weighted scheduling
        within this waiting room is unavailable, a failure response
        message must be returned indicating, "Weighted scheduling
        within this waiting room is unavailable."

        Bit 3 of the Flags field, if zero, indicates that this
        waiting room should be configured as a single FIFO queue.
        All cells arriving at this waiting room will receive
        first-in-first-out service. If Frame-Based Scheduling or VC
        Merging are also selected, the strict first-in-first-out
        service discipline will be modified by the requirement to
        support Frame-Based Scheduling or VC Merging.

    x: Bits 4--7 of the Flags field are not used.

Priority
        Specifies the priority level in the scheduler to which the
        waiting room should be attached. Priorities are numbered
        from zero, with priority level zero being the highest
        priority.

Waiting Room Size
        The required size of the waiting room. The size of a
        waiting room specifies the maximum number of cells
        permitted to wait for transmission via that waiting room.
        Any further cells arriving at that waiting room beyond this
        number will be discarded. If the switch is unable to grant
        the size requested in the Scheduler Establishment request
        message it may reply with the actual size allocated to the
        waiting room in the Waiting Room Size field of the success
        response message. A value of zero for the Waiting Room
        Size indicates that the default value should be used.

   Discard Threshold
            The required value of the discard threshold. The discard
            threshold specifies the number of cells waiting for
            transmission via a waiting room after which further
            arriving cells will be subject to a discard mechanism. The
            value of the Discard Threshold must be less than or equal
            to the value of the Waiting Room Size parameter for any
            given waiting room. If the switch is unable to grant the
            value of discard threshold requested in the Scheduler
            Establishment request message it may reply with the actual
            value of discard threshold allocated to the waiting room in
            the Discard Threshold field of the success response
            message. A value of zero for the Discard Threshold
            indicates that the default value should be used.

9.4 QoS Class Establishment Message

   The QoS Class Establishment message is used to configure a QoS class
   on a specified port or to modify the parameters of an already
   established QoS class. It configures the classifier and the
   regulator functions for the QoS class. It also configures the QoS
   class policer if a policing function is available for QoS classes.

   Two styles of QoS class are available. In one style each component
   connection of the QoS class may be routed independently to an output
   port and waiting room specified in its connection management message.
   In this case the Scheduler Identifier, and if required, the Excess
   Scheduler Id, are specified in the QoS Connection Management message
   that references this style of QoS class. In the alternative style of
   QoS class, all component connections in the QoS class are routed to
   the same waiting room on the same output port. In this case the
   Output Port, the Scheduler Identifier, and if required, the Excess
   Scheduler Id, are specified in the QoS Class Establishment message.

   The classifier and regulator functions must be located together,
   either on an input port, on an output port, or centralized. Each port
   declares the location of its classifier and regulator functions at
   initialization using the QoS Configuration message. If the classifier
   and regulator functions are located on an input port, only
   connections that arrive at that input port may join a QoS class
   established on that port. However, each connection that is part of a
   QoS class established on that port may be switched to a different
   output port. If the classifier and regulator functions are located on
   an output port, connections that arrive at any input port may join a
   QoS class established on that port. However, all connections within a
   QoS class established on that port must be switched to that output
   port. For a centralized classifier and regulator function, there is

no restriction on the input ports on which connections in a QoS class
must arrive, or on the output ports to which connections in a QoS
class must be switched. (For the case of a centralized classifier
and regulator the actual port specified in the QoS Class
Establishment message is used only for administrative purposes. Any
valid value of Port and Port Session Number, that specifies a
centralized classifier and regulator function, may be used.)

The QoS Class Establishment message is:

     Message Type = 98

The QoS Class Establishment request and success response messages
have the following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    | Message Type  |    Result     |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Transaction Identifier                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            Port                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Port Session Number                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     QoS Class Identifier                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Regulator   | Excess Action |       QoS Class Weight        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Scheduler Identifier        |      Excess Scheduler Id      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Output Port                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                  QoS Class Policer Parameters                 ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                  QoS Class Regulator Parameters               ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
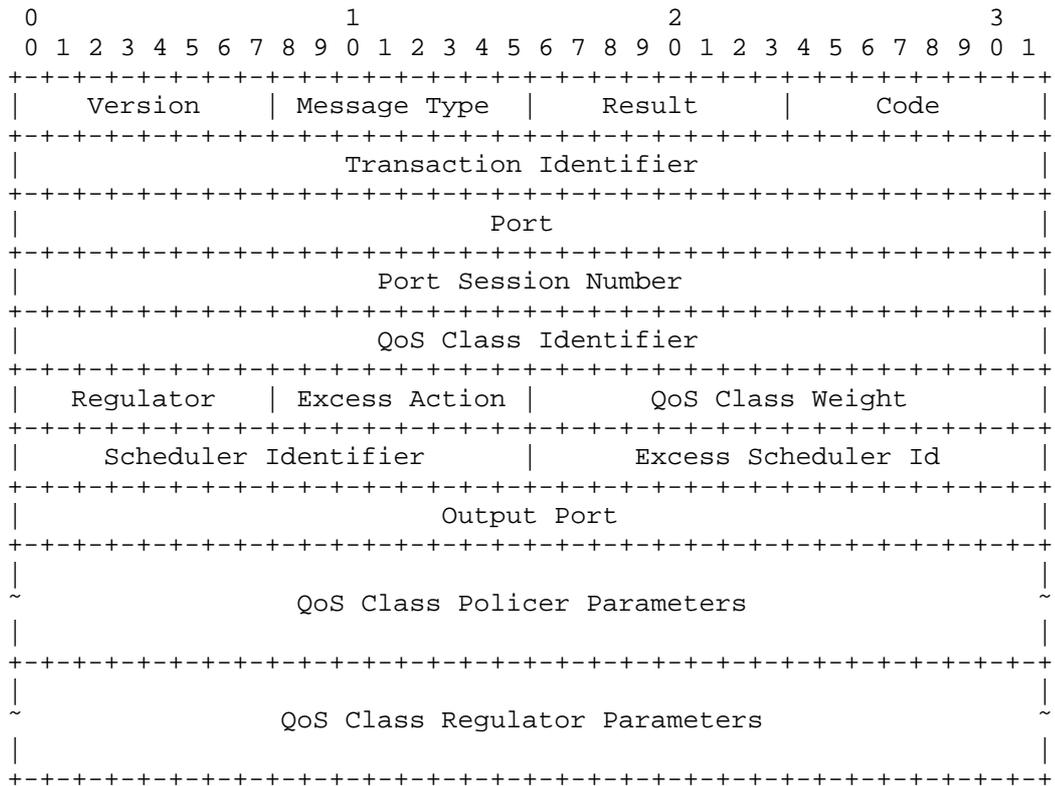
QoS Class Identifier
          The QoS Class Identifier is selected by the controller. It
          is used to identify the QoS class being established or
          modified, in future QoS Connection Management and QoS Class
          Establishment messages. It is taken from a namespace that

is global across the entire switch. No two QoS classes may
have the same QoS Class Identifier regardless of the switch
ports on which they are defined. A QoS Class Identifier in
a QoS Class Establishment message must be greater than 0
and less than 0xFFFFFFFF.

Regulator

The Regulator field specifies which function is required of
the regulator. Three possible functions are currently
defined: none, policing, and shaping.

    None: Regulator = 1
    Policing: Regulator = 2
    Shaping: Regulator = 3

If the Regulator function is specified as none, no
operations are performed by the regulator on the cells
output from the classifier. Cells output from the
classifier are transferred directly to the waiting room
specified by the Scheduler Identifier.

If policing is specified, a token bucket policer will be
applied to the QoS class. The policer determines which
cells conform to the specified policer traffic parameters
and which do not. Conforming cells are transferred directly
to the waiting room specified by the Scheduler Identifier.
The action to be taken by the policer on the excess traffic
is specified by the Excess Action field. The policer
traffic parameters are specified in the QoS Class Regulator
Parameters fields.

If shaping is specified, traffic shaping will be applied to
the QoS class. Cells in a QoS class should leave the
regulator spaced evenly apart at a rate defined by the QoS
Class Regulator Parameters fields. These cells are
transferred directly to the waiting room specified by the
Scheduler Identifier. The jitter on the conforming cell
stream on exit from the shaping function of the regulator
is not specified.

Excess Action

        0 1 2 3 4 5 6 7
       +-+-+-+-+-+-+-+-+
       |T|D|S|x x x x x|
       +-+-+-+-+-+-+-+-+
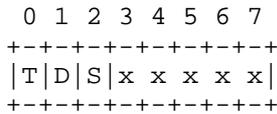
     T: Tagging
          If bit 0 of the Excess Action field is set, all cells
          transferred to the waiting room specified by the Excess
          Scheduler Id will have their CLP bit set. If bit 0 of the
          Excess Action field is zero, the CLP bit of cells
          transferred to the waiting room specified by the Excess
          Scheduler Id will remain unchanged.

     D: Discard
          This function is only available if policing is selected as
          the regulator function. If the Regulator field specifies
          Policing, and bit 1 of the Excess Action field is set, all
          cells determined by the policer to be in excess of the
          traffic parameters must be discarded. In this case the
          Excess Scheduler Id is not used and bit 0 of the Excess
          Action field should be ignored.

     S: Differentiated Scheduling
          This function operates differently according to whether
          policing or shaping is selected as the regulator function.

          If the Regulator field specifies Policing, and bit 1 of the
          Excess Action field is zero, and bit 2 of the Excess Action
          field is set, all cells determined by the policer to be in
          excess of the traffic parameters must be transferred to the
          waiting room specified by the Excess Scheduler Id. In this
          case care must be taken in the implementation to ensure
          that within each virtual path connection or virtual channel
          connection, cells depart in the same order that they
          arrived. If the Regulator field specifies Policing, and
          bit 1 of the Excess Action field is zero, and bit 2 of the
          Excess Action field is zero, all cells determined by the
          policer to be in excess of the traffic parameters must be
          transferred to the waiting room specified by the Scheduler
          Identifier. In this case the Excess Scheduler Id is not
          used.

          If the Regulator field specifies Shaping, and bit 2 of the
          Excess Action field is zero, cells will be transferred from
          the QoS class to the waiting room pointed to by the
          Scheduler Identifier at a rate defined by the QoS Class
          Regulator Parameters. In this case the Excess Scheduler Id
          is not used. If the Regulator field specifies Shaping, and
          bit 2 of the Excess Action field is set, additional cells
          will be scheduled for transmission by the waiting room
          pointed to by the Excess Scheduler Id. This permits a
          minimum cell rate to be allocated to the QoS class using
          the QoS Class Regulator Parameters and additional bandwidth

to be shared by the QoS class. The additional share of
bandwidth is determined according to the parameters of the
waiting room pointed to by the Excess Scheduler Id. If the
Excess Scheduler Id is specified in the QoS Class
Establishment message, the additional bandwidth will be
shared by the entire QoS class. If the Excess Scheduler Id
is specified in each individual QoS Connection Management
message, the additional bandwidth is specific to that
connection and not shared by the entire QoS class. Care
must be taken in the implementation to ensure that within
each virtual path connection or virtual channel connection,
cells depart in the same order that they arrived.

x: Bits 3--7 of the Excess Action field are not used.

QoS Class Weight
If bit 1 of the Scheduler Flags field of the QoS
Configuration message indicates that weighted service may
be applied to a QoS class, the QoS Class Weight parameter
specifies the share of the bandwidth available to the
waiting room that should be given to this QoS class.

The QoS Class Weight is an unsigned 16-bit field specifying
a binary fraction. I.e. the bandwidth share, as a fraction
of the bandwidth available to the waiting room, is given
by:

    Bandwidth share = QoS Class Weight * 2**(-16)

A QoS Class Weight of zero indicates equal sharing between
all QoS classes sharing this waiting room that request a
QoS Class Weight of zero. While a 16-bit field is used to
specify the QoS Class Weight it is understood that the
accuracy of the bandwidth sharing is hardware dependent and
is not specified.

If the Regulator field of the QoS Class Establishment
message indicates None, or Policer, the QoS Class Weight
should be applied to the waiting room pointed to by the
Scheduler Identifier. If the Regulator field of the QoS
Class Establishment message indicates Shaper, the QoS Class
Weight should be applied to the waiting room pointed to by
the Excess Scheduler Id.

If the specified waiting room is unable to offer weighted
sharing for a QoS class, a failure response message should
be returned with the failure code indicating: "This waiting
room is unable to offer weighted sharing for a QoS class."

   Scheduler Identifier
           If all conforming traffic from this QoS class is directed
           to the same waiting room, on the same output port, this
           field specifies the Scheduler Identifier for the entire QoS
           class. The Scheduler Identifier points to the waiting room,
           on the output port specified by the Output Port field, to
           which all conforming traffic should be sent. If this field
           is not used it should be set to 0xFFFF. If each component
           connection of the QoS class specifies its own output port
           and waiting room, the Scheduler Identifier must be
           specified in the QoS Connection Management message and this
           field must be set to 0xFFFF.

   Excess Scheduler Id
           If all conforming traffic from this QoS class is directed
           to the same waiting room, on the same output port, this
           field specifies the Excess Scheduler Id for the entire QoS
           class. The Excess Scheduler Id points to the waiting room,
           on the output port specified by the Output Port field, to
           which all excess traffic should be sent. If this field is
           not used it should be set to 0xFFFF. If each component
           connection of the QoS class specifies its own output port
           and waiting room, the Excess Scheduler Id must be specified
           in the QoS Connection Management message and this field
           must be set to 0xFFFF. If the Scheduler Id is specified in
           the QoS Class Establishment message, the Excess Scheduler
           Id must also be specified in the QoS Class Establishment
           message (or not used). If the Scheduler Id is specified in
           the QoS Connection Management message, the Excess Scheduler
           Id must also be specified in the QoS Connection Management
           message (or not used). The Excess Scheduler Id must not
           point to the same waiting room on the same output port as
           the Scheduler Identifier.

    Output Port
           If the Scheduler Identifier field in the QoS Establishment
           message is not 0xFFFF the Output Port field specifies the
           Output Port to which traffic from this QoS class should be
           routed. If the Scheduler Identifier field in the QoS
           Establishment message is 0xFFFF, this field is not used.

   QoS Class Policer Parameters
           A policer function may be applied to a QoS class on output
           from the classifier independently of the regulator
           function. The QoS class policer function is identical to
           the connection policer function defined in the QoS

Connection Management message with the exception that it
applies to all cells that belong to the QoS class rather
than just cells that belong to a single connection.

The QoS Class Policer Parameters have the following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     QoS Class Increment-1                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       QoS Class Limit-1                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     QoS Class Increment-2                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       QoS Class Limit-2                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Reserved                  |C|A|x x x x x x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
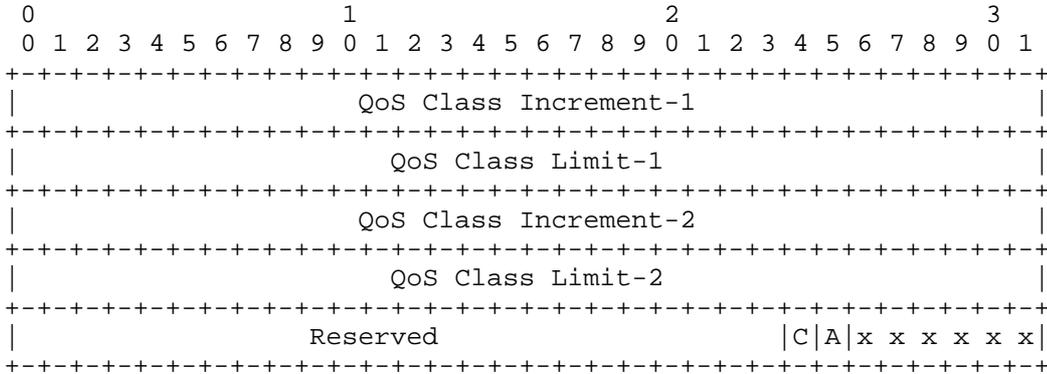
The definition of these fields is given in the UPC
Parameters section of the QoS Connection Management
message.

QoS Class Regulator Parameters
        The QoS class regulator function is identical to the
        regulator function defined in the QoS Connection Management
        message with the exception that it applies to all cells
        that belong to the QoS class rather than just cells that
        belong to a single connection.

        The QoS Class Regulator Parameters have the following
        format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  QoS Class Regulator Increment                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    QoS Class Regulator Limit                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
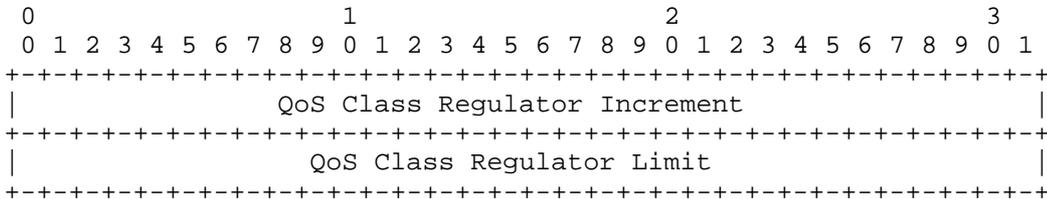
The definition of these fields is given in the Regulator
Parameters section of the QoS Connection Management
message.

9.5 QoS Release Message

   The QoS Release message is used to delete a Scheduler Identifier or a
   QoS Class Identifier and to release all resources associated with it.

   The QoS Release message is:

      Message Type = 99

   The QoS Release request and success response messages have the
   following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    |  Message Type |     Result    |      Code     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Transaction Identifier                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            Port                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Port Session Number                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Reserved           |       Scheduler Identifier       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      QoS Class Identifier                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
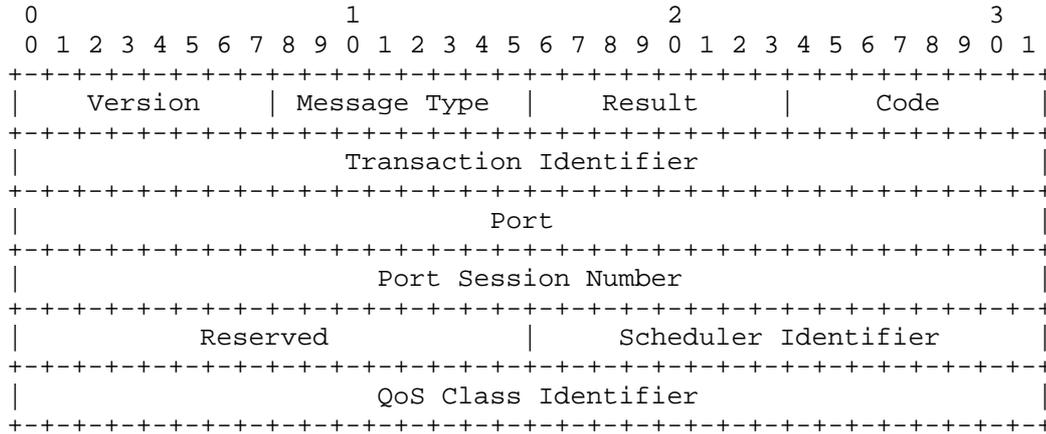
   Port
           If the QoS Release message contains a Scheduler Identifier,
           the Port field must contain the Port Number of the switch
           output port to which the Scheduler Identifier applies. If
           the QoS Release message contains a QoS Class Identifier,
           any valid Port number may be used. (The QoS Class
           Identifier has a global namespace.)

   Port Session Number
           The current Port Session Number for the port specified in
           the Port field.

   Scheduler Identifier
           If the Scheduler Identifier contains the value 0xFFFF the
           QoS Class Identifier specified in the QoS Class Identifier
           field should be released. Else, if the value of the
           Scheduler Identifier lies in the range 0x0100 -- 0xFFFE
           inclusive, the Scheduler Identifier specified by the
           Scheduler Identifier field should be released. A Scheduler

                Identifier with a value less than 0x0100 is invalid in a
                QoS Release message. (It specifies a default value which
                may not be released.)

       QoS Class Identifier
                If the Scheduler Identifier contains the value 0xFFFF the
                QoS Class Identifier field specifies the QoS Class
                Identifier to be released.

    If the QoS Release message requests that a Scheduler Identifier be
    released, and the Scheduler Identifier is still in use by one or more
    established connections, a failure response must be returned with the
    failure code indicating: "Scheduler Identifier still in use." If the
    QoS Release message requests that a QoS Class Identifier be released,
    and the QoS Class Identifier is still in use by one or more
    established connections, a failure response must be returned with the
    failure code indicating: "QoS Class Identifier still in use."

9.6 QoS Connection Management Message

    The QoS Connection Management message is used by the controller to
    establish and modify virtual channel connections and virtual path
    connections across the switch which require QoS parameters to be
    specified. The functionality of the QoS Connection Management message
    is identical to that of the Add Branch connection management message
    with the additional specification of QoS parameters. No specific QoS
    connection release messages are defined. QoS connections may be
    released with the Delete Tree, Delete All, and Delete Branches
    messages defined in Section 4, "Connection Management Messages." When
    a QoS connection is released, all associated QoS resources are
    released.

    There are three styles of connection with specified QoS parameters:

    QoS Connection:
       This connection style specifies its own individual QoS parameters
       and is routed independently to the waiting room and output port
       specified in the QoS Connection Management message. It is not a
       member of a QoS class. Each output branch of a point-to-multipoint
       QoS connection may specify its own QoS parameters which may be
       different from all other output branches of that point-to-
       multipoint QoS connection, if the switch supports this capability.
       However, all output branches must specify identical connection
       policer parameters. A QoS Connection Management message requesting
       this style of connection is identified by a QoS Class Identifier
       with the value 0xFFFFFFFF.

QoS Class Connection:
    This connection style does not specify its own individual QoS
    parameters. It is a member of a QoS class, and the QoS parameters
    are specified by the QoS class. It is, however, routed
    independently to the waiting room and output port specified in the
    QoS Connection Management message. Each output branch of a
    point-to-multipoint QoS Class Connection must use the same QoS
    parameters. A QoS Connection Management message requesting this
    style of connection will have a valid QoS Class Identifier and a
    valid Scheduler Identifier.

QoS Class Member:
    This connection style does not specify its own individual QoS
    parameters. It is a member of a QoS class, and the QoS parameters
    are specified by the QoS class. The QoS class also specifies the
    waiting room and output port to which all members of the class are
    routed. This style of connection does not support point-to-
    multipoint connections. A QoS Connection Management message
    requesting this style of connection will have a valid QoS Class
    Identifier and a Scheduler Identifier with the value 0xFFFF.

To request a virtual channel connection with specified QoS
parameters, the Virtual Channel Connection (VCC) QoS Connection
Management message is:

    Message Type = 100.

To request a virtual path connection with specified QoS parameters,
the Virtual Path Connection (VPC) QoS Connection Management message
is:

    Message Type = 101.

The QoS Connection Management message has the following format for
both request and response messages:

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Version    |  Message Type  |    Result      |     Code     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                    Transaction Identifier                     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                     Port Session Number                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                        Input Port                           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |M|Q|B|C|      Input VPI        |           Input VCI          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                        Output Port                          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |x x x x|     Output VPI        |          Output VCI          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      Number of Branches       |      Scheduler Identifier     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                     QoS Class Identifier                     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   Regulator   | Excess Action  |     Connection Weight        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |S|A|x x x x x|     Reserved     |     Excess Scheduler Id      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   ~                       UPC Parameters                         ~
   |                                                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   ~                    Regulator Parameters                      ~
   |                                                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
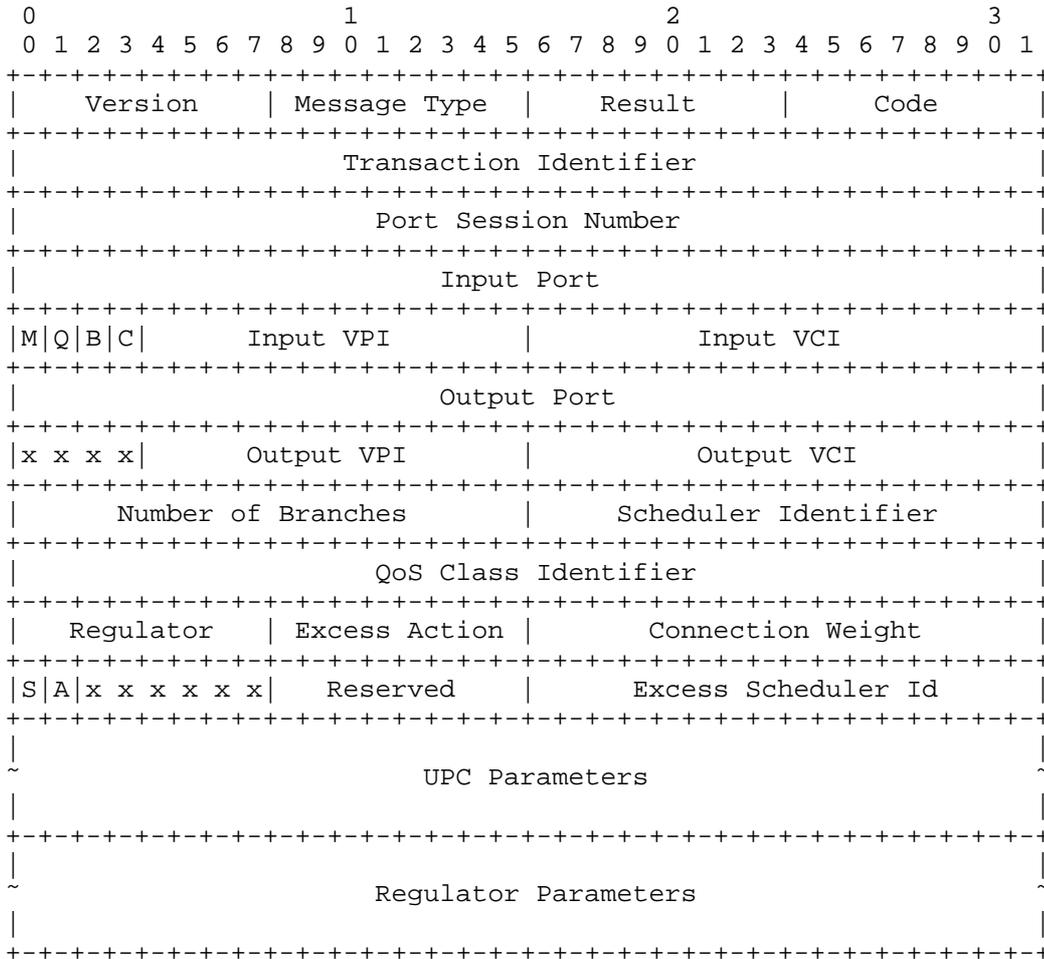
Port Session Number
Input Port
Input VPI
Input VCI
Output Port
Output VPI
Output VCI
Number of Branches
          The definition of these fields is exactly the same as
          defined for the Add Branch message in Section 4.1,
          "Connection Management Messages."

M B C Flags
        The definition of the M, B, and C flags is exactly the same
        as defined in Section 4, "Connection Management Messages."
        They apply to the QoS Connection Management message exactly
        as defined for the Add Branch message.

Q: QoS Profile Flag The QoS Profile flag is not used in the QoS
        Connection Management message.

Scheduler Identifier
        For QoS Connection and QoS Class Connection styles, the
        Scheduler Identifier points to the waiting room, on the
        output port specified by the Output Port field, to which
        all conforming traffic on the connection should be routed.
        The values 0 -- 255 specify the default settings for the
        scheduler. Each of the default values maps directly to one
        of the scheduler priority levels. A Scheduler Identifier in
        the range 0 -- 255 may be used without first being
        established by a Scheduler Establishment message. All
        Scheduler Identifiers in the range 0x0100 to 0xFFFE must
        first be established by a Scheduler Establishment message.

        A Scheduler Identifier with a value of 0xFFFF indicates
        that a QoS Class Member connection style is being
        requested. In this connection style, the waiting room and
        output port are specified by reference to the QoS class
        specified by the QoS Class Identifier field. In this case
        the QoS Class Identifier field must contain a valid QoS
        Class Identifier.

QoS Class Identifier
        For QoS Class Connection and QoS Class Member connection
        styles, the QoS Class Identifier specifies the QoS Class to
        which the connection belongs. It must first be established
        by a QoS Class Establishment message and must have a value
        greater than 0 and less than 0xFFFFFFFF.

        A QoS Class Identifier with a value of 0xFFFFFFFF indicates
        that a connection of style "QoS Connection" is being
        requested. In this connection style, the connection does
        not belong to a QoS class. All QoS parameters are specified
        by the QoS Connection Management message and apply only to
        the specified connection.

Regulator
Excess Action
        The Regulator and Excess Action parameters are only used in
        connection requests of style "QoS Connection." The

definition of these fields in the QoS Connection Management
message is exactly the same as defined for the QoS Class
Establishment message with the exception that they apply to
an individual connection rather than to an entire QoS
class.

Connection Weight
        This field is only used in connections of style "QoS
        Connection" and "QoS Class Connection." For QoS Class
        Member style connections, the QoS Class Weight parameter of
        the QoS Class Establishment message should be used to
        assign a weight to the QoS Class.

        If bit 0 of the Scheduler Flags field of the QoS
        Configuration message indicates that weighted service may
        be applied to a connection, the Connection Weight parameter
        specifies the share of the bandwidth available to the
        waiting room that should be given to this connection.

        The Connection Weight is an unsigned 16-bit field
        specifying a binary fraction. I.e. the bandwidth share, as
        a fraction of the bandwidth available to the waiting room,
        is given by:

            Bandwidth share = Connection Weight * 2**(-16)

        A Connection Weight of zero indicates equal sharing between
        all connections in this waiting room that request a
        Connection Weight of zero. While a 16-bit field is used to
        specify the Connection Weight it is understood that the
        accuracy of the bandwidth sharing is hardware dependent and
        is not specified.

        For connections of style "QoS Class Connection," if the
        Regulator function of the QoS Class is specified as None,
        or Policer, the Connection Weight should be applied to the
        waiting room pointed to by the Scheduler Identifier field
        in the QoS Connection Management message. If the Regulator
        function of the QoS Class is specified as Shaper, the
        Connection Weight should be applied to the waiting room
        pointed to by the Excess Scheduler Id field in the QoS
        Connection Management message.

        For connections of style "QoS Connection," if the Regulator
        field of the QoS Connection Management message specifies
        None, or Policer, the Connection Weight should be applied
        to the waiting room pointed to by the Scheduler Identifier
        field. If the Regulator field of the QoS Connection

Management message specifies Shaper, the Connection Weight
should be applied to the waiting room pointed to by the
Excess Scheduler Id field.

If the specified waiting room is unable to offer weighted
sharing for a connection, a failure response message should
be returned with the failure code indicating: "this waiting
room is unable to offer weighted sharing for a connection."

QoS Flags

   S: Selective Discard
      If the Selective Discard flag is set, only cells with the
      Cell Loss Priority (CLP) bit set will be subject to the
      discard mechanism when the number of cells in the waiting
      room exceeds the Discard Threshold. If the Selective
      Discard flag is zero, all cells (CLP=0 and CLP=1) will be
      subject to the discard mechanism when the number of cells
      in the waiting room exceeds the Discard Threshold.
      Selective discard can be combined with packet discard. In
      this case only packets in which at least one cell has the
      CLP bit set will be subject to the discard mechanism.

   A: All Branches
      For a QoS Connection Management message that specifies a
      point-to-multipoint connection, if the All Branches flag is
      set, all branches of the point-to-multipoint connection
      must be set to the QoS parameters specified in the message.
      If the All Branches flag is zero, only the single output
      branch specified in the message should be set to the QoS
      parameters specified in the message. For a QoS Connection
      Management message that specifies a point-to-point
      connection, the All Branches flag is not used.

   x: Unused

Excess Scheduler Id
      For connections of style "QoS Connection" and "QoS Class
      Connection," the Excess Scheduler Id points to the waiting
      room, on the output port specified by the Output Port
      field, to which all excess traffic should be routed. The
      values 0 -- 255 specify the default settings for the
      scheduler. Each of the default values maps directly to one
      of the scheduler priority levels. An Excess Scheduler Id in
      the range 0 -- 255 may be used without first being
      established by a Scheduler Establishment message. All

values of Excess Scheduler Id in the range 0x0100 to 0xFFFE
must first be established by a Scheduler Establishment
message.

If this field is not used it should be set to 0xFFFF. The
Excess Scheduler Id must not point to the same waiting room
on the same output port as the Scheduler Identifier.

UPC Parameters
All connection styles may be subject to a Usage Parameter
Control (UPC) function, also known as a connection policer.
The policing function is applied to each individual
connection before it is combined with other connections
into a QoS class by the classifier function. A policing
function applied to an entire QoS class is defined in the
QoS Class Establishment message.

The connection policer is defined by reference to the
Generic Cell Rate Algorithm (GCRA) defined by the ATM Forum
[af-tm-0056], although any equivalent policing algorithm
may be used. The GCRA takes two parameters, the increment
(I) and the limit (L). The reciprocal of the increment
(1/I) specifies the rate being policed. The limit specifies
the burst tolerance. (For comparison with the token bucket
policer discussed in [Partridge], the size of the token
bucket is given by L/I.)

Two policers in series may be specified to permit the
policing of both peak rate and average rate (also called
sustainable rate). The parameters for the first policer are
Increment-1 and Limit-1. For comparison with the ATM Forum
specification these would be used to police the Peak Cell
Rate (PCR) and Cell Delay Variation Tolerance (CDVT)
respectively. The parameters for the second policer are
Increment-2 and Limit-2. For comparison with the ATM Forum
specification these would be used to police the Sustainable
Cell Rate (SCR), and Burst Tolerance. (The Burst Tolerance
may be computed from the Maximum Burst Size [af-tm-0056].)

There are two configurations in which the two policers may
be connected in series. In the All Cells configuration,
all cells (cells with the Cell Loss Priority (CLP) bit set
to zero and cells with the CLP bit set to one) are subject
to the policing action of both policers in series. In the
CLP Selective configuration, all cells, both CLP=0 and
CLP=1, are policed by the first policer; but only cells

with CLP=0 are subject to policing by the second policer.
Either tagging or discard may be specified for each of the
policer configurations.

The values of the parameters Increment and Limit in the UPC
Parameters fields are given in terms of a time unit
specified by the switch in the QoS Configuration Parameters
message. The time unit is specified by the switch as a
rate, the Scaling Factor, which gives the rate in cells per
second that would result from an Increment parameter value
of one. Thus to determine the value of the Increment
parameter from the desired policed rate given in cells per
second:

    Increment parameter = (Scaling_Factor)/(policed_rate)

To determine the value of the Limit parameter from the
desired Cell Delay Variation Tolerance (CDVT) given in
seconds:

    Limit parameter = CDVT * Scaling_Factor

To determine the value of the Limit parameter from the
desired Burst Tolerance (BT) given in seconds:

    Limit parameter = BT * Scaling_Factor

The Increment and Limit parameters are specified as 32-bit
unsigned integers; so the choice of the Scaling Factor
allows the switch to select the range and granularity of
the policer parameters with respect to the line rate of the
switch port. For example, a SONET STS-3c (155.52 Mbps)
switch port has a line rate of approximately 353 kcells/s.
With a Scaling Factor value of 353,000,000 we can specify a
policed rate slightly less than the line rate with a
granularity of 0.1%. For a policed rate of 1 kbps we can
still support a bucket size of 31 cells.

The UPC Parameters have the following format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Increment-1                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Limit-1                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Increment-2                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Limit-2                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Reserved                   |C|A|x x x x x x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Increment-1
        The increment parameter for the first policer, specified as
        a 32-bit unsigned integer. A value of zero for the
        Increment-1 parameter is used to disable the first policer.
        In this case all cells will be considered to conform to the
        traffic parameters of the first policer.

Limit-1
        The limit parameter for the first policer, specified as a
        32-bit unsigned integer.

Increment-2
        The increment parameter for the second policer, specified
        as a 32-bit unsigned integer. A value of zero for the
        Increment-2 parameter is used to disable the second
        policer. In this case all cells will be considered to
        conform to the traffic parameters of the second policer.

Limit-2
        The limit parameter for the second policer, specified as a
        32-bit unsigned integer.

Flags

    C: Configuration
        If the Configuration flag is set, the policer should be set
        to the All Cells configuration. If the Configuration flag
        is zero, the policer should be set to the CLP Selective
        configuration.

        In the All Cells configuration, all cells (both CLP=0 and
        CLP=1) are subject to the policing action of both policers
        in series. In the CLP Selective configuration, all cells,
        both CLP=0 and CLP=1, are policed by the first policer; but

only cells with CLP=0 are subject to policing by the second
policer. Either tagging or discard may be specified for
each of the policer configurations.

A: Action
If the Action flag is zero, discard is required as the
policing action. If the Action flag is set, tagging is
required as the policing action.

If tagging is selected in the All Cells configuration, any
cell with CLP=0 in either policer, that the policer
determines to be in excess of the specified policer
parameters, will be changed to CLP=1. If discard is
selected in the All Cells configuration, any cell (CLP=0 or
CLP=1) in either policer, that the policer determines to be
in excess of the specified policer parameters, will be
discarded.

In the CLP Selective configuration, the first policer is
always set to discard any cell (CLP=0 or CLP=1) that it
determines to be in excess of its specified policer
parameters. If tagging is selected in the CLP Selective
configuration, the second policer will change the CLP bit
to CLP=1 of any cell that it determines to be in excess of
its specified parameters. If discard is selected in the CLP
Selective configuration, the second policer will discard
any cell that it determines to be in excess of its
specified parameters.

To configure the policer for the conformance definitions
specified by the ATM Forum [af-tm-0056] the following
configurations are suggested:

    CBR.1:   One policer,   All Cells,   Discard
    VBR.1:   Two policers,   All Cells,   Discard
    VBR.2:   Two policers,   CLP Selective,   Discard
    VBR.3:   Two policers,   CLP Selective,   Tagging
    UBR.1:   One policer,   All Cells,   Discard
    UBR.2:   One policer,   All Cells,   Tagging.

x: Unused

Regulator Parameters
Only connections of style "QoS Connection" require the
Regulator Parameters to be specified in the QoS Connection
Management message. For connections of style "QoS Class
Connection" and "QoS Class Member" the Regulator Parameters
are specified in the QoS Class Establishment message.

The Regulator Parameters are specified in a similar manner
to the UPC parameters. If the regulator function is
specified as Policing, a single GCRA policer is applied to
all cells (both CLP=0 and CLP=1) on the connection. The
policer takes two parameters: an increment, the Regulator
Increment, and a limit, the Regulator Limit. The reciprocal
of the increment (1/I) specifies the rate being policed.
The limit (L) specifies the burst tolerance. (For
comparison with the token bucket policer discussed in
[Partridge], the size of the token bucket is given by L/I.)

The Regulator Increment and Regulator Limit parameters are
32-bit unsigned integers. Their values are determined in
terms of the Scaling Factor specified by the switch in the
QoS Configuration Parameters message. To determine the
value of the Regulator Increment parameter from the desired
policed rate given in cells per second:

    Regulator Increment = (Scaling_Factor)/(policed_rate)

For a policed rate (r) the GCRA policer guarantees that
over any time period T the amount of traffic determined by
the policer to be conforming to the traffic parameters does
not exceed:

    rT + L/I

The value of the Regulator Limit may be determined from
this relation.

If the regulator function is specified as Shaping, only the
Regulator Increment parameter is used. The Regulator Limit
parameter is not used. The value of the Regulator Increment
parameter is determined in terms of the Scaling Factor
specified by the switch in the QoS Configuration Parameters
message. To determine the value of the Regulator Increment
parameter from the desired shaper rate, given in cells per
second, on output from the shaper:

    Regulator Increment = (Scaling_Factor)/(shaper_rate)

An Increment value of zero is used to disable the policer.
In this case all cells on that connection will be
considered to conform to the policer traffic parameters. A
shaper given a Regulator Increment parameter of zero will
perform no shaping function on that connection.

  The Regulator Parameters have the following format:

```
     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
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                     Regulator Increment                      |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                       Regulator Limit                        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
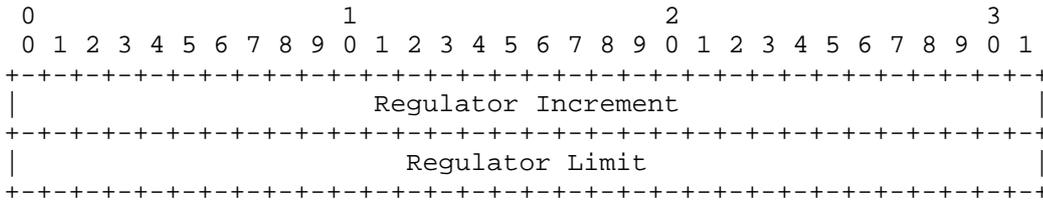
9.7 QoS Failure Response Codes

   A failure response message is formed by returning the request message
   that caused the failure with the Result field in the header
   indicating failure (Result = 4) and the Code field giving the failure
   code. The failure code specifies the reason for the switch being
   unable to satisfy the request message. The following additional
   failure codes are defined for use in response to QoS messages.
   General failure codes are specified in Section 3.2, Failure Response
   Messages.

        128: Weighted scheduling within this waiting room is unavailable.
        129: This waiting room is unable to offer weighted sharing for a
              QoS class.
        130: This waiting room is unable to offer weighted sharing for a
              connection.
        131: Scheduler Identifier still in use.
        132: QoS Class Identifier still in use.
        133: Invalid QoS parameter.
        134: Insufficient QoS resources.
        135: Any point-to-multipoint connection arriving on this input
              port must use the same QoS parameters for all output
              branches.

10. Adjacency Protocol

   The adjacency protocol is used to synchronize state across the link,
   to agree on which version of the protocol to use, to discover the
   identity of the entity at the other end of a link, and to detect when
   it changes. GSMP is a hard state protocol. It is therefore important
   to detect loss of contact between switch and controller, and to
   detect any change of identity of switch or controller. No GSMP
   messages other than those of the adjacency protocol may be sent
   across the link until the adjacency protocol has achieved
   synchronization.

10.1 Packet Format

   All GSMP messages belonging to the adjacency protocol have the
   following structure:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    | Message Type  |     Timer     |M|     Code    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Sender Name                          |
+                               +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                               |                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+                               +
|                          Receiver Name                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Sender Port                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Receiver Port                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Sender Instance                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Receiver Instance                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
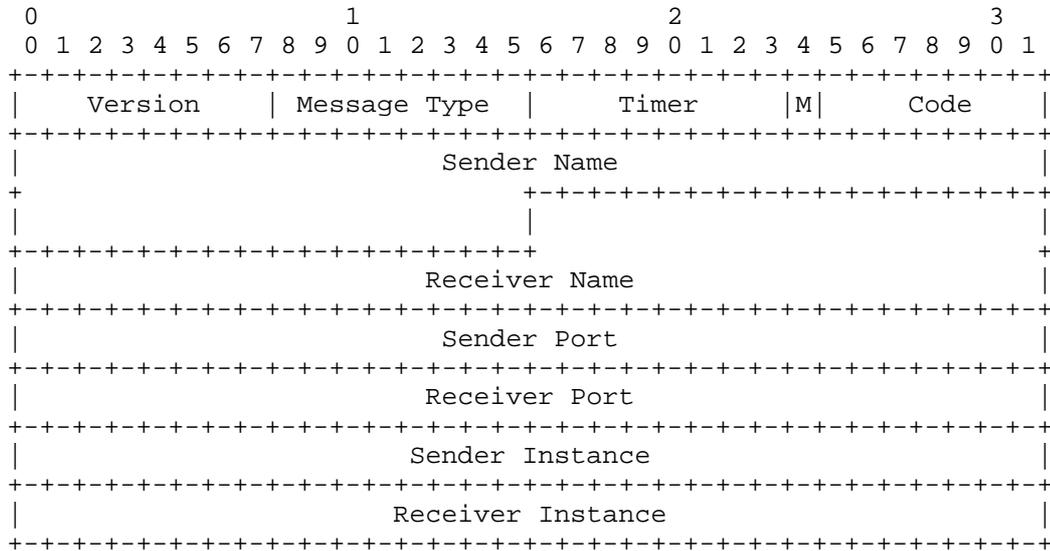
   Version

           In the adjacency protocol the Version field is used for
           version negotiation. In a SYN message the Version field
           always contains the highest version understood by the
           sender. A receiver receiving a SYN message with a version
           higher than understood will ignore that message. A
           receiver receiving a SYN message with a version lower than
           its own highest version, but a version that it understands,
           will reply with a SYNACK with the version from the received
           SYN in its GSMP Version field. This defines the version of
           the GSMP protocol to be used while the adjacency protocol
           remains synchronized. All other messages will use the
           agreed version in the Version field.

           The version number for the version of the GSMP protocol
           defined by this specification is Version = 2.

   Message Type
           The adjacency protocol is:

                Message Type = 10

Timer

>   The Timer field is used to inform the receiver of the timer
>   value used in the adjacency protocol of the sender. The
>   timer specifies the nominal time between periodic adjacency
>   protocol messages. It is a constant for the duration of a
>   GSMP session. The timer field is specified in units of
>   100ms.

M-Flag

>   The M-Flag is used in the SYN message to indicate whether
>   the sender is a master or a slave. If the M-Flag is set in
>   the SYN message, the sender is a master. If zero, the
>   sender is a slave. The GSMP protocol is asymmetric, the
>   controller being the master and the switch being the slave.
>   The M-Flag prevents a master from synchronizing with
>   another master, or a slave with another slave. If a slave
>   receives a SYN message with a zero M-Flag, it must ignore
>   that SYN message. If a master receives a SYN message with
>   the M-Flag set, it must ignore that SYN message. In all
>   other messages the M-Flag is not used.

Code

>   Field specifies the function of the message. Four Codes are
>   defined for the adjacency protocol:

>   SYN: Code = 1
>   SYNACK: Code = 2
>   ACK: Code = 3
>   RSTACK: Code = 4.

Sender Name

>   For the SYN, SYNACK, and ACK messages, is the name of the
>   entity sending the message. The Sender Name is a 48-bit
>   quantity that is unique within the operational context of
>   the device. A 48-bit IEEE 802 MAC address, if available,
>   may be used for the Sender Name. If the Ethernet
>   encapsulation is used the Sender Name must be the Source
>   Address from the MAC header. For the RSTACK message, the
>   Sender Name field is set to the value of the Receiver Name
>   field from the incoming message that caused the RSTACK
>   message to be generated.

Receiver Name

>   For the SYN, SYNACK, and ACK messages, is the name of the
>   entity that the sender of the message believes is at the
>   far end of the link. If the sender of the message does not
>   know the name of the entity at the far end of the link,
>   this field should be set to zero. For the RSTACK message,

the Receiver Name field is set to the value of the Sender
Name field from the incoming message that caused the RSTACK
message to be generated.

Sender Port
        For the SYN, SYNACK, and ACK messages, is the local port
        number of the link across which the message is being sent.
        For the RSTACK message, the Sender Port field is set to the
        value of the Receiver Port field from the incoming message
        that caused the RSTACK message to be generated.

Receiver Port
        For the SYN, SYNACK, and ACK messages, is what the sender
        believes is the local port number for the link, allocated
        by the entity at the far end of the link. If the sender of
        the message does not know the port number at the far end of
        the link, this field should be set to zero. For the RSTACK
        message, the Receiver Port field is set to the value of the
        Sender Port field from the incoming message that caused the
        RSTACK message to be generated.

Sender Instance
        For the SYN, SYNACK, and ACK messages, is the sender's
        instance number for the link. It is used to detect when the
        link comes back up after going down or when the identity of
        the entity at the other end of the link changes. The
        instance number is a 32-bit number that is guaranteed to be
        unique within the recent past and to change when the link
        or node comes back up after going down. Zero is not a valid
        instance number. For the RSTACK message, the Sender
        Instance field is set to the value of the Receiver Instance
        field from the incoming message that caused the RSTACK
        message to be generated.

Receiver Instance
        For the SYN, SYNACK, and ACK messages, is what the sender
        believes is the current instance number for the link,
        allocated by the entity at the far end of the link. If the
        sender of the message does not know the current instance
        number at the far end of the link, this field should be set
        to zero. For the RSTACK message, the Receiver Instance
        field is set to the value of the Sender Instance field from
        the incoming message that caused the RSTACK message to be
        generated.

10.2 Procedure

   The adjacency protocol is described by the following rules and state
   tables.

   The rules and state tables use the following operations:

    o The "Update Peer Verifier" operation is defined as storing the
      values of the Sender Instance, Sender Port, and Sender Name fields
      from a SYN or SYNACK message received from the entity at the far
      end of the link.

    o The procedure "Reset the link" is defined as:

         1. Generate a new instance number for the link
         2. Delete the peer verifier (set to zero the values of Sender
            Instance, Sender Port, and Sender Name previously stored by
            the Update Peer Verifier operation)
         3. Send a SYN message
         4. Enter the SYNSENT state.

    o The state tables use the following Boolean terms and operators:

         A   The Sender Instance in the incoming message matches the
              value stored from a previous message by the "Update Peer
              Verifier" operation.

         B   The Sender Instance, Sender Port, and Sender Name fields in
              the incoming message match the values stored from a
              previous message by the "Update Peer Verifier" operation.

         C   The Receiver Instance, Receiver Port, and Receiver Name
              fields in the incoming message match the values of the
              Sender Instance, Sender Port, and Sender Name currently
              sent in outgoing SYN, SYNACK, and ACK messages.

         "&&" Represents the logical AND operation

         "||" Represents the logical OR operation

         "!" Represents the logical negation (NOT) operation.

    o A timer is required for the periodic generation of SYN, SYNACK,
      and ACK messages. The value of the timer is announced in the Timer
      field. The period of the timer is unspecified but a value of one
      second is suggested.

There are two independent events: the timer expires, and a packet
arrives. The processing rules for these events are:

```
Timer Expires:    Reset Timer
                  If state = SYNSENT Send SYN
                  If state = SYNRCVD Send SYNACK
                  If state = ESTAB   Send ACK
```

```
 Packet Arrives:
     If incoming message is an RSTACK:
         If (A && C && !SYNSENT) Reset the link
         Else Discard the message.
     If incoming message is a SYN, SYNACK, or ACK:
         Response defined by the following State Tables.
     If incoming message is any other GSMP message and state !=
         ESTAB:
         Discard incoming message.
         If state = SYNSENT Send SYN (Note 1)
         If state = SYNRCVD Send SYNACK (Note 1)
```

Note 1: No more than two SYN or SYNACK messages should be
sent within any time period of length defined by the
timer.

o State synchronization across a link is considered to be achieved
  when the protocol reaches the ESTAB state. All GSMP messages,
  other than adjacency protocol messages, that are received before
  synchronization is achieved will be discarded.

State Tables

State: SYNSENT

```
+=========================================================================+
|     Condition     |               Action               | New State |
+===================+====================================+===========+
|   SYNACK && C     | Update Peer Verifier; Send ACK     |   ESTAB   |
+-------------------+------------------------------------+-----------+
|   SYNACK && !C    |            Send RSTACK             |  SYNSENT  |
+-------------------+------------------------------------+-----------+
|      SYN          | Update Peer Verifier; Send SYNACK  |  SYNRCVD  |
+-------------------+------------------------------------+-----------+
|      ACK          |            Send RSTACK             |  SYNSENT  |
+=========================================================================+
```

State: SYNRCVD

```
+=======================================================================+
|     Condition      |              Action              | New State |
+====================+==================================+===========+
|   SYNACK && C      |  Update Peer Verifier; Send ACK  |   ESTAB   |
+--------------------+----------------------------------+-----------+
|   SYNACK && !C     |           Send RSTACK            |  SYNRCVD  |
+--------------------+----------------------------------+-----------+
|       SYN          | Update Peer Verifier; Send SYNACK|  SYNRCVD  |
+--------------------+----------------------------------+-----------+
|  ACK && B && C     |           Send ACK               |   ESTAB   |
+--------------------+----------------------------------+-----------+
|  ACK && !(B && C)  |           Send RSTACK            |  SYNRCVD  |
+=======================================================================+
```

State: ESTAB

```
+=======================================================================+
|     Condition      |              Action              | New State |
+====================+==================================+===========+
|   SYN || SYNACK    |          Send ACK (note 2)       |   ESTAB   |
+--------------------+----------------------------------+-----------+
|   ACK && B && C    |          Send ACK (note 3)       |   ESTAB   |
+--------------------+----------------------------------+-----------+
|  ACK && !(B && C)  |           Send RSTACK            |   ESTAB   |
+=======================================================================+
```

   Note 2: No more than two ACKs should be sent within any time period
   of length defined by the timer. Thus, one ACK must be sent every time
   the timer expires. In addition, one further ACK may be sent between
   timer expirations if the incoming message is a SYN or SYNACK. This
   additional ACK allows the adjacency protocol to reach synchronization
   more quickly.

   Note 3: No more than one ACK should be sent within any time period of
   length defined by the timer.

10.3 Loss of Synchronization

   If after synchronization is achieved, no valid GSMP messages are
   received in any period of time in excess of three times the value of
   the Timer field announced in the incoming adjacency protocol
   messages, loss of synchronization may be declared.

   The preferred procedure for a switch to use when it looses
   synchronization with its active controller is to attempt to establish

synchronization with (one of) its backup controller(s). However, in
this preferred approach, it must not reset its state until it
achieves synchronization with a backup controller. This means that
if, before achieving synchronization with a backup controller, it
regains synchronization with its original controller, it may continue
the original session (and cease attempting to establish
synchronization with a backup controller). If synchronization with
the original session is regained it is the responsibility of the
controller to ensure consistent state between the switch and
controller.

While the above is the preferred procedure, it is also the case that
the simplest procedure when declaring loss of synchronization with
the active controller is to reset the switch state, and start
searching for a controller. This simple procedure is legitimate.

11. Summary of Failure Response Codes

The following list gives a summary of the failure codes defined for
failure response messages:

    1: Unspecified reason not covered by other failure codes.
    2: Invalid request message.
    3: The specified request is not implemented on this switch.
    4: Invalid Port Session Number.
    5: One or more of the specified ports does not exist.
    6: One or more of the specified ports is down.
    7: Unused. (This failure code has been replaced by failure codes
        18--21.)
    8: The specified connection does not exist.
    9: The specified branch does not exist.
    10: A branch belonging to the specified point-to-multipoint
        connection is already established on the specified output
        port and the switch cannot support more than a single
        branch of any point-to-multipoint connection on the same
        output port.
    11: The limit on the maximum number of point-to-multipoint
        connections that the switch can support has been reached.
    12: The limit on the maximum number of branches that the
        specified point-to-multipoint connection can support has
        been reached.
    13: Unable to assign the requested VPI/VCI value to the requested
        branch on the specified point-to-multipoint connection.
    14: General problem related to the manner in which point-to-
        multipoint is supported by the switch.
    15: Out of resources (e.g. memory exhausted, etc.).
    16: Failure specific to the particular message type. (The meaning
        of this failure code depends upon the Message Type. It is

                defined within the description of any message that uses
                it.)
         17: Cannot label each output branch of a point-to-multipoint tree
                with a different label.
         18: One or more of the specified input VPIs is invalid.
         19: One or more of the specified input VCIs is invalid.
         20: One or more of the specified output VPIs is invalid.
         21: One or more of the specified output VCIs is invalid.
         22: Invalid Class of Service field in a Connection Management
                message.
         23: Insufficient resources for QoS Profile.
         24: Virtual path switching is not supported on this input port.
         25: Point-to-multipoint virtual path connections are not
                supported on either the requested input port or the
                requested output port.
         26: Attempt to add a virtual path connection branch to an
                existing virtual channel connection.
         27: Attempt to add a virtual channel connection branch to an
                existing virtual path connection.
         28: Only point-to-point bidirectional connections may be
                established.
         29: Cannot support requested VPI range.
         30: Cannot support requested VCI range on all requested VPIs.
         31: The transmit cell rate of this output port cannot be changed.
         32: Requested transmit cell rate out of range for this output
                port.
        128: Weighted scheduling within this waiting room is unavailable.
        129: This waiting room is unable to offer weighted sharing for a
                QoS class.
        130: This waiting room is unable to offer weighted sharing for a
                connection.
        131: Scheduler Identifier still in use.
        132: QoS Class Identifier still in use.
        133: Invalid QoS parameter.
        134: Insufficient QoS resources.
        135: Any point-to-multipoint connection arriving on this input
                port must use the same QoS parameters for all output
                branches.

12. Summary of Message Set

   The following table gives a summary of the messages defined in this
   version of the specification. It also indicates which messages must
   be supported in a minimal implementation of the protocol. Those
   messages marked as "Required" must be supported by the switch for an
   implementation to be considered to conform to this specification.
   (While the controller should also implement those messages marked

"Required," conformance cannot be tested for the controller due to
the Master-Slave nature of the protocol.)

```
     Message Name                 Message Type     Status


Connection Management Messages
     Add Branch VCC....................16          Required
               VPC....................26
     Delete Tree.......................18
     Delete All........................20
     Delete Branches...................17          Required
     Move Branch VCC...................22
               VPC.................27

Port Management Messages
     Port Management...................32          Required
     Label Range.......................33

State and Statistics Messages
     Connection Activity...............48
     Port Statistics...................49          Required
     Connection Statistics.............50
     QoS Class Statistics..............51
     Report Connection State...........52

Configuration Messages
     Switch Configuration..............64          Required
     Port Configuration................65          Required
     All Ports Configuration...........66          Required

Event Messages
     Port Up...........................80
     Port Down.........................81
     Invalid VPI/VCI...................82
     New Port..........................83
     Dead Port.........................84

Quality of Service Messages
     QoS Configuration.................96
     Scheduler Establishment...........97
     QoS Class Establishment...........98
     QoS Release.......................99
     QoS Connection Management VCC....100
                               VPC....101

Adjacency Protocol....................10          Required
```

REFERENCES

   [af-tm-0056] ATM Forum Traffic Management Specification 4.0, af-tm-
                0056.000, April 1996.

   [I.361]   "B-ISDN ATM Layer Specification," International
                Telecommunication Union, ITU-T Recommendation I.361,
                Mar. 1993.

   [I.363]   "B-ISDN ATM Adaptation Layer (AAL) Specification,"
                International Telecommunication Union, ITU-T
                Recommendation I.363, Mar. 1993.

   [IpsilonMIB] Ipsilon IP Switch MIB,
                http://www.ipsilon.com/products/ips.mib

   [Partridge] C. Partridge, "Gigabit Networking," Addison-Wesley,
                1994.

   [RFC1700]   Reynolds, J., and J. Postel, "Assigned Numbers," STD 2,
                RFC 1700, October 1994.

   [RFC1987]   Newman, P, Edwards, W., hinden, R., Hoffman, E. Ching
                Liaw, F., Lyon, T. and G. Minshall, "Ipsilon's General
                Switch Management Protocol Specification," Version 1.1,
                RFC 1987, August 1996.

SECURITY CONSIDERATIONS

   Physical security on the control link connecting the controller to
   the switch is assumed. Security issues are not discussed in this
   document.

AUTHORS' ADDRESSES

   Peter Newman   Phone: +1 (408) 990 2003
   Nokia   EMail: pn@ipsilon.com

   W. L. Edwards, Chief Scientist   Phone: +1 (913) 534 5334
   Sprint   EMail: texas@sprintcorp.com

   Robert M. Hinden   Phone: +1 (408) 990 2004
   Nokia   EMail: hinden@ipsilon.com

   Eric Hoffman   Phone: +1 (408) 990 2010
   Nokia   EMail: hoffman@ipsilon.com

Fong Ching Liaw   Phone: +1 (408) 873 2688
Coppercom   EMail: fong@coppercom.com

Tom Lyon   Phone: +1 (408) 990 2001
Nokia   EMail: pugs@ipsilon.com

Greg Minshall   Phone: +1 (650) 237 3164
Fiberlane Communications   EMail: minshall@fiberlane.com

Nokia (Sunnyvale) is located at:

    232 Java Drive
    Sunnyvale, CA 94089
    USA

Sprint is located at:

    Sprint
    Sprint Technology Services - Long Distance Division
    9300 Metcalf Avenue
    Mailstop KSOPKB0802
    Overland Park, KS 66212-6333
    USA

Fiberlane Communications is located at:

    1399 Charleston Road
    Mountain View, CA 94043
    USA

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