                 General Switch Management Protocol (GSMP) V3

Status of this Memo

   This document specifies an Internet standards track protocol for the
   Internet community, and requests discussion and suggestions for
   improvements. Please refer to the current edition of the "Internet
   Official Protocol Standards" (STD 1) for the standardization state
   and status of this protocol. Distribution of this memo is unlimited.

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Abstract

   This document describes the General Switch Management Protocol
   Version 3 (GSMPv3). The GSMPv3 is an asymmetric protocol that allows
   one or more external switch controllers to establish and maintain the
   state of a label switch such as, an ATM, frame relay or MPLS switch.
   The GSMPv3 allows control of both unicast and multicast switch
   connection state as well as control of switch system resources and
   QoS features.

Acknowledgement

   GSMP was created by P. Newman, W. Edwards, R. Hinden, E. Hoffman, F.
   Ching Liaw, T. Lyon, and G. Minshall (see [6] and [7]). This version
   of GSMP is based on their work.

Contributors

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   members of the GSMP group have made significant contributions to this
   specification. Among the contributors who have contributed
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Specification of Requirements

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
   document are to be interpreted as described in [RFC2119].

Table of Contents

1. Introduction

   The General Switch Management Protocol (GSMP) is a general purpose
   protocol to control a label 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, request and delete reservation of switch
   resources, and request statistics. It also allows the switch to
   inform the controller of asynchronous events such as a link going
   down. 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. Also a switch may be
   controlled by more than one controller by using the technique of
   partitioning.

   A "physical" switch can be partitioned into several virtual switches
   that are referred to as partitions. In this version of GSMP, switch
   partitioning is static and occurs prior to running GSMP. The
   partitions of a physical switch are isolated from each other by the
   implementation and the controller assumes that the resources
   allocated to a partition are at all times available to that
   partition. A partition appears to its controller as a label switch.
   Throughout the rest of this document, the term switch (or
   equivalently, label switch) is used to refer to either a physical,
   non-partitioned switch or to a partition. The resources allocated to
   a partition appear to the controller as if they were the actual
   physical resources of the partition. For example if the bandwidth of
   a port were divided among several partitions, each partition would
   appear to the controller to have its own independent port.

   GSMP controls a partitioned switch through the use of a partition
   identifier that is carried in every GSMP message. Each partition has
   a one-to-one control relationship with its own logical controller
   entity (which in the remainder of the document is referred to simply
   as a controller) and GSMP independently maintains adjacency between
   each controller-partition pair.

   Kinds of label switches include frame or cell switches that support
   connection oriented switching, using the exact match-forwarding
   algorithm based on labels attached to incoming cells or frames. 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. Cells or labelled
   frames arrive at the switch from an external communication link on

incoming labelled channels at an input port. Cells or labelled
frames depart from the switch to an external communication link on
labelled channels from an output port.

A switch may support multiple label types, however, each switch port
can support only one label type. The label type supported by a given
port is indicated by the switch to the controller in a port
configuration message. Connections may be established between ports,
supporting different label types. Label types include ATM, Frame
Relay, MPLS Generic and FEC Labels.

A connection across a switch is formed by connecting an incoming
labelled channel to one or more outgoing labelled channels.
Connections are referenced by the input port on which they originate
and the Label values of their incoming labelled channel.

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 connection is established with a certain quality of
service (QoS). This version of GSMP includes a default QoS
Configuration and additionally allows the negotiation of alternative,
optional QoS configurations. The default QoS Configuration includes
three QoS Models: a Service Model, a Simple Abstract Model (strict
priorities) and a QoS Profile Model.

The Service Model is based on service definitions found external to
GSMP such as in Integrated Services or ATM Service Categories. Each
connection is assigned a specific service that defines the handling
of the connection by the switch. Additionally, traffic parameters
and traffic controls may be assigned to the connection depending on
the assigned service.

In the Simple Abstract Model, a connection is assigned a priority
when it is established. It may be assumed that for connections that
share the same output port, a cell or frame on a connection with a
higher priority is much more likely to exit the switch before a cell
or frame 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.

The QoS Profile Model provides a simple mechanism that allows
connection to be assigned QoS semantics defined externally to GSMP.
The QoS Profile Model can be used to indicate pre-defined
Differentiated Service Per Hop Behaviours (PHBs). Definition of QoS
profiles is outside of the scope of this specification.

All GSMP switches MUST support the default QoS Configuration. A GSMP
switch may additionally support one or more alternative QoS
Configurations. The QoS models of alternative QoS configurations are
defined outside the GSMP specification. GSMP includes a negotiation
mechanism that allows a controller to select from the QoS
configurations that a switch supports.

GSMP contains an adjacency protocol. The adjacency protocol is used
to synchronise states 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

GSMP packets may be transported via any suitable medium. GSMP packet
encapsulations for ATM, Ethernet and TCP are specified in [15].
Additional encapsulations for GSMP packets may be defined in separate
documents.

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 six classes of GSMP
request-response message: Connection Management, Reservation
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. The
controller can be required to acknowledge event messages, but by
default does not do so. There is also an adjacency protocol message
used to establish synchronisation 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.

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 opaque sub-fields 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 states synchronised.

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

3.1 GSMP Packet Format

3.1.1 Basic GSMP Message 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     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |            Transaction Identifier             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|      SubMessage Number      |              Length           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                         Message Body                          ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
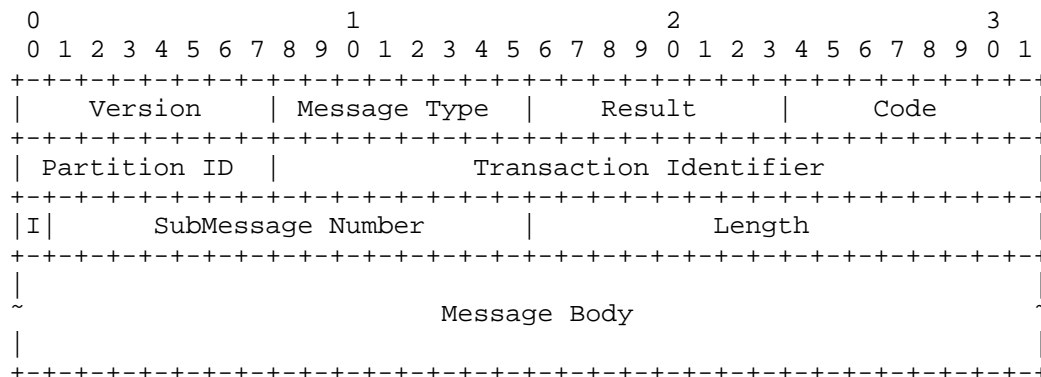
(The convention in the documentation of Internet Protocols [5] is to
express numbers in decimal. Numbers in hexadecimal format are
specified by prefacing them with the characters "0x". Numbers in
binary format are specified by prefacing them with the characters
"0b". Data is pictured in "big-endian" order. That is, fields are
described left to right, with the most significant byte on the left
and the least significant byte on the right. Whenever a diagram
shows a group of bytes, the order of transmission of those bytes is
the normal order in which they are read in English. Whenever a byte
represents a numeric quantity, the left most bit in the diagram is
the high order or most significant bit. That is, the bit labelled 0
is the most significant bit. Similarly, whenever a multi-byte field
represents a numeric quantity, the left most bit of the whole field
is the most significant bit. When a multi-byte quantity is
transmitted, the most significant byte is transmitted first. This is
the same coding convention as is used in the ATM layer [1] and AAL-5
[2][3].)

   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 the following
       classes: Connection Management, Reservation Management, Port
       Management, State and Statistics, Configuration, Quality of
       Service, Events and messages belonging to an Abstract or
       Resource Model (ARM) extension. 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 that 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 State 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 was 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. 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.

"More" in the result indicates that the message, either request
or 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.

ReturnReceipt is a result field used in Events to indicate that
an acknowledgement is required for the message. The default
for Events Messages is that the controller will not acknowledge
Events. In the case where a switch requires acknowledgement,
it will set the Result Field to ReturnReceipt in the header of
the Event Message.

The encoding of the result field is:

                NoSuccessAck: Result = 1
                AckAll: Result = 2
                Success: Result = 3
                Failure: Result = 4
                More: Result = 5
                ReturnReceipt   Result = 6

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.

Partition ID
   Field used to associate the command with a specific switch
   partition. The format of the Partition ID is not defined in
   GSMP. If desired, the Partition ID can be divided into
   multiple sub-identifiers within a single partition. For
   example: the Partition ID could be subdivided into a 6-bit
   partition number and a 2-bit sub-identifier which would allow a
   switch to support 64 partitions with 4 available IDs per
   partition.

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.

I flag
   If I is set then the SubMessage Number field indicates the
   total number of SubMessage segments that compose the entire
   message. If it is not set then the SubMessage Number field
   indicates the sequence number of this SubMessage segment within
   the whole message.

SubMessage Number
   When a message is segmented because it exceeds the MTU of the
   link layer, each segment will include a submessage number to
   indicate its position. Alternatively, if it is the first
   submessage in a sequence of submessages, the I flag will be set
   and this field will contain the total count of submessage
   segments.

Length
   Length of the GSMP message including its header fields and
   defined GSMP message body. The length of additional data
   appended to the end of the standard message SHOULD be included
   in the Length field.

3.1.2 Fields commonly found in GSMP messages

   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, "5: 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.

3.1.2.1 Additional General Message Information

    1. 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.

    2. Flags that are undefined will be designated as: x: reserved

    3. It is not an error for a GSMP message to contain additional data
       after the end of the Message Body. This is allowed to support
       proprietary and experimental purposes. However, the maximum
       transmission unit of the GSMP message, as defined by the data link
       layer encapsulation, MUST NOT be exceeded. The length of
       additional data appended to the end of the standard message SHOULD
       be included in the message length field.

    4. A success response message MUST NOT be sent until the requested
       operation has been successfully completed.

3.1.3 Labels

   All labels in GSMP have a common structure composed of tuples,
   consisting of a Type, a Length, and a Value. Such tuples are
   commonly known as TLV's, and are a good way of encoding information
   in a flexible and extensible format. A label TLV is encoded as a 2
   octet field that uses 12 bits to specify a Type and four bits to
   specify certain behaviour specified below, followed by a 2 octet
   Length field, followed by a variable length Value field.
   Additionally, a label field can be composed of many stacked labels
   that together constitute the label.

   A summary of TLV labels supported in this version of the protocol is
   listed below:

       TLV Label   Type   Section Title
       ---------   ----   -------------
       ATM Label   0x100   ATM TLV Labels
       FR Label   0x101   Frame Relay TLV Labels
       MPLS Gen Label 0x102   MPLS Generic TLV Labels
       FEC Label   0x103   FEC TLV Labels

   All Labels will be designated as follow:

    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
   +-+
   |x|S|x|x| Label Type | Label Length |
   +-+
   | |
   ~   Label Value   ~
   | |
   +-+
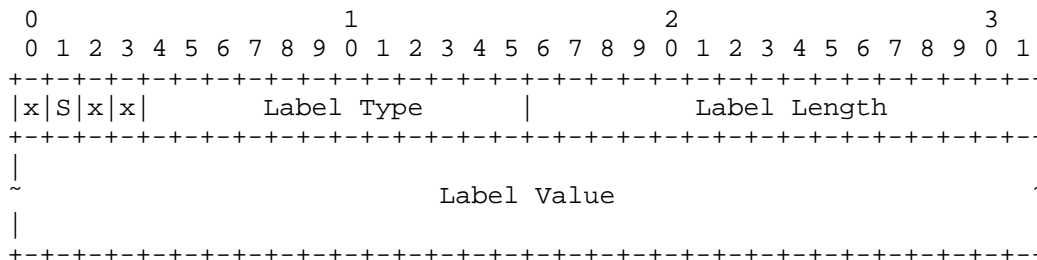
      x: Reserved Flags.
         These are generally used by specific messages and will be
         defined in those messages.

      S: Stacked Label Indicator
         Label Stacking is discussed below in section 3.1.3.5

      Label Type
         A 12-bit field indicating the type of label.

      Label Length
         A 16-bit field indicating the length of the Label Value field
         in bytes.

     Label Value
        A variable length field that is an integer number of 32 bit
        words long. The Label Value field is interpreted according to
        the Label Type as described in the following sections.

3.1.3.1 ATM Labels

   If the Label Type = ATM Label, the labels MUST be interpreted as an
   ATM labels as shown:

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |x|S|x|x|    ATM Label (0x100)   |          Label Length         |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |x x x x|           VPI          |               VCI             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
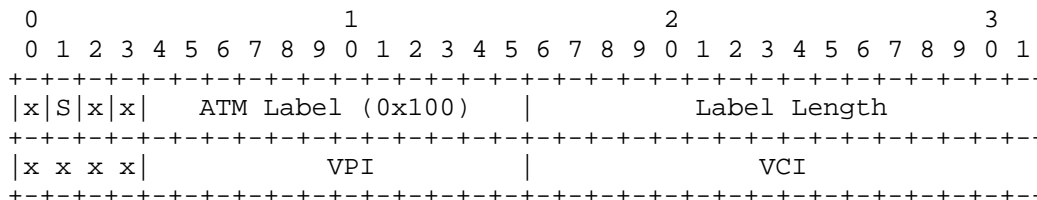
   For a virtual path connection (switched as a single virtual path
   connection) or a virtual path (switched as one or more virtual
   channel connections within the virtual path) the VCI field is not
   used.

   ATM distinguishes between virtual path connections and virtual
   channel connections. 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).

3.1.3.2 Frame Relay Labels

   If the TLV Type = FR Label, the labels MUST be interpreted as a Frame
   Relay labels as shown:
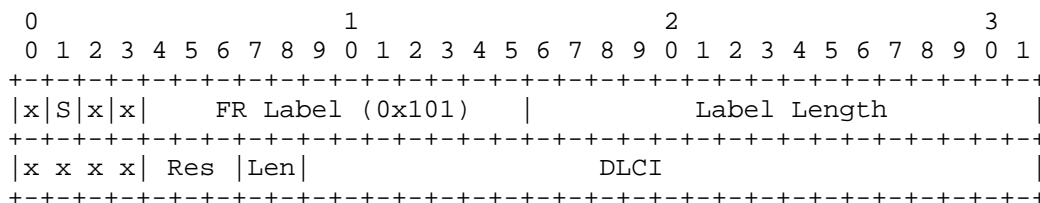
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|    FR Label (0x101)   |          Label Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x| Res |Len|                  DLCI                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

      Res
         The Res field is reserved in [21], i.e., it is not explicitly
         reserved by GSMP.

      Len
         The Len field specifies the number of bits of the DLCI. The
         following values are supported:

            Len DLCI bits
            0   10
            2   23

      DLCI
         DLCI is the binary value of the Frame Relay Label. The
         significant number of bits (10 or 23) of the label value is to
         be encoded into the Data Link Connection Identifier (DLCI)
         field when part of the Frame Relay data link header [13].

3.1.3.3 MPLS Generic Labels

   If a port's attribute PortType=MPLS, then that port's labels are for
   use on links for which label values are independent of the underlying
   link technology. Examples of such links are PPP and Ethernet. On
   such links the labels are carried in MPLS label stacks [14]. If the
   Label Type = MPLS Generic Label, the labels MUST be interpreted as
   Generic MPLS labels as shown:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x| MPLS Gen Label (0x102)|          Label Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x x x x x x x x x|                MPLS Label             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
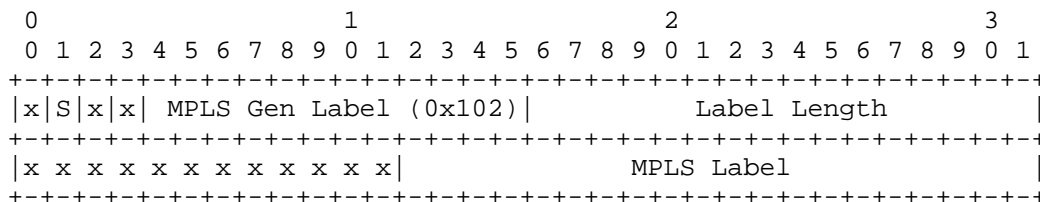
    MPLS Label
        This is a 20-bit label value as specified in [14], represented
        as a 20-bit number in a 4-byte field.

3.1.3.4 FEC Labels

   Labels may be bound to Forwarding Equivalence Classes (FECs) as
   defined in [18]. A FEC is a list of one or more FEC elements. The
   FEC TLV encodes FEC items. In this version of the protocol only,
   Prefix FECs are supported. If the Label Type = FEC Label, the labels
   MUST be interpreted as Forwarding Equivalence Class Labels as shown:

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |x|S|x|x|   FEC Label (0x103)   |           Label Length        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   ~                         FEC Element 1                         ~
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   ~                         FEC Element n                         ~
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
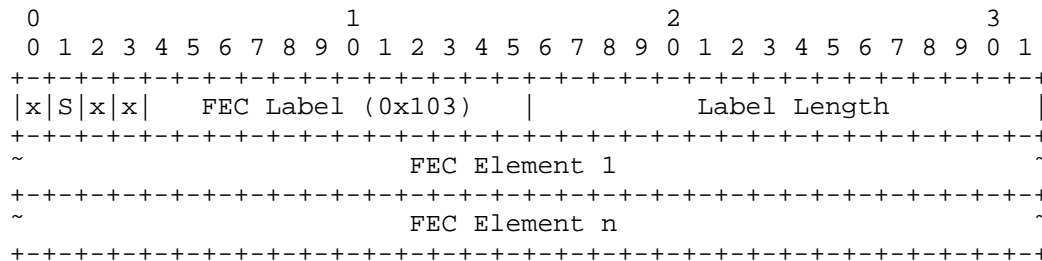
    FEC Element
        The FEC element encoding depends on the type of FEC element.
        In this version of GSMP only, Prefix FECs are supported.

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Element Type |        Address Family         | Prefix Length |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   ~                            Prefix                            ~
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
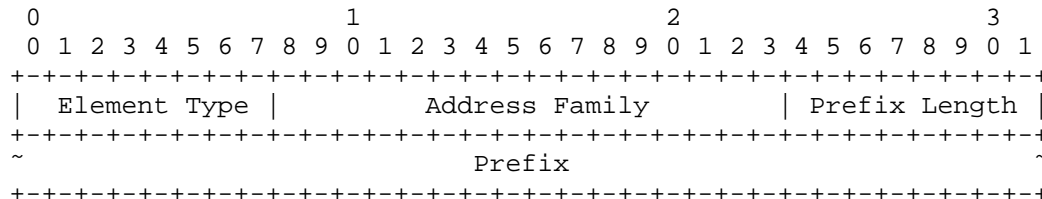
    Element Type
        In this version of GSMP the only supported Element Type is
        Prefix FEC Elements. The Prefix FEC Element is a one-octet
        value, encoded as 0x02.

    Address Family
        Two-byte quantity containing a value from ADDRESS FAMILY
        NUMBERS in [5], that encodes the address family for the address
        prefix in the Prefix field.

Prefix Length
    One byte containing the length in bits of the address prefix
    that follows. A length of zero indicates a prefix that matches
    all addresses (the default destination); in this case the
    Prefix itself is zero bytes.

Prefix
    An address prefix encoded according to the Address Family
    field, whose length, in bits, was specified in the Prefix
    Length field.

3.1.3.5 Label Stacking

   Label stacking is a technique used in MPLS [14] that allows
   hierarchical labelling. MPLS label stacking is similar to, but
   subtly different from, the VPI/VCI hierarchy of labels in ATM. There
   is no set limit to the depth of label stacks that can be used in
   GSMP.

   When the Stacked Label Indicator S is set to 1 it indicates that an
   additional label field will be appended to the adjacent label field.
   For example, a stacked Input Short Label could be designated as
   follows:

```
      +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
      |x|S|x|x|                                                       |
      +-+-+-+-+                        Input Label                    |
      ~                                                               ~

      +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   ** |x|S|x|x|                                                       |
      +-+-+-+-+                     Stacked Input Label               |
      ~                                                               ~

      +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
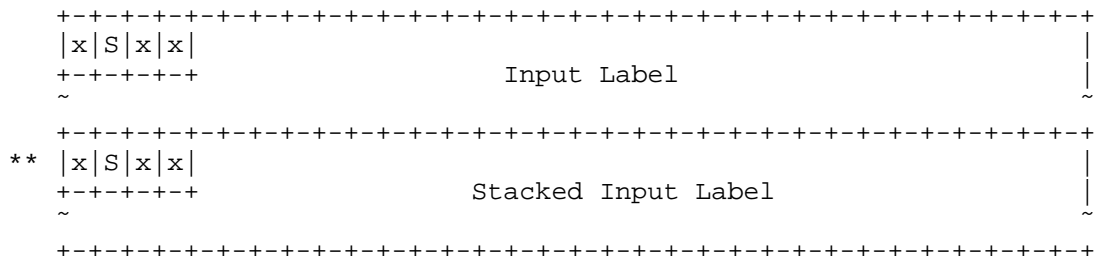
       ** Note: There can be zero or more Stacked Labels fields (like
          those marked **) following an Input or Output Label field. A
          Stacked Label follows the previous label field if and only if
          the S Flag in the previous label is set.

   When a label is extended by stacking, it is treated by the protocol
   as a single extended label, and all operations on that label are
   atomic. For example, in an add branch message, the entire input
   label is switched for the entire output label. Likewise, in Move
   Input Branch and Move Output Branch messages, the entire label is
   swapped. For that reason, in all messages that designate a label
   field, it will be depicted as a single 64-bit field, though it might
   be instantiated by many 64-bit fields in practice.

3.1.4 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.)

   A warning response message is a success response (Result = 3) with
   the Code field specifying the warning code. The warning code
   specifies a warning that was generated during the successful
   operation.

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

      - Invalid Message

      - General Message Failure

      - Specific Message Failure
         A failure response specified in the text defining the message
         type.

      - Connection Failures

      - Virtual Path Connection Failures

      - Multicast Failures

      - QoS Failures

      - General Failures

      - Warnings

   If multiple failures match in any of the categories, the one that is
   listed first should be returned. Descriptions of the Failure
   response messages can be found in section 12.

4. Connection Management Messages

4.1 General Message Definitions

   Connection management messages are used by the controller to
   establish, delete, modify and verify 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      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |              Transaction Identifier           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|     SubMessage Number       |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Port Session Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Reservation ID                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Input Port                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Input Service Selector                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Output Port                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Output Service Selector                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|IQS|OQS|P|x|N|O|                Adaptation Method               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|                                                       |
+-+-+-+-+                       Input Label                     |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|                                                       |
+-+-+-+-+                       Output Label                    |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
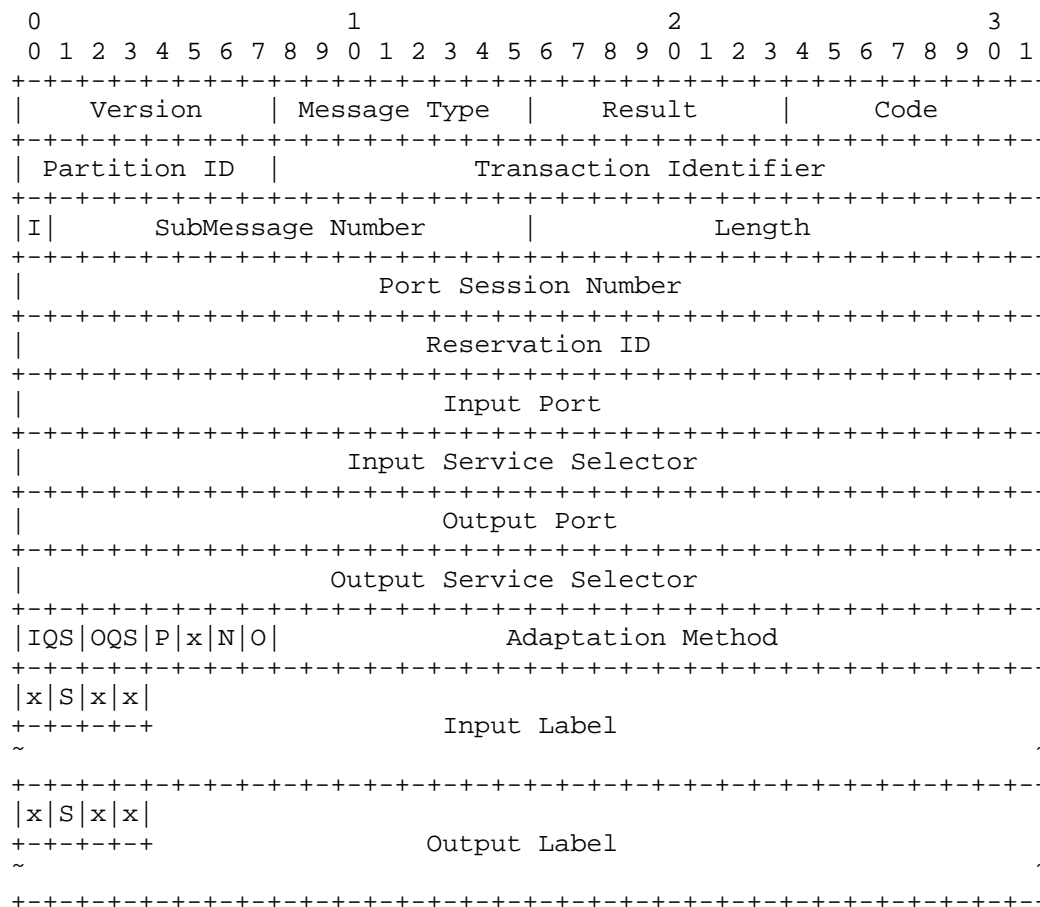
When required, the Add Branch, Move Input Branch and Move Output
Branch messages have an additional, variable length data block
appended to the above message. This will be required when
indicated by the IQS and OQS flags (if the value of either is set
to 0b10) and the service selector. The additional data block has
the following format:
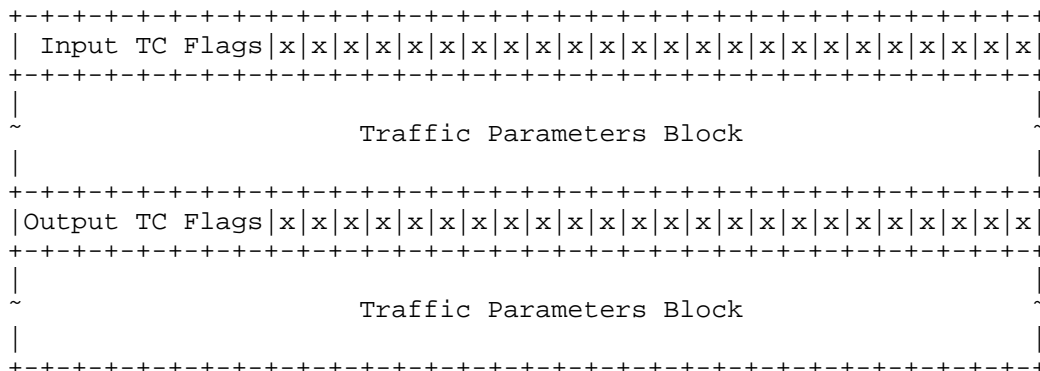
```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Input TC Flags|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                              |
~                   Traffic Parameters Block                   ~
|                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Output TC Flags|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                              |
~                   Traffic Parameters Block                   ~
|                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Note: Fields and Parameters that have been explained in the
   description of the general messages will not be explained in
   this section. Please refer to section 3.1 for details.

Reservation ID
   Identifies the reservation that MUST be deployed for the branch
   being added. Reservations are established using reservation
   management messages (see Chapter 5). A value of zero indicates
   that no Reservation is being deployed for the branch. If a
   reservation with a corresponding Reservation ID exists, then
   the reserved resources MUST be applied to the branch. If the
   numerical value of Reservation ID is greater than the value of
   Max Reservations (from the Switch Configuration message), a
   failure response is returned indicating "20: Reservation ID out
   of Range". If the value of Input Port differs from the input
   port specified in the reservation, or if the value of Output
   Port differs from the output port specified in the reservation,
   a failure response MUST be returned indicating "21: Mismatched
   reservation ports". If no reservation corresponding to
   Reservation ID exists, a failure response MUST be returned
   indicating "23: Non-existent reservation ID".

If a valid Reservation ID is specified and the Service Model is
used (i.e., IQS or OQS=0b10) then the Traffic Parameters Block
may be omitted from the Add Branch message indicating that the
Traffic Parameters specified in the corresponding Reservation
Request message are to be used.

Input Port
   Identifies a switch input port.

Input Label
   Identifies an incoming labelled channel arriving at the switch
   input port indicated by the Input Port field. The value in the
   Input Label field MUST be interpreted according to the Label
   Type attribute of the switch input port indicated by the Input
   Port field.

Input Service Selector
   Identifies details of the service specification being used for
   the connection. The interpretation depends upon the Input QoS
   Model Selector (IQS).

   IQS = 00: In this case, the Input Service Selector indicates a
             simple priority.

   IQS = 01: In this case, the Input Service Selector is an opaque
             service profile identifier. The definition of these
             service profiles is outside the scope of this
             specification. Service Profiles can be used to
             indicate pre-defined Differentiated Service Per Hop
             Behaviours.

   IQS = 10: In this case, the Input Service Selector corresponds
             to a Service Spec as defined in Chapter 8.2. When
             the value of either IQS or OQS is set to 0b10, then a
             Traffic Parameters Block is appended to the message.

   IQS = 11: In this case the Input Service Selector corresponds
             to an ARM service specification. Definition of ARM
             service specifications is outside the scope of this
             specification and is determined by the MType as
             defined in Chapter 8.1.

Output Port
   Identifies a switch output port.

Output Label
  Identifies an outgoing labelled channel departing at the switch
  output port indicated by the Output Port field. The value in
  the Output Label field MUST be interpreted according to the
  Label Type attribute of the switch input port indicated by the
  Output Port field

Output Service Selector
  Identifies details of the service model being used. The
  interpretation depends upon the Output QoS Model selector
  (OQS).

  OQS = 00: In this case the Output Service Selector indicates a
            simple priority.

  OQS = 01: In this case the Output Service Selector is an opaque
            service profile identifier. The definition of these
            service profiles is outside the scope of this
            specification. Service Profiles can be used to
            indicate pre-defined Differentiated Service Per Hop
            Behaviours.

  OQS = 10: In this case the Output Service Selector corresponds
            to a Service Spec as defined in Chapter 8.2. When
            the value of either IQS or OQS is set to 0b10 then a
            Traffic Parameters Block is appended to the message.

  OQS = 11: In this case the Output Service Selector corresponds
            to an ARM service specification. Definition of ARM
            service specifications is outside the scope of this
            specification and is determined by the MType as
            defined in Chapter 8.1.

IQS, OQS
  Input and Output QoS Model Selector:
  The QoS Model Selector is used to specify a QoS Model for the
  connection. The values of IQS and OQS determine respectively
  the interpretation of the Input Service Selector and the Output
  Service Selector, and SHOULD be interpreted as a priority, a
  QoS profile, a service specification, or an ARM specification
  as shown:

      IQS/OQS QoS Model   Service Selector
      ------- ---------   ---------------
      00   Simple Abstract   Model Priority
      01   QoS Profile Model   QoS Profile
      10   Default Service Model Service Specification
      11   Optional ARM   ARM Specification

P Flag
   If the Parameter flag is set it indicates that a single
   instance of the Traffic Parameter block is provided. This
   occurs in cases where the Input Traffic Parameters are
   identical to Output Traffic Parameters.

N Flag
   The Null flag is used to indicate a null adaptation method.
   This occurs when the branch is connecting two ports of the same
   type.

O Flag
   The Opaque flag indicates whether the adaptation fields are
   opaque, or whether they are defined by the protocol. See the
   definition of Adaptation Method below for further information.

Adaptation Method
   The adaptation method is used to define the adaptation framing
   that may be in use when moving traffic from one port type to
   another port type; e.g., from a frame relay port to an ATM
   port. The content of this field is defined by the Opaque flag.
   If the Opaque flag is set, then this field is defined by the
   switch manufacturer and is not defined in this protocol. If
   the opaque flag is not set, the field is divided into two 12-
   bit fields as follows:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|IQS|OQS|P|x|N|O|    Input Adaptation   |   Output Adaptation   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
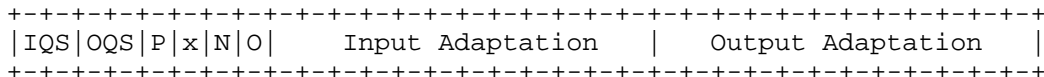
   Input Adaptation
      Adaptation framing method used on incoming connections.

   Output Adaptation
      Adaptation framing method used on outgoing connections.

   Adaptation Types:

      0x100   PPP
      0x200   FRF.5
      0x201   FRF.8

Input and Output TC Flags
   TC (Traffic Control) Flags are used in Add Branch, Move Input
   Branch and Move Output Branch messages for connections using
   the Service Model (i.e., when IQS or OQS=0b10). The TC Flags
   field is defined in Section 10.6.

    Input and Output Traffic Parameters Block
        This variable length field is used in Add Branch, Move Input
        Branch and Move Output Branch messages for connections using
        the Service Model (i.e., when IQS or OQS=0b10). Traffic
        Parameters Block is defined in Section 10.5. The Traffic
        Parameters Block may be omitted if a valid, non-zero
        Reservation ID is specified, in which case the Traffic
        Parameters of the corresponding Reservation Request message are
        used. If the P flag is set, then the appended message block
        will only include a single traffic parameter block which will
        be used for both input and output traffic.

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. 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.

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 and Input Label will establish a
point-to-point connection. The second Add Branch message with the
same Input Port and Input Label fields will convert the connection to
a point-to-multipoint connection with two branches. 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 and Input Label 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 labelled
channel to one or more output labelled channels.

In GSMP 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 label.)

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 states 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.

4.2 Add Branch Message

   The Add Branch message is a connection management message used to
   establish a connection or to add an additional branch to an existing
   connection. It may also be used to check the connection state stored
   in the switch. The connection is specified by the Input Port and
   Input Label fields. The output branch is specified by the Output
   Port and Output Label fields. The quality of service requirements of
   the connection are specified by the QoS Model Selector and Service
   Selector fields. To request a connection the Add Branch message is:

      Message Type = 16

```
 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     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID   |           Transaction Identifier            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|      SubMessage Number       |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Port Session Number                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Reservation ID                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Input Port                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Input Service Selector                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Output Port                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Output Service Selector                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|IQS|OQS|P|x|N|O|               Adaptation Method               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|M|B|                                                       |
+-+-+-+-+                       Input Label                     |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|M|R|                                                       |
+-+-+-+-+                       Output Label                    |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

When the value of either IQS or OQS is set to 0b10 then the following
Traffic Parameters Block is appended to the above message:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Input TC Flags |x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                  Input Traffic Parameters Block               ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Output TC Flags|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                  Output Traffic Parameters Block              ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Note: Fields and Parameters that have been explained in the
      description of the general connection message will not be
      explained in this section. Please refer to section 4.1 for
      details.

   M: Multicast
      Multicast flags are used as a hint for point-to-multipoint or
      multipoint-to-point connections in the Add Branch message.
      They are not used in any other connection management messages
      and in these messages they SHOULD be set to zero. There are
      two instances of the M-bit in the Add Branch message; one for
      input branch specified by the Input Port and Input Label fields
      and one for the output branch specified by the Output Port and
      Output Label fields. If set for the input branch (in front of
      Input Label field), it indicates that the 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. If set for the output
      branch (in front of the Output Label field), it indicates that
      the connection is very likely to be a multipoint-to-point
      connection. If zero, it indicates that this connection is very
      likely to be a point-to-point connection or is unknown.

      If M flags are set for input as well as output branches, it
      indicates that the connection is very likely to be a
      multipoint-to-multipoint connection.

      The Multicast flags are 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 or a multipoint-to-point connection and

on such connections it SHOULD be ignored by the receiver.
(Except in cases where the connection replace bit is enabled
and set, the receipt of the second and subsequent Add Branch
messages from the receiver indicates a point-to-multipoint or a
multipoint-to-point connection.) If it is known that this is
the first branch of a point-to-multipoint or a multipoint-to-
point 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 the multicast flag is not
mandatory and may be ignored by the switch. If unused, the
flags SHOULD be set to zero. Some switches use a different
data structure for multicast connections rather than for
point-to-point connections. These flags prevent the switch
from setting up a point-to-point structure for the first branch
of a multicast connection that MUST immediately be deleted and
reconfigured as point-to-multipoint or multipoint-to-point when
the second branch is established.

B: Bi-directional
    The Bi-directional 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 Bi-directional flag in an Add Branch message, if set,
    requests that two unidirectional connections 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
    Label, Output Port and Output Label as specified in the Add
    Branch message. The reverse direction is derived by exchanging
    the values specified in the Input Port and Input Label fields,
    with those of the Output Port and Output Label fields
    respectively. Thus, a connection in the reverse direction
    originates at the input port specified by the Output Port
    field, on the label specified by the Output Label field. It
    departs from the output port specified by the Input Port field,
    on the label specified by the Input Label field.

    The Bi-directional flag is simply a convenience to establish
    two unidirectional connections in opposite directions between
    the same two ports, with identical Labels, using a single Add
    Branch message. In all future messages the two unidirectional
    connections MUST be handled separately. There is no bi-
    directional 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.

     R: Connection Replace
        The Connection Replace flag applies only to the Add Branch
        message and is not used in any other Connection Management
        messages. The R flag is used in cases when creation of
        multipoint-to-point connections is undesirable (e.g., POTS
        applications where fan-in is meaningless). If the R flag is
        set, the new connection replaces any existing connection if the
        label is already in use at the same Output Port.

        The Connection Replace mechanism allows a single Add Connection
        command to function as either a Move Branch message or a
        combination of Delete Branch/Add Branch messages. This
        mechanism is provided to support existing 64k call handling
        applications, such as emulating 64k voice switches.

        The use of R flag is optional and MUST be pre-configured in the
        Port Management message [see section 6.1] to activate its use.
        The R flag MUST NOT be set if it is not pre-configured with the
        Port Management message. The switch MUST then return a Failure
        Response message: "36: Replace of connection is not activated
        on switch". Information about whether the function is active
        or not, can be obtained by using the Port Configuration message
        [see section 8.2].

        The R flag MUST NOT be set if either the M flag or the B flag
        is set. If a switch receives an Add connection request that
        has the R flag set with either the B or the M flag set, it MUST
        return a failure response message of: "37: Connection
        replacement mode cannot be combined with Bi-directional or
        Multicast mode"

  If the connection specified by the Input Port and Input Label fields
  does not already exist, it MUST be established with the single output
  branch specified in the request message. If the Bi-directional 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.

  If the connection specified by the Input Port and Input Label fields
  already exists and the R flag is not set, 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 connection specified by the Input Port and Input Label 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 a previously
established state. For messages that are reasserting a 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 or frames).

If the connection specified by the Input Port and Input Label fields
already exists, and the Bi-directional Flag in the Flags field is
set, a failure response MUST be returned indicating: "15: Point-to-
point bi-directional connection already exists".

It should be noted that different switches support multicast in
different ways. There may be a limit to the total number of point-
to-multipoint or multipoint-to-point connections certain switches can
support, and possibly a limit on the maximum number of branches that
a point-to-multipoint or multipoint-to-point connection may specify.
Some switches also impose a limit on the number of different Label
values that may be assigned e.g., 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.

4.2.1 ATM specific procedures:

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

    Message Type = 26

An ATM virtual path connection can only be established between ATM
ports, i.e., ports with the "ATM" Label Type attribute. If an ATM
VPC Add Branch message is received and either the switch input port
specified by the Input Port field or the switch output port specified
by the Output Port field is not an ATM port, a failure response
message MUST be returned indicating, "28: ATM Virtual path switching
is not supported on non-ATM ports".

If an ATM 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,
"24: ATM virtual path switching is not supported on this input port".

If an ATM 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 "27: Attempt to add an ATM
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, "26: Attempt to
add an ATM virtual path connection branch to an existing virtual
channel connection".

4.3 Delete Tree Message

   The Delete Tree message is a Connection Management message used to
   delete an entire connection. All remaining branches of the
   connection are deleted. A connection is defined by the Input Port
   and the Input Label fields. The Output Port and Output Label 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.

4.4 Verify Tree Message

   The Verify Tree message has been removed from this version of GSMP.

      Message Type = 19

   If a request message is received with Message Type = 19, a failure
   response MUST be returned with the Code field indicating:

   "3: The specified request is not implemented on this switch.".

4.5 Delete All Input Port Message

   The Delete All Input Port message is a connection management message
   used to delete all connections on a switch input port. All
   connections that originate at the specified input port MUST be
   deleted. On completion of the operation all dynamically assigned
   Label values for the specified port MUST be unassigned, i.e., there
   MUST be no connections established in the Label space that GSMP
   controls on this port. The Service Selectors, Output Port, Input

Label and Output Label fields are not used in this message. The
Delete All Input Port 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
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 Input Port request.

        3: The specified request is not implemented on this switch.

        4: One or more of the specified ports does not exist.

        5: Invalid Port Session Number.

If any field in a Delete All Input Port message not covered by the
above failure codes is invalid, a failure response MUST be returned
indicating: "2: Invalid request message". Else, the Delete All Input
Port operation MUST be completed successfully and a success message
returned. No other failure messages are permitted.

4.6 Delete All Output Port Message

The Delete All message is a connection management message used to
delete all connections on a switch output port. All connections that
have the specified output port MUST be deleted. On completion of the
operation all dynamically assigned Label values for the specified
port MUST be unassigned, i.e., there MUST be no connections
established in the Label space that GSMP controls on this port. The
Service Selectors, Input Port, Input Label and Output Label fields
are not used in this message. The Delete All Output Port message is:

    Message Type = 21

If the Result field of the request message is "AckAll", a success
response message MUST be sent upon completion of the operation. 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 Output Port request.

3: The specified request is not implemented on this switch.

4: One or more of the specified ports does not exist.

5: Invalid Port Session Number.

If any field in a Delete All Output Port message not covered by the
above failure codes is invalid, a failure response MUST be returned
indicating: "2: Invalid request message". Else, the delete all
operation MUST be completed successfully and a success message
returned. No other failure messages are permitted.

4.7 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 channel, 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      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |            Transaction Identifier             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|      SubMessage Number      |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|      Number of Elements         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                    Delete Branch Elements                     ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Note: Fields and Parameters that have been explained in the
      description of the general connection message will not be
      explained in this section. Please refer to section 4.1 for
      details.

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 a branch to be deleted and has
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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Error |x|x|x|x|x|x|x|x|x|x|x|        Element Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Port Session Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Input Port                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Output Port                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|                                                       |
+-+-+-+-+                     Input Label                       |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|                                                       |
+-+-+-+-+                     Output Label                      |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Note: Fields and Parameters that have been explained in the
    description of the general connection message will not be
    explained in this section. Please refer to section 4.1 for
    details.

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 12, "Failure
    Response Codes".

    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, a connection is specified by the Input
Port and Input Label fields. The specific branch to be deleted is
indicated by the Output Port and Output Label fields.

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 "10: General Message
Failure" 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.

4.8 Move Output Branch Message

   The Move Output Branch message is used to move a branch of an
   existing connection from its current output port label to a new
   output port label in a single atomic transaction. The Move Output
   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      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |            Transaction Identifier             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|    SubMessage Number        |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Port Session Number                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Input Port                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Input Service Selector                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Old Output Port                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       New Output Port                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Output Service Selector                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|IQS|OQS|P|x|N|O|                Adaptation Method               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|                                                       |
+-+-+-+-+                      Input Label                      |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|                                                       |
+-+-+-+-+                    Old Output Label                   |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|                                                       |
+-+-+-+-+                    New Output Label                   |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

When the value of either IQS or OQS is set to 0b10 then the following
Traffic Parameters Block is appended to the above message:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Input TC Flags |x x x x x x x x x x x x x x x x x x x x x x x x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                 Input Traffic Parameters Block                ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Output TC Flags|x x x x x x x x x x x x x x x x x x x x x x x x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                Output Traffic Parameters Block                ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
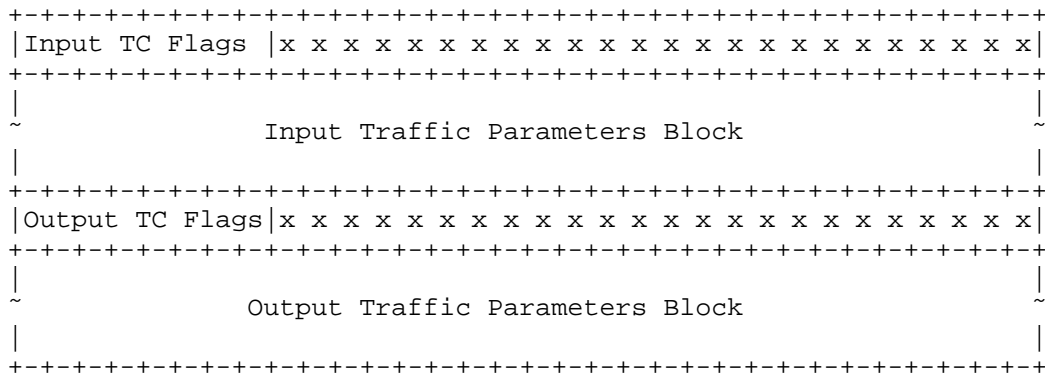
   Note: Fields and Parameters that have been explained in the
      description of the general connection message will not be
      explained in this section. Please refer to section 4.1 for
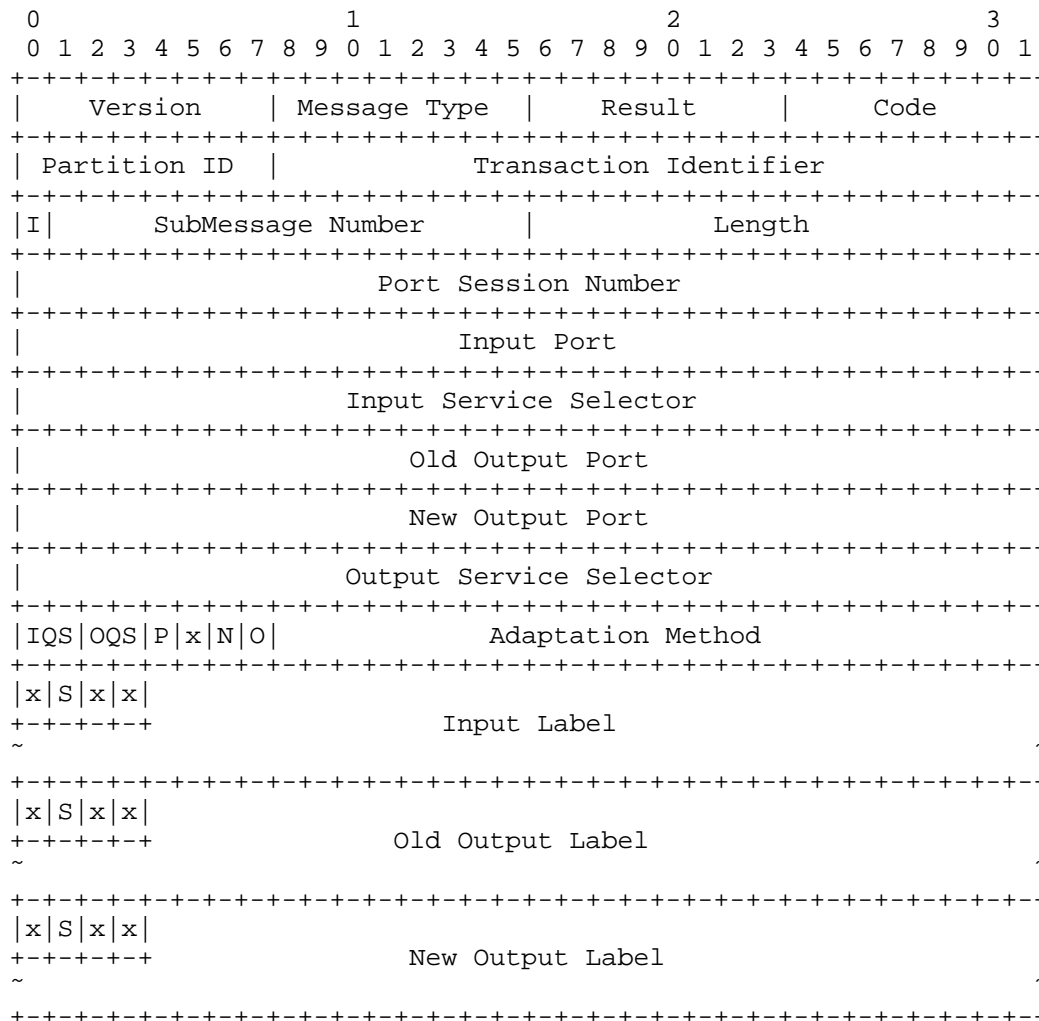   details.

The Move Output Branch message is a connection management message
used to move a single output branch of connection from its current
output port and Output Label, to a new output port and Output Label
on the same connection. None of the connection's other output
branches are modified. When the operation is complete the original
Output Label on the original output port will be deleted from the
connection.

The Move Output Branch message is:

   Message Type = 22

For the Move Output Branch message, if the connection specified by
the Input Port and Input Label fields already exists, and the output
branch specified by the Old Output Port and Old Output Label fields
exists as a branch on that connection, the output branch specified by
the New Output Port and New Output Label fields is added to the
connection and the branch specified by the Old Output Port and Old
Output Label 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 Move Output Branch message, if the connection specified by
the Input Port and Input Label fields already exists, but the output
branch specified by the Old Output Port and Old Output Label fields

does not exist as a branch on that connection, a failure response
MUST be returned with the Code field indicating, "12: The specified
branch does not exist".

4.8.1 ATM Specific Procedures:

The ATM VPC Move Output 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 Output 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 Output 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,
"12: The specified branch does not exist".

If the virtual channel connection specified by the Input Port and
Input Label 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, "11: 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 and Input

   Label 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.

4.9 Move Input Branch Message

   The Move Input Branch message is used to move a branch of an existing
   connection from its current input port label to a new input port
   label in a single atomic transaction. The Move Input 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      |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     | Partition ID  |             Transaction Identifier            |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |I|     SubMessage Number       |            Length             |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |                      Port Session Number                      |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |                         Output Port                           |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |                   Input Service Selector                      |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |                      Old Input Port                           |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |                      New Input Port                           |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |                   Output Service Selector                     |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |IQS|OQS|P|x|N|O|                Adaptation Method               |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |x|S|x|x|                                                       |
     +-+-+-+-+                    Output Label                       |
     ~                                                               ~
     |                                                               |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |x|S|x|x|                                                       |
     +-+-+-+-+                   Old Input Label                     |
     ~                                                               ~
     |                                                               |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |x|S|x|x|                                                       |
     +-+-+-+-+                   New Input Label                     |
     ~                                                               ~
     |                                                               |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

When the value of either IQS or OQS is set to 0b10, then the
following Traffic Parameters Block is appended to the above message:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Input TC Flags |x x x x x x x x x x x x x x x x x x x x x x x x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                 Input Traffic Parameters Block                ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Output TC Flags|x x x x x x x x x x x x x x x x x x x x x x x x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                 Output Traffic Parameters Block               ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
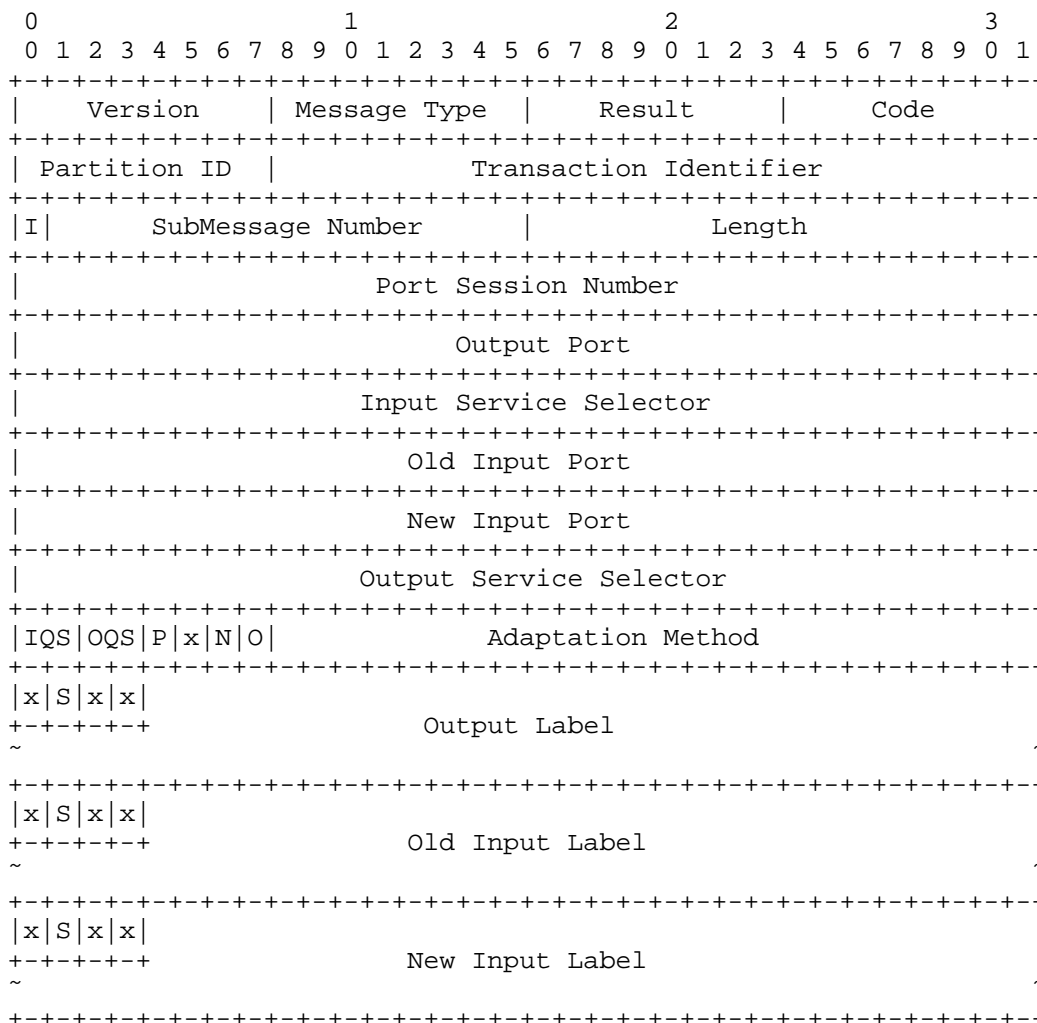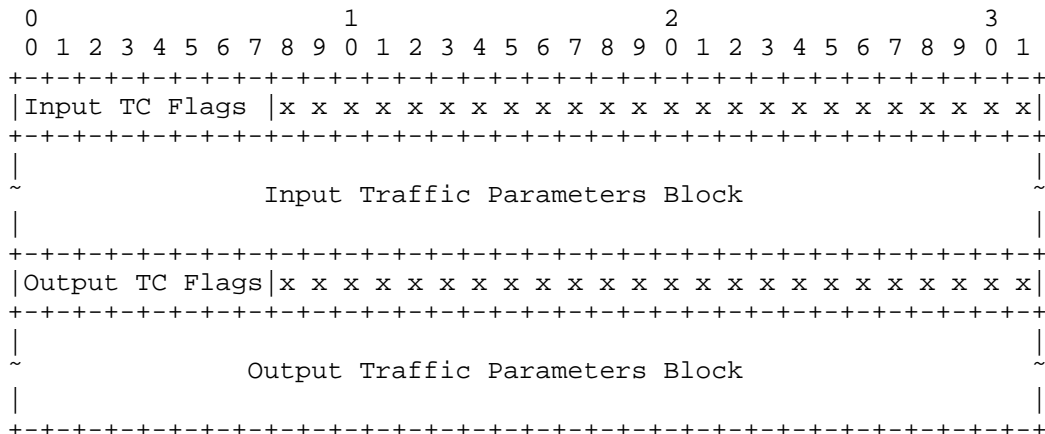
   Note: Fields and Parameters that have been explained in the
      description of the general connection message will not be
      explained in this section. Please refer to section 4.1 for
      details.

The Move Input Branch message is a connection management message used
to move a single input branch of connection from its current input
port and Input Label, to a new input port and Input Label on the same
connection. None of the connection's other input branches are
modified. When the operation is complete, the original Input Label
on the original input port will be deleted from the connection.

   The Move Input Branch message is:

      Message Type = 23

For the Move Input Branch message, if the connection specified by the
Output Port and Output Label fields already exists, and the input
branch specified by the Old Input Port and Old Input Label fields
exists as a branch on that connection, the input branch specified by
the New Input Port and New Input Label fields is added to the
connection and the branch specified by the Old Input Port and Old
Input Label 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 Input Branch operation has been
completed.

For the Move Input Branch message, if the connection specified by the
Output Port and Output Label fields already exists, but the input
branch specified by the Old Input Port and Old Input Label fields
does not exist as a branch on that connection, a failure response
MUST be returned with the Code field indicating, "12: The specified
branch does not exist".

4.9.1 ATM Specific Procedures:

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

The VPC Move Input Branch message is:

    Message Type = 28

For the VPC Move Input Branch message, if the virtual path connection
specified by the Output Port and Output VPI fields already exists,
and the input branch specified by the Old Input Port and Old Input
VPI fields exists as a branch on that connection, the input branch
specified by the New Input Port and New Input VPI fields is added to
the connection and the branch specified by the Old Input Port and Old
Input 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 Input Branch operation has been
completed.

For the VPC Move Input Branch message, if the virtual path connection
specified by the Output Port and Output VPI fields already exists,
but the input branch specified by the Old Input Port and Old Input

VPI fields does not exist as a branch on that connection, a failure
response MUST be returned with the Code field indicating, "12: The
specified branch does not exist".

If the virtual channel connection specified by the Output Port and
Output Label fields, or if the virtual path connection specified by
the Output Port and Output VPI fields does not exist, a failure
response MUST be returned with the Code field indicating, "11: The
specified connection does not exist".

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

5. Reservation Management Messages

GSMP allows switch resources (e.g., bandwidth, buffers, queues,
labels, etc.) to be reserved for connections before the connections
themselves are established. This is achieved through the
manipulation of Reservations in the switch.

Reservations are hard state objects in the switch that can be created
by the controller by sending a Reservation Request message. Each
Reservation is uniquely identified by an identifying number called a
Reservation ID. Reservation objects can be deleted with the Delete
Reservation message or the Delete All Reservations message. A
reservation object is also deleted when the Reservation is deployed
by specifying a Reservation ID in a valid Add Branch message.

The reserved resources MUST remain reserved until either the
reservation is deployed, in which case the resources are applied to a
branch, or the reservation is explicitly deleted (with a Delete
Reservation message or a Delete All Reservations message), in which
case the resources are freed. Reservations and reserved resources
are deleted if the switch is reset.

A Reservation object includes its Reservation ID plus all the
connection state associated with a branch with the exception that the
branch's input label and/or output label may be unspecified. The
Request Reservation message is therefore almost identical to the Add
Branch message.

The switch establishes the maximum number of reservations it can
store by setting the value of Max Reservations in the Switch
Configuration response message. The switch indicates that it does
not support reservations by setting Max Reservations to 0. The valid
range of Reservation IDs is 1 to Max Reservations).

5.1 Reservation Request Message

The Reservation Request message creates a Reservation in the switch
and reserves switch resources for a connection that may later be
established using an Add Branch message. The Reservation Request
Message is:

    Message Type = 70

The Reservation Request message has the following format for the
request message:
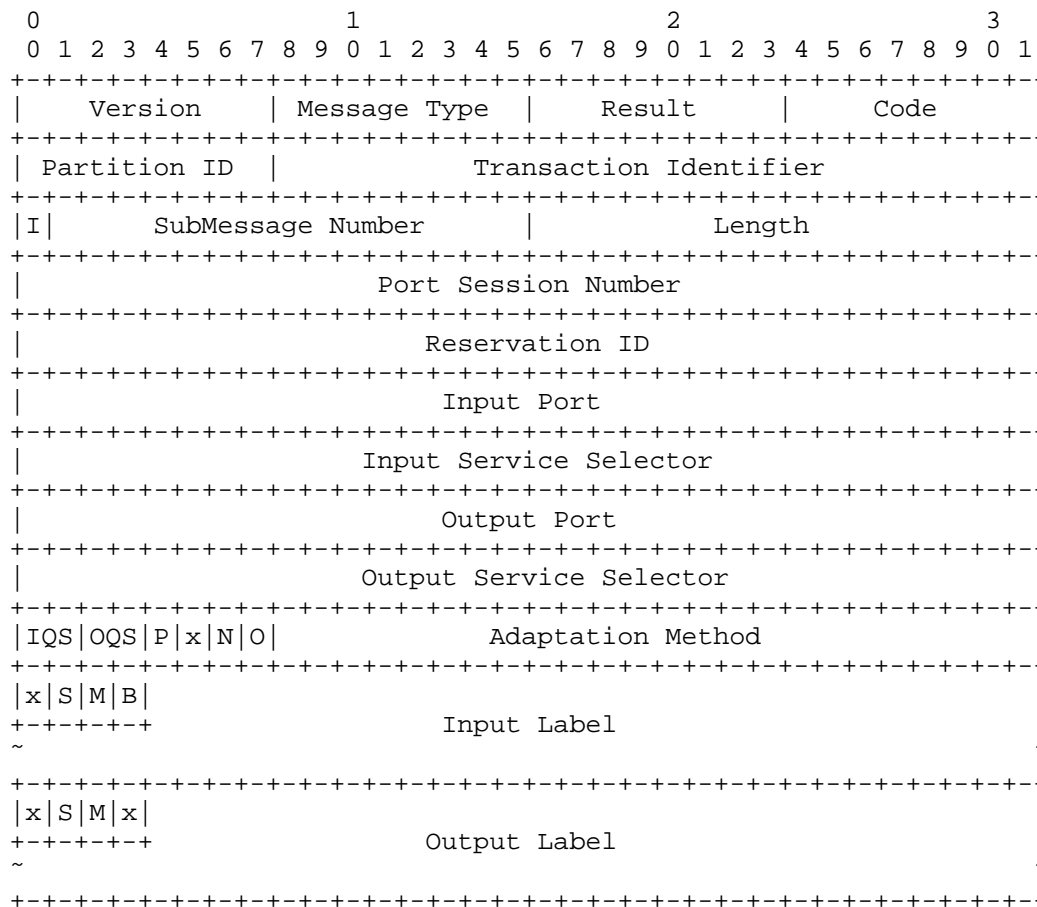
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    | Message Type  |    Result     |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |           Transaction Identifier              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|    SubMessage Number        |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Port Session Number                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Reservation ID                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Input Port                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Input Service Selector                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Output Port                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Output Service Selector                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|IQS|OQS|P|x|N|O|                Adaptation Method               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|M|B|                                                       |
+-+-+-+-+                    Input Label                        |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|M|x|                                                       |
+-+-+-+-+                    Output Label                       |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
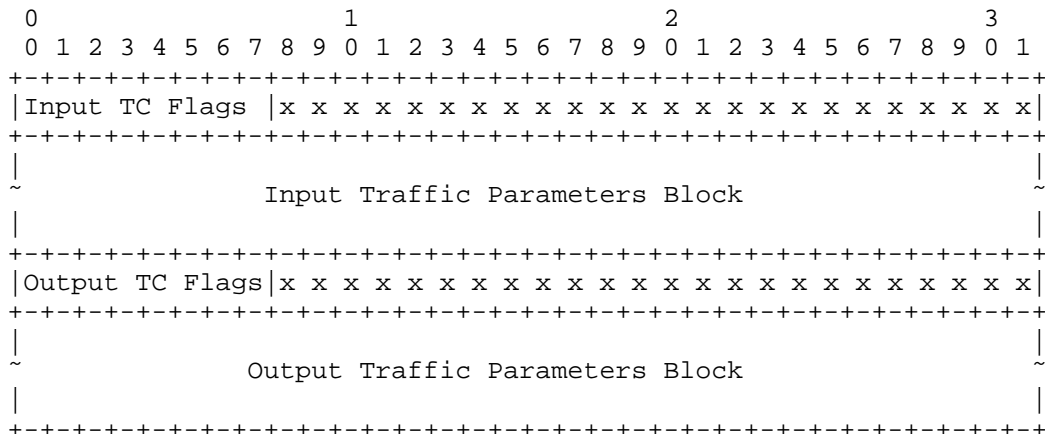
When the value of either IQS or OQS is set to 0b10 then the following
Traffic Parameters Block is appended to the above message:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Input TC Flags |x x x x x x x x x x x x x x x x x x x x x x x x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~               Input Traffic Parameters Block                  ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Output TC Flags|x x x x x x x x x x x x x x x x x x x x x x x x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~               Output Traffic Parameters Block                 ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Note: Fields and Parameters that have been explained in the
      description of the general connection message will not be
      explained in this section. Please refer to section 4.1 for
      details.

All the fields of the Reservation Request message have the same
meanings as they do in the Add Branch message with the following
exceptions:

   Reservation ID
      Specifies the Reservation ID of the Reservation. If the
      numerical value of the Reservation ID is greater than the value
      of the Max Reservations (from the Switch Configuration
      message), a failure response is returned indicating "20: the
      Reservation ID out of Range". If the value of Reservation ID
      matches that of an extant Reservation, a failure response is
      returned indicating "22: Reservation ID in use".

   Input Label
      If a specific input label is specified, then that label is
      reserved along with the required resources. If the Input Label
      is 0 then the switch reserves the resources, but will not bind
      them to a label until the add branch command is given, which
      references the Reservation Id. If the input label is 0, then
      all stacked labels MUST also be zeroed.

     Output Label
        If a specific Output Label is specified then that label is
        reserved along with the required resources. If the Output
        Label is 0 then the switch reserves the resources, but will not
        bind them to a label until the add branch command is given
        which references the Reservation Id. If the Output Label is 0,
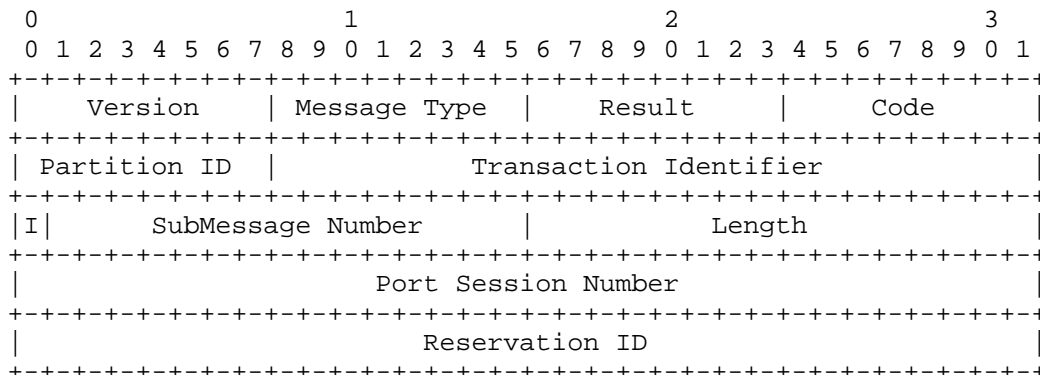   then all stacked labels MUST also be zeroed

   When the switch receives a valid Reservation Request it reserves all
   the appropriate switch resources needed to establish a branch with
   corresponding attributes. If sufficient resources are not available,
   a failure response is returned indicating "18: Insufficient
   resources". Other failure responses are as defined for the Add
   Branch message.

5.2 Delete Reservation Message

   The Delete Reservation message deletes a Reservation object in the
   switch and frees the reserved switch resources associated with that
   reservation object. The Reservation Request Message is:

      Message Type = 71

   The Delete Reservation 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       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |              Transaction Identifier           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|    SubMessage Number        |              Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Port Session Number                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Reservation ID                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   If the Reservation ID matches that of an extant Reservation then the
   reservation is deleted and corresponding switch resources are freed.
   If the numerical value of the Reservation ID is greater than the
   value of the Max Reservations (from the Switch Configuration
   message), a failure response is returned indicating "20: Reservation
   ID out of Range". If the value of Reservation ID does not match that
   of any extant Reservation, a failure response is returned indicating
   "23: Non-existent reservation ID".

5.3 Delete All Reservations Message

   The Delete All Reservation message deletes all extant Reservation
   objects in the switch and frees the reserved switch resources of
   these reservations. The Reservation Request Message is:

      Message Type = 72

   The Delete All Reservation 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      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Partition ID  |           Transaction Identifier              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |I|     SubMessage Number       |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
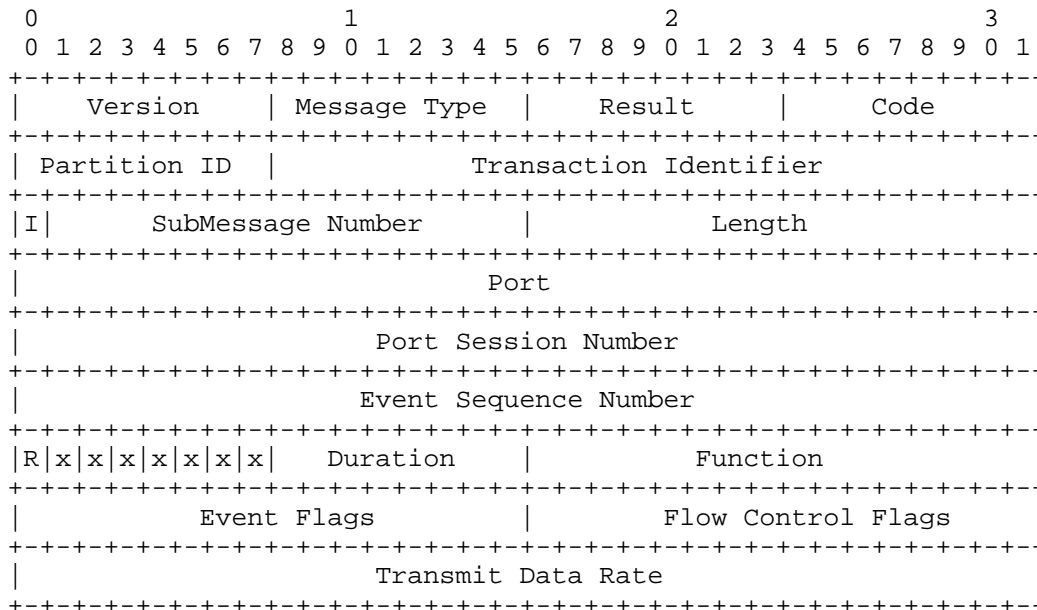
6. Management Messages

6.1 Port Management Message

   The Port Management message allows a port to be brought into service,
   to be taken out of service, to be set to loop back, reset, or to
   change the transmit data rate. 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. The Port Management message MAY also be
   used for enabling the replace connection mechanism. The Port
   Management message is also used as part of the Event Message flow
   control mechanism.

   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     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |            Transaction Identifier             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|     SubMessage Number       |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Port                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Port Session Number                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Event Sequence Number                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|R|x|x|x|x|x|x|x|    Duration      |            Function         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Event Flags           |       Flow Control Flags    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Transmit Data Rate                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Note: Fields and Parameters that have been explained in the
      description of the general messages will not be explained in
      this section. Please refer to section 3.1 for details.

   Event Sequence Number
      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 initialised. 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.

   R: Connection Replace
      The R flag shall only be checked when the Function field = 1
      (Bring Up). If the R flag is set in the Port Management
      request message, it indicates that a switch controller requests
      the switch port to support the Connection Replace mechanism.

Connection Replace behaviour is described in chapter 4.2. If a
switch does not support the Connection Replace mechanism, it
MUST reply with the failure response: "45: Connection Replace
mechanism not supported on switch" and reset the R-flag. Upon
successful response, the R flag SHOULD remain set in the
response message.

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 originate at the specified input port MUST be deleted
        and a new Port Session Number MUST be selected, preferably
        using some form of random number. On completion of the
        operation all dynamically assigned Label values for the
        specified input port MUST be unassigned, i.e., no
        connections will be established in the Label space that GSMP
        controls on this input port. Afterwards, the Port Status of
        the port will be Available.

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

        The behaviour 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 behaviour 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. Data 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 functions of the input
    port above the physical layer, e.g., header translation, are
    performed upon the looped back data. Afterwards, the Port
    Status of the port will be Internal Loopback.

External Loopback:
    Function = 4. Data 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 functions of the input
    port, above the physical layer are performed upon the looped
    back data. Afterwards, the Port Status of the port will be
    External Loopback.

Bothway Loopback:
    Function = 5. Both internal and external loopbacks are
    performed. Afterwards, the Port Status of the port will be
    Bothway Loopback.

Reset Input Port:
    Function = 6. All connections that originate at the
    specified input port MUST be deleted and the input and
    output port hardware re-initialised. On completion of the
    operation, all dynamically assigned Label values for the
    specified input port MUST be unassigned, i.e., no
    connections will be established in the Label space that GSMP
    controls on this input port. The range of labels that may
    be controlled by GSMP on this port will be set to the
    default values specified in the Port Configuration message.
    The transmit data 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. Afterwards, the Port Status
    of the port will be Unavailable.

Reset Flags:
    Function = 7. This function is used to reset the Event
    Flags and Flow Control Flags. For each bit that is set in
    the Event Flags field, the corresponding Event Flag in the
    switch port MUST be reset to 0. For each bit that is set in
    the Flow Control Flags field, the corresponding Flow Control
    Flag in the switch port MUST be toggled; i.e., flow control

for the corresponding event is turned off if is currently on
and it is turned on if it is currently off. The Port Status
of the port is not changed by this function.

Set Transmit Data Rate:
   Function = 8. Sets the transmit data rate of the output
   port as close as possible to the rate specified in the
   Transmit Data Rate field. In the success response message,
   the Transmit Data Rate MUST indicate the actual transmit
   data rate of the output port. If the transmit data rate of
   the requested output port cannot be changed a failure
   response MUST be returned with the Code field indicating:
   "43: The transmit data rate of this output port cannot be
   changed". If the transmit data rate of the requested output
   port can be changed, but the value of the Transmit Data Rate
   field is beyond the range of acceptable values, a failure
   response MUST be returned with the Code field indicating:
   "44: Requested transmit data rate out of range for this
   output port". In the failure response message, the Transmit
   Data Rate MUST contain the same value as contained in the
   request message that caused the failure. The transmit data
   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 Data Rate
   This field is only used in request and success response
   messages with the Function field set to "Set Transmit Data
   Rate". It is used to set the output data rate of the output
   port. It is specified in cells/s and bytes/s. If the Transmit
   Data Rate field contains the value 0xFFFFFFFF the transmit data
   rate of the output port SHOULD be set to the highest valid
   value.

Event Flags
   Field in the request message that 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. Depending on the
   setting in the Flow Control Flag, a port is either subject to
   flow control or not. If it is subject to flow control, then it
   is not permitted to send another Event message of the same type
   before the Event Flag has been reset. To reset an event flag,
   the Function field in the request message is set to "Reset
   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 messages and the
bits of the Event Flags field is as follows:

```
                          1
          0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         |U|D|I|N|Z|A|x|x|x|x|x|x|x|x|x|x|
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

         U: Port Up           Bit  0, (most significant bit)
         D: Port Down         Bit  1,
         I: Invalid Label     Bit  2,
         N: New Port          Bit  3,
         Z: Dead Port         Bit  4,
         A: Adjacency Event   Bit  5,
         x: Unused            Bits 6-15.
```

Flow Control Flags Field
    The flags in this field are used to indicate whether the flow
    control mechanism described in the Events Flag field is turned
    on or not. If the Flow Control Flag is set, then the flow
    control mechanism for that event on that port is activated. To
    toggle the flow control mechanism, the Function field in the
    request message is set to "Reset Flags". When doing a reset,
    for each flag that is set in the Flow Control Flags field, the
    corresponding flow control mechanism MUST be toggled.
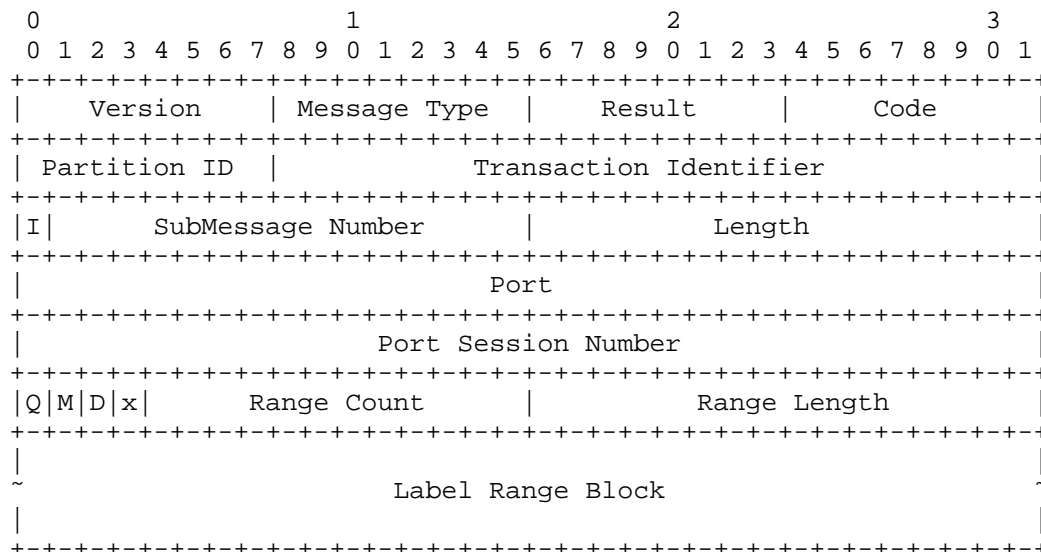
    The Flow Control Flags correspond to the same event definitions
    as defined for the Event Flag.

6.2 Label Range Message

   The default label range, Min Label to Max Label, is specified for
   each port by the Port Configuration or the All Ports Configuration
   messages. When the protocol is initialised, 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 labels
   supported by 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      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |           Transaction Identifier              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|    SubMessage Number        |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Port                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Port Session Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Q|M|D|x|    Range Count        |         Range Length          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                      Label Range Block                        ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

     Note: Fields and Parameters that have been explained in the
        description of the general messages will not be explained in
        this section. Please refer to section 3.1 for details.

Each element of the Label Range Block has the following format:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|V|C|                                                       |
+-+-+-+-+                    Min Label                          |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x|                                                       |
+-+-+-+-+                    Max Label                          |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Remaining Labels                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Flags

      Q: Query
         If the Query flag is set in a request message, the switch
         MUST respond with the current range of valid labels. 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.

      M: Multipoint Query
         If the Multipoint Query flag is set the switch MUST respond
         with the current range of valid specialized multipoint
         labels. The current label range is not changed by a request
         message with the Multipoint Query flag set.

      D: Non-contiguous Label Range Indicator
         This flag will be set in a Query response if the labels
         available for assignment belong to a non-contiguous set.

      V: Label
         The Label flag use is port type specific.

      C: Multipoint Capable
         Indicates label range that can be used for multipoint
         connections.

   Range Count
      Count of Label Range elements contained in the Label Range
      Block.

   Range Length
      Byte count in the Label Range Block.

Min Label
The minimum label value in the range.

Max Label
The maximum label value in the range.

Remaining Labels
The maximum number of remaining labels that could be requested
for allocation on the specified port.

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

If the switch is unable to satisfy a request to change the Label
range, it MUST return a failure response message with the Code field
set to: "40: Cannot support one or more requested label ranges". In
this failure response message, the switch MUST use the Min Label and
Max Label fields to suggest a label range that it is able to satisfy.

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,
"4: One or more of the specified ports does not exist".

If the Query flag is set in the request message, the switch MUST
reply with a success response message containing the current range of
valid labels that are supported by the port. The Min Label and Max
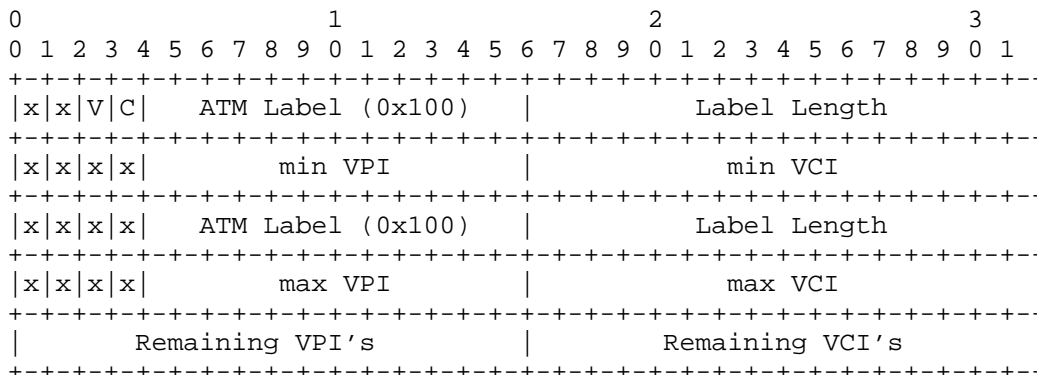Label fields are not used in the request message.

If the Multipoint Query flag is set in the request message and the
switch does not support a range of valid multipoint labels, then the
switch MUST reply with a failure response message with the Code field
set to, "42: Specialised multipoint labels not supported". The Min
Label and Max Label fields are not used in the Multipoint request
message.

If a label range changes and there are extant connection states with
labels used by the previous label range, a success response message
MUST be returned with the Code field set to, "46: One or more labels
are still used in the previous Label Range". This action indicates
that the label range has successfully changed but with a warning that
there are extant connection states for the previous label range.

6.2.1 Labels

6.2.1.1 ATM Labels

   If the Label Type = ATM Label, the labels range message MUST be
   interpreted as an ATM Label as shown:

```
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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|V|C|    ATM Label (0x100)   |          Label Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x|        min VPI         |             min VCI           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x|    ATM Label (0x100)   |          Label Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x|        max VPI         |             max VCI           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       Remaining VPI's          |        Remaining VCI's         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

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

      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 Label 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 VPI's, Remaining VCI's
          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 VPI's and VCI's
          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 VPI's and VCI's 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 VPI's
          and VCI's is available to every switch port.

   If the Query flag and the Label flag are set in the request message,
   the switch MUST reply with a success response message containing the
   current range of valid VPI's 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 Label flag is zero in the request
   message, the switch MUST reply with a success response message
   containing the current range of valid VCI's 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: "13: One or more of
   the specified Input Labels 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 Label flag is set in the request
   message, the Min VPI and Max VPI fields specify the new range of
   VPI's to be allocated to the input port specified by the Port field.
   The range of VPI's previously allocated to this port SHOULD be
   increased or decreased to the specified value.

   If the Query flag and the Label flag are zero in the request message,
   the Min VCI and Max VCI fields specify the range of VCI's to be
   allocated to each of the VPI's specified by the VPI range. The range
   of VCI's previously allocated to each of the VPI's 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 VPI's within the specified VPI range.

   If the switch is unable to satisfy a request to change the label
   range, it MUST return a failure response message with the Code field
   set to: "40: Cannot support one or more requested label ranges". If
   the switch is unable to satisfy a request to change the VPI, the
   switch MUST use the Min VPI and Max VPI fields to suggest a VPI range
   that it would be able to satisfy and set the VCI fields to zero, or
   if the switch is unable to satisfy a request to change the VCI range

on all VPI's within the requested VPI range, the switch MUST use the
Min VPI, Max VPI, Min VCI, and Max VCI fields to suggest a VPI and
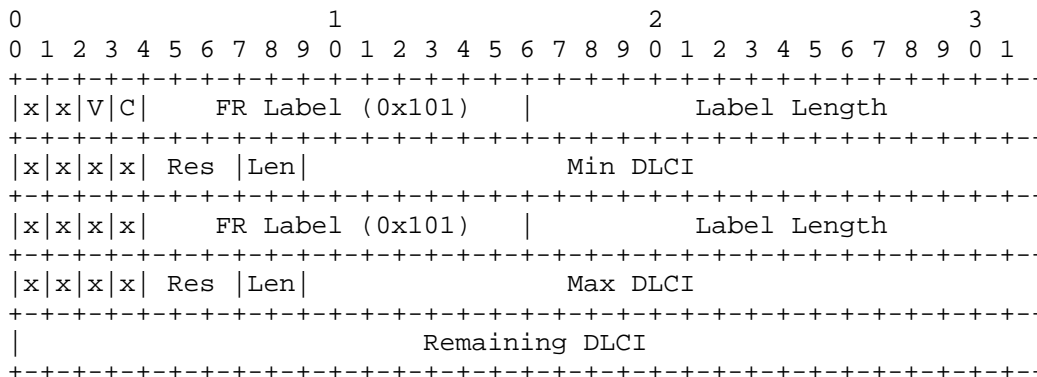VCI range that it would be able to satisfy.

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 VPI's, the VCI
range that can be supported is often more constrained. Often the Min
VCI MUST be 0 or 32. Typically all VCI's 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
VPI's and a range of VCI's within each VPI, the most likely use is to
change either the VPI range or the range of VCI's within a single
VPI. It is possible for a VPI to be valid but to be allocated no
valid VCI's. 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 VCI's.

6.2.1.2 Frame Relay Labels

If the Label Type = FR Label, the labels range message MUST be
interpreted as Frame Relay Labels as shown:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|V|C|    FR Label (0x101)    |          Label Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x| Res |Len|            Min DLCI                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x|    FR Label (0x101)    |          Label Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x| Res |Len|            Max DLCI                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Remaining DLCI                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   V: Label
      The Label flag is not used.

   Res
      The Res field is reserved in [21], i.e., it is not explicitly
      reserved by GSMP.

Len
    The Len field specifies the number of bits of the DLCI. The
    following values are supported:

    Len   DLCI bits
    0   10
    2   23

Min DLCI, Max DLCI
    Specify a range of DLCI values, Min DLCI to Max DLCI inclusive.
    The values SHOULD be right justified in the 23-bit fields and
    the preceding bits SHOULD be set to zero. A single DLCI may be
    specified with a Min DLCI and a Max DLCI having the same value.
    In a request message, if the value of the Max DLCI field is
    less than or equal to the value of the Min DLCI field, the
    requested range is a single DLCI with a value equal to the Min
    DLCI field. Zero is a valid value.

Remaining DLCI's
    This field is unused in the request message. In the success
    response message and in the failure response message, this
    field gives the maximum number of remaining DLCI's 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 DLCI's 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 DLCI's is available
    to every switch port.

6.2.1.3 MPLS Generic Labels

   The Label Range Block for PortTypes using MPLS labels. These types
   of labels are for use on links for which label values are independent
   of the underlying link technology. Examples of such links are PPP
   and Ethernet. On such links the labels are carried in MPLS label
   stacks [14]. If Label Type = MPLS Gen Label, the labels range
   message MUST be interpreted as MPLS Generic Label as shown:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|V|C| MPLS Gen Label (0x102)|          Label Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x|x|x|x|x|x|x|x|          Min MPLS Label                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x| MPLS Gen Label (0x102)|          Label Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x|x|x|x|x|x|x|x|          Max MPLS Label                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Remaining Labels                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   V: Label
      The Label flag is not used.

   Min MPLS Label, Max MPLS Label
      Specify a range of MPLS label values, Min MPLS Label to Max
      MPLS Label inclusive. The Max and Min MPLS label fields are 20
      bits each.

   Remaining MPLS Labels
      This field is unused in the request message. In the success
      response message and in the failure response message this field
      gives the maximum number of remaining MPLS Labels 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 MPLS Labels 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 Labels is available
      to every switch port.

6.2.1.4 FEC Labels

   The Label Range message is not used for FEC Labels and is for further
   study.

7. 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 and connections. 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 connections have recently been carrying traffic. The
Statistics message is used to query the various port and connection
traffic and error counters.

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

7.1 Connection Activity Message

The Connection Activity message is used to determine whether one or
more specific 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 connection. Each connection is
specified by its input port and Input Label which are specified in
the Input Port and Input Label 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 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      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |           Transaction Identifier              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|    SubMessage Number        |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       Number of Records       |x x x x x x x x x x x x x x x x|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                        Activity Records                       ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Note: Fields and Parameters that have been explained in the
      description of the general messages will not be explained in
      this section. Please refer to section 3.1 for details.

   Number of Records
      Field specifies the number of Activity Records to follow. The
      number of 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:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|V|C|A|x|        TC Count       |         TC Block Length       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Input Port                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                         Traffic Count                         +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|                                                       |
+-+-+-+-+                   Input Label                         |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

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 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 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.

TC Count
  In cases where per connection traffic counting is supported,
  this field contains the count of Traffic Count entries.

TC Block Length
  In cases where per connection traffic counting is supported,
  this field contains the Traffic Count block size in bytes.

Input Port
  Identifies the port number of the input port on which the
  connection of interest originates 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 Label
   Fields identify the specific connection for which statistics
   are being requested.

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 Connection
Activity records returned in the message. If the switch is incapable
of detecting per connection activity, a failure response MUST be
returned indicating, "3: The specified request is not implemented on
this switch".

7.2 Statistics Messages

The Statistics messages are used to query the various port,
connection 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      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |            Transaction Identifier             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|     SubMessage Number       |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Port                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|                                                       |
+-+-+-+-+                       Label                           |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Note: Fields and Parameters that have been explained in the
   description of the general messages will not be explained in
   this section. Please refer to section 3.1 for details.

     Label
          The Label Fields identifies the specific connection for which
          statistics are being requested.

   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      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Partition ID  |           Transaction Identifier              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |I|     SubMessage Number       |            Length             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                             Port                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |x|S|x|x|                                                       |
   +-+-+-+-+                       Label                           |
   ~                                                               ~
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   +                       Input Cell Count                        +
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   +                       Input Frame Count                       +
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   +                    Input Cell Discard Count                   +
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   +                   Input Frame Discard Count                   +
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   +                  Header Checksum Error Count                  +
   |                                                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                               |
   +                    Input Invalid Label Count                  +
   |                                                               |
```

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

   Note: Field and Parameters that have been explained in the
      description of the general messages will not be explained in
      this section. Please refer to section 3.1 for details.

   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. These fields are relevant for label type = ATM,
      for all other label types these fields SHOULD be set to zero by
      the sender and ignored by the receiver.

   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. These fields are relevant for label types = FR
      and MPLS, for all other label types these fields SHOULD be set
      to zero by the sender and ignored by the receiver.

   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. These fields are relevant for label
      type = ATM, for all other label types these fields SHOULD be
      set to zero by the sender and ignored by the receiver.

   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. These fields are relevant for label

types = FR and MPLS, for all other label types these fields
SHOULD be set to zero by the sender and ignored by the
receiver.

Header Checksum Error Count
    Gives the value of a free running 64-bit counter counting cells
    or frames discarded due to header checksum errors on arrival at
    an input port. For an ATM switch this would be the HEC count.

Invalid Label Count
    Gives the value of a free running 64-bit counter counting cells
    or frames discarded because their Label is invalid on arrival
    at an input port.

7.2.1 Port Statistics Message

The Port Statistics message requests the statistics for the switch
port specified in the Port field. The contents of the Label field in
the Port Statistics request message is ignored. All of the count
fields in the success response message refer to per-port counts
regardless of the connection to which the cells or frames 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

7.2.2 Connection Statistics Message

The Connection Statistics message requests the statistics for the
connection specified in the Label field that originates on the switch
input port specified in the Port field. All of the count fields in
the success response message refer only to the specified connection.
The Header Checksum Error Count and Invalid Label 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

7.2.3 QoS Class Statistics Message

   The QoS Class Statistics message is not supported in this version of
   GSMP.

      Message Type = 51 is reserved.

7.3 Report Connection State Message

   The Report Connection State message is used to request an input port
   to report the connection state for a single 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:
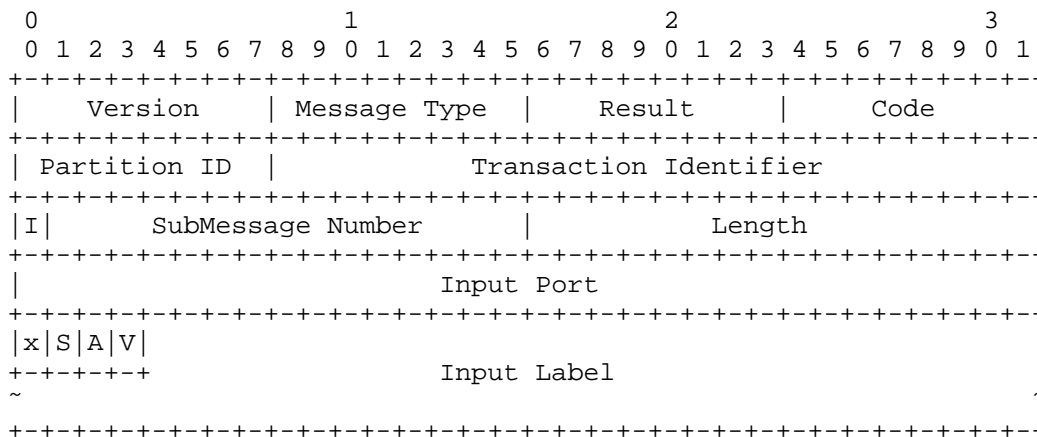
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    | Message Type  |    Result     |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |             Transaction Identifier            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|     SubMessage Number       |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Input Port                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|A|V|                                                       |
+-+-+-+-+                     Input Label                       |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

      Note: Field and Parameters that have been explained in the
         description of the general messages will not be explained in
         this section. Please refer to section 3.1 for details.

      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 connections that originate at the
>   input port specified by the Input Port field. In this case
>   the Input Label field and the Label flag are unused.
>
>   V: ATM VPI
>   The ATM VPI flag may only be set for ports with
>   PortType=ATM. If the switch receives a Report Connection
>   State message in which the ATM VPI flag set and in which the
>   input port specified by the Input Port field does not have
>   PortType=ATM, the switch MUST return a Failure response "28:
>   ATM Virtual Path switching is not supported on non-ATM
>   ports".
>
>   If the All Connections flag is zero and the ATM VPI flag is
>   also zero, the message requests the connection state for the
>   connection that originates at the input port specified by
>   the Port and Input Label fields.
>
>   ATM specific procedures:
>   If the All Connections flag is zero and the ATM VPI flag is
>   set and the input port specified by the Input Port field has
>   LabelType=ATM, the message requests the connection state for
>   the virtual path connection that originates at the input
>   port specified by the Input Port and Input VPI fields. If
>   the specified Input VPI identifies an ATM 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.

Input Label
>   Field identifies the specific connection for which the
>   connection state is being requested. For requests that do not
>   require a connection to be specified, the Input Label field is
>   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      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |            Transaction Identifier             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|      SubMessage Number      |            Length              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Input Port                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Sequence Number                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                     Connection Records                        ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Note: Fields and Parameters that have been explained in the
      description of the general messages will not be explained in
      this section. Please refer to section 3.1 for details.

   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 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. "More" in the Result field of a
response message indicates that one or more further success
response messages should be expected in response to the same
request message. "Success" in the Result field indicates that
the response to the request has been completed. The Result
values are defined in chapter 3.1.1.

Each Connection Record has the following format:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|A|V|P|    Record Count    |            Record Length           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|                                                       |
+-+-+-+-+                      Input Label                      |
~                                                              ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                              |
~                   Output Branch Records                      ~
|                                                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
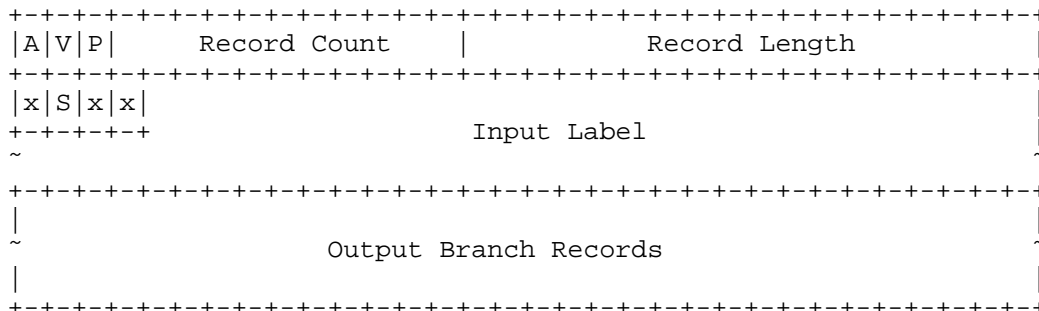
Flags

A: All Connections

V: ATM VPI
   For the first Connection Record in each success response
   message, the All Connections and the ATM VPI 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: ATM VPC
   The ATM VPC flag may only be set for ports with
   PortType=ATM. The ATM VPC flag, if set and only if set,
   indicates that the Connection Record refers to an ATM
   virtual path connection.

Input Label
   The input label of the connection specified in this Connection
   Record.

Record Count
   Count of Output Branch Records included in a response message.

   Record Length
      Length in bytes of Output Branch Records field

   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
      Label field of the Connection Record and the Input Port field
      of the Report Connection State message. A point-to-point
      connection will require only a single Output Branch Record. A
      point-to-multipoint connection will require multiple Output
      Branch Records. 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                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|                                                       |
+-+-+-+-+                   Output Label                        |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
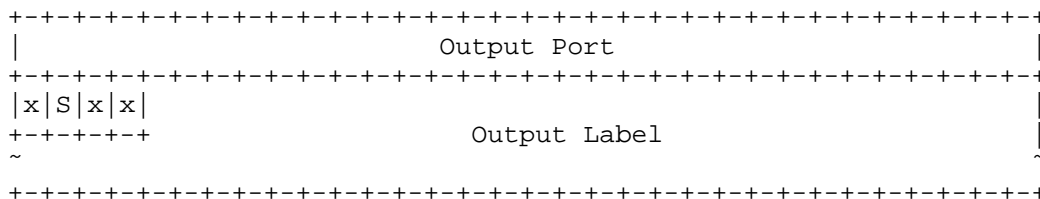
   Output Port
      The output port of the switch to which this output branch is
      routed.

   Output Label
      The output label of the output branch specified in this Output
      Branch Record.

      ATM specific procedures:
         If this Output Branch Record is part of a Connection Record
         that specifies a virtual path connection (the ATM 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, "10: General Message Failure". 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 connection.

8. 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.

8.1 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 switch configuration message.

The Switch Configuration 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      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |            Transaction Identifier             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|    SubMessage Number        |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     MType     |     MType     |     MType     |     MType      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Firmware Version Number    |          Window Size           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Switch Type          |                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+                                +
|                          Switch Name                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Max Reservations                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Note: Fields and Parameters that have been explained in the
      description of the general messages will not be explained in
      this section. Please refer to section 3.1 for details.

   MType
      Represents an alternative QoS Configuration type. In the
      request message the requested MType is in the most significant
      (leftmost) MType byte; the other three MType bytes are unused.
      The reply message will either accept the MType request by
      including the requested MType in the leftmost MType field of
      the response message or it will reject the MType request by
      responding with MType=0, the default MType, in the first MType
      field. Optionally, in the case of a rejection, the switch
      reply can include up to 3 additional MType values, each of
      which indicates an available alternative QoS Configuration. A
      switch that supports only the default QoS Configuration always
      returns MType=0 in all four MType fields. MType negotiation is
      discussed in section 8.1.1.

         0   - Indicates use of the default GSMP model
         1-200   - Reserved
         201-255   - Experimental

   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 organisation 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 Organisationally Unique
        Identifier (OUI) that identifies the manufacturer of the
        switch.

    Max Reservations
        The maximum number of Reservations that the switch can support
        (see Chapter 5). A value of 0 indicates that the switch does
        not support Reservations.

8.1.1 Configuration Message Processing

   After adjacency between a controller and after a switch is first
   established the controller that opts to use a QoS Configuration model
   other then the default would send the Switch Configuration request
   including the requested QoS Configuration's MType value in the
   request message. This request MUST be sent before any connection
   messages are exchanged. If the switch can support the requested QoS
   configuration, then the switch includes the requested MType value in
   the response message as an indication that it accepts the request.
   If the switch cannot support the requested QoS Configuration, it
   replaces the MType value in the request message with that of the
   default QoS Configuration, i.e., MType=0.

   The switch configuration response messages may additionally include
   the MType values of up to three alternative QoS Configurations that
   the switch supports and that the controller may choose between.

   The exchange continues until the controller sends a requested MType
   that the switch accepts or until it sends a connection request
   message. If the exchange ends without confirmation of an alternate
   switch model, then the default Mtype=0 is be used.

   Once an MType has been established for the switch, it cannot be
   changed without full restart, that is the re-establishment of
   adjacency with the resetting of all connections.

8.2 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:
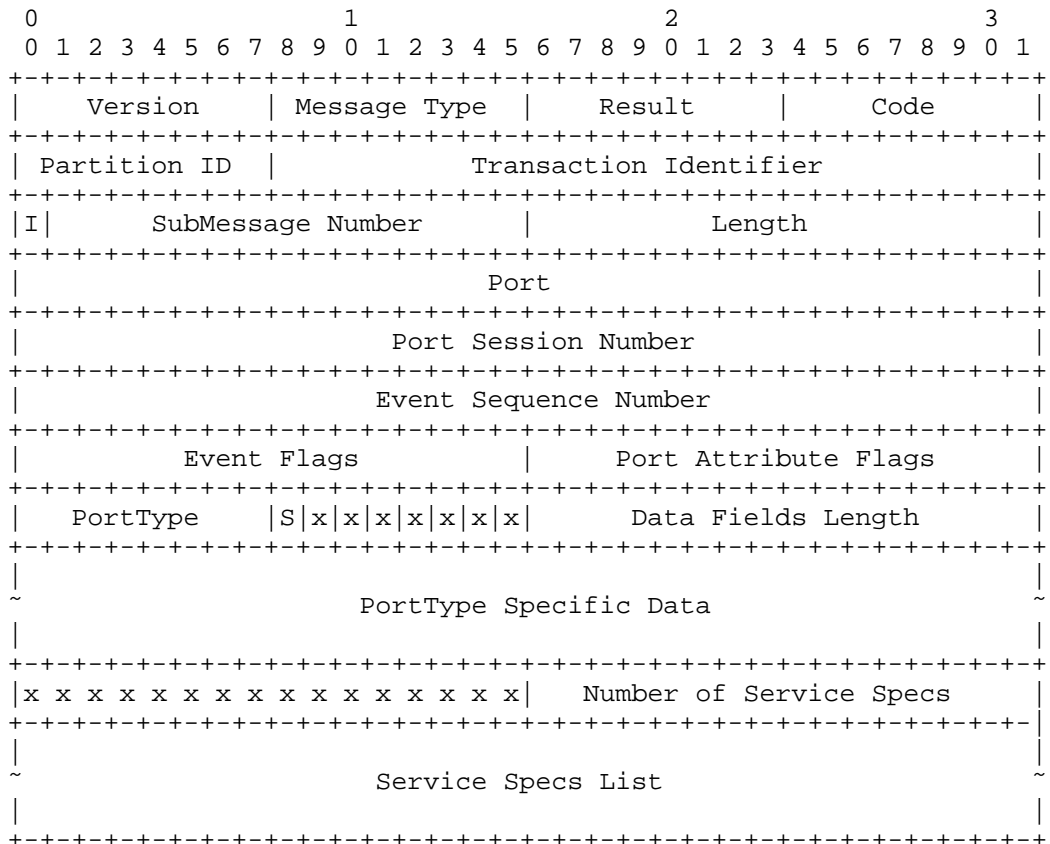
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    | Message Type  |    Result     |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |           Transaction Identifier              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|     SubMessage Number       |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Port                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Port Session Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Event Sequence Number                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Event Flags           |    Port Attribute Flags       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   PortType    |S|x|x|x|x|x|x|x|      Data Fields Length       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                    PortType Specific Data                     ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x x x x x x x x x x x x x|   Number of Service Specs     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-|
|                                                               |
~                      Service Specs List                       ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Note: Fields and Parameters that have been explained in the
      description of the general messages will not be explained in
      this section. Please refer to section 3.1 for details.

   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.

Event Sequence Number
   The Event Sequence Number is set to zero when the port is
   initialised. 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 is
   explained in section 9.

Event Flags
   Event Flags in a switch port corresponds to a type of Event
   message.

Port Attribute Flags
   Port Attribute Flags indicate specific behaviour of a switch
   port. The format of the Port Attribute Flags field is given
   below:

```
          0                   1
          0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
         |R|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|x|
         +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
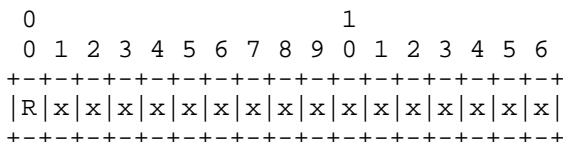
   R: Connection Replace flag
      If set, indicates that connections being established by an
      Add Branch message with a corresponding R-bit set will
      replace any previously established connection if a clash
      between the established output branch and the requested
      output branch occurs [see chapter 4.2].

   x: Unused.

PortType

   1: PortType is ATM
   2: PortType is FR
   3: PortType is MPLS

S: Service Model
   If set, indicates that Service Model data follows the
   PortSpecific port configuration data.

Data Fields Length
   The total length in bytes of the combined PortType Specific
   Data and Service Model Data fields. The length of each of
   these fields may be derived from the other data so the value of
   Data Fields Length serves primarily as a check and to assist
   parsing of the All Ports Configuration message success
   response.

     PortType Specific Data
        This field contains the configuration data specific to the
        particular port type as specified by the PortType field. The
        field format and length also depends on the value of the
        PortType. PortType Specific Data is defined below.

     Number of Service Specs
        Field contains the total number of Service Specs following in
        the remainder of the Port Configuration message response or
        Port Configuration Record.

     Service Specs List
        The Service Specs correspond to the Input and Output Service
        selectors used in Connection Management and Reservation
        messages. Specifically they define the possible values used
        when the Service Selector (IQS or OQS) is set to 0b10
        indicating the use of the default service specification model
        defined in Chapter 10.

     Service Spec
        The format of each service spec is given below:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Service ID           |         Capability Set ID     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
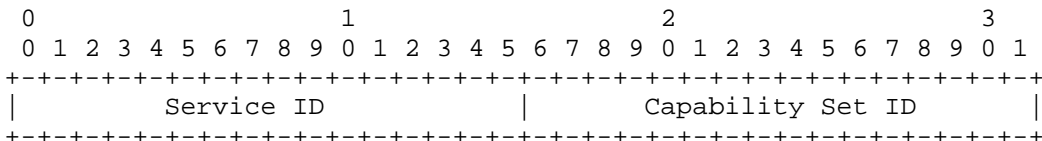
        Each Service Spec identifies a Service supported by the switch
        together with the Capability Set ID that identifies the
        parameters of that instance of the Service. The Service Spec
        List may contain more than one Service Spec sharing the same
        Service ID. However, each Service Spec in the Service Specs
        List MUST be unique.

        Service ID
           Field contains the Service ID of a Service supported on the
           port. Service ID values are defined as part of the Service
           definition in Chapter 9.6.

        Capability Set ID
           Field identifies a Capability Set ID of the Service
           specified by the Service ID that is supported on the port.
           Capability Set ID values are defined by the Switch in the
           Service Configuration response message (see Section 8.4).
           The switch MUST NOT return a {Service ID, Capability Set ID}
           pair that is not reported in a Service Configuration
           response message.

8.2.1 PortType Specific Data

   The length, format and semantics of the PortType Specific Data field
   in the Port Configuration message success response and in the Port
   Records of the All Port Configuration message success response all
   depend on the PortType value of the same message or record
   respectively. The specification of the PortType Specific Data field
   is given below. For each defined PortType value the Min and Max
   Label fields are given in the subsequent subsections.
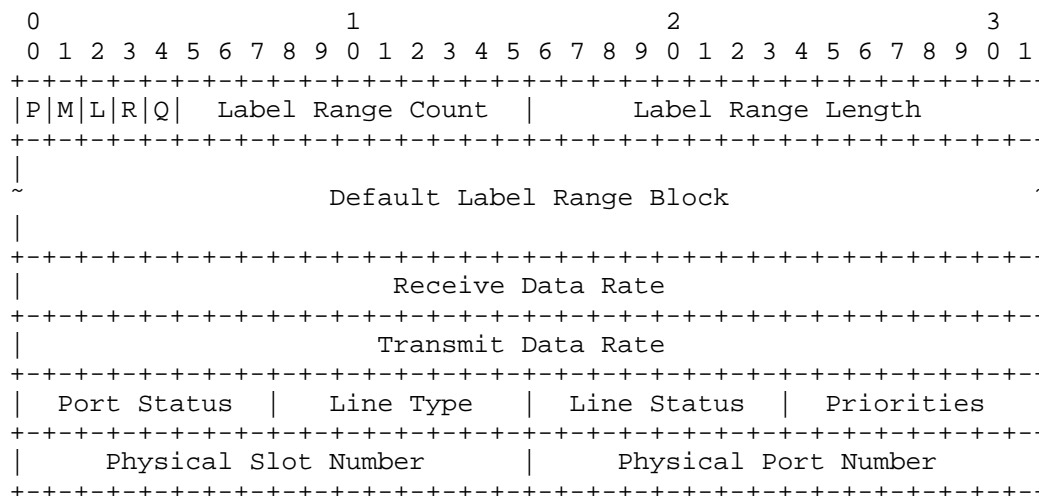
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|P|M|L|R|Q|  Label Range Count  |      Label Range Length       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                   Default Label Range Block                   ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Receive Data Rate                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Transmit Data Rate                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Port Status  |  Line Type   | Line Status  |   Priorities    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Physical Slot Number     |     Physical Port Number       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

      Note: Fields and Parameters that have been explained in the
         description of the general messages will not be explained in
         this section. Please refer to section 3.1 for details.

   Where each of the ranges in the Default Label Range Blocks will have
   the following format:

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|V|C|                                                       |
+-+-+-+-+                       Min Label                       |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x|                                                       |
+-+-+-+-+                       Max Label                       |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
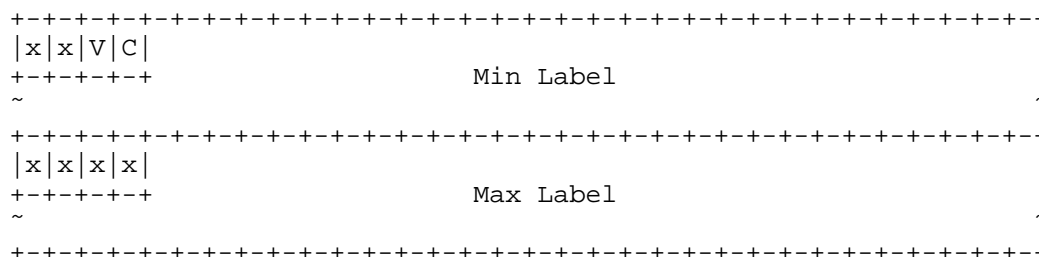
Flags

     P: VP Switching
       The ATM VPC flag may only be set for ports with
       PortType=ATM. 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 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.

     V: Label
       The Label flag is port type specific.

     C: Multipoint Capable
       This flag indicates that the label range may be used for
       multipoint connections.

Label Range Count
   The total number of Default Label Range elements contained in
   the Default Label Range Block.

Label Range Length
   Byte count in the Default Label Range Block.

Min Label
   The specification of the Min Label field for each defined
   PortType value is given in the subsequent subsections. The
   default minimum value of a dynamically assigned incoming label
   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 Label
   The specification of the Max Label field for each defined
   PortType value is given in the subsequent subsections. The
   default maximum value of a dynamically assigned incoming label
   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.

Receive Data Rate

   The maximum rate of data that may arrive at the input port in;

   cells/s   for PortType = ATM
   bytes/s   for PortType = FR
   bytes/s   for PortType = MPLS

Transmit Data Rate

   The maximum rate of data that may depart from the output port
   in;

   cells/s   for PortType = ATM
   bytes/s   for PortType = FR
   bytes/s   for PortType = MPLS

   (The transmit data rate of the output port may be changed by
   the Set Transmit Data 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 or frames. When a port changes to the
    Available state from any other administrative state, all
    dynamically assigned 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 or frames will be transmitted from
    this port. No cells or frames 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 or frames
    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 functions of the input port above the
    physical layer, e.g., header translation, are performed upon
    the looped back cells or frames.

External Loopback:
    Port Status = 4. The port has intentionally been taken out
    of service and is in external loopback: cells or frames
    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 functions of the input port above the physical layer
    are performed upon the looped back cells or frames.

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 initialisation
is not defined by GSMP.

Line Type
    The type of physical transmission interface for this port. The
    values for this field are defined by the IANAifType's specified
    in [17].

The following values are identified for use in this version
of the protocol.

```
PortType = Unknown: other(1)
PortType = MPLS:    ethernetCsmacd(6),
                    ppp(23)
PortType = ATM:     atm(37)
PortType = FR:      frameRelayService(44)
```

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. 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 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 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, a
   cell or frame on a connection with a higher priority is much
   more likely to exit the switch before a cell or frame 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 the 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.

8.2.1.1 PortType Specific data for PortType=ATM

   If PortType=ATM, the Default Label Range Block has the following
   format:
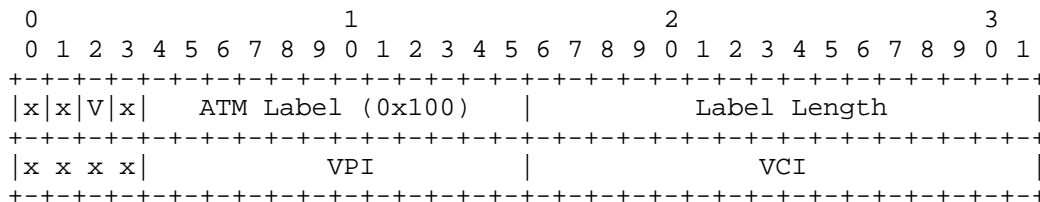
```
0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|V|x|    ATM Label (0x100)   |          Label Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x|         VPI           |              VCI               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

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

   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.

   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.

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 VPI's 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 VPI's
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 a 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 a dynamically assigned incoming
    VCI that the connection table on the input port can support and
    may be controlled by GSMP.

    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 VCI's that may be written into
    the cell header. Use of the Label Range message allows the
    range of VCI's 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 honour 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

8.2.1.2 PortType Specific data for PortType=FR

If PortType=FR, the Default Label Range Block 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|    FR Label (0x101)   |          Label Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x|Res|Len|                     DLCI                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
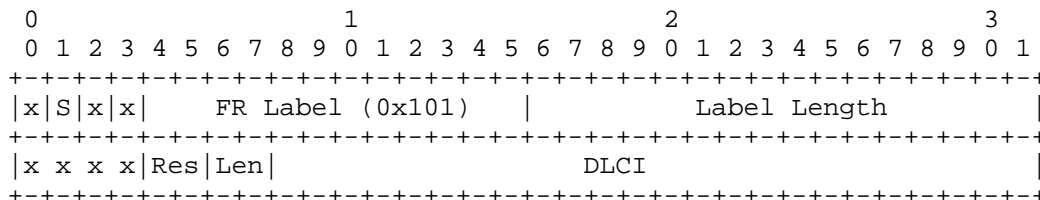
   Res
      The Res field is reserved in [21], i.e., it is not explicitly
      reserved by GSMP.

   Len
      This field specifies the number of bits of the DLCI. The
      following values are supported:

      Len DLCI bits
      0   10
      2   23

   Min DLCI, Max DLCI
      Specify a range of DLCI values, Min DLCI to Max DLCI inclusive.
      The values SHOULD be right justified in the 23-bit fields and
      the preceding bits SHOULD be set to zero. A single DLCI may be
      specified with a Min DLCI and a Max DLCI having the same value.
      In a request message, if the value of the Max DLCI field is
      less than or equal to the value of the Min DLCI field, the
      requested range is a single DLCI with a value equal to the Min
      DLCI field. Zero is a valid value.

8.2.1.3 PortType Specific data for PortType=MPLS

   The Default Label Range Block for PortTypes using MPLS labels. These
   types of labels are for use on links for which label values are
   independent of the underlying link technology. Examples of such
   links are PPP and Ethernet. On such links the labels are carried in
   MPLS label stacks [14]. Ports of the Type MPLS have the following
   format:
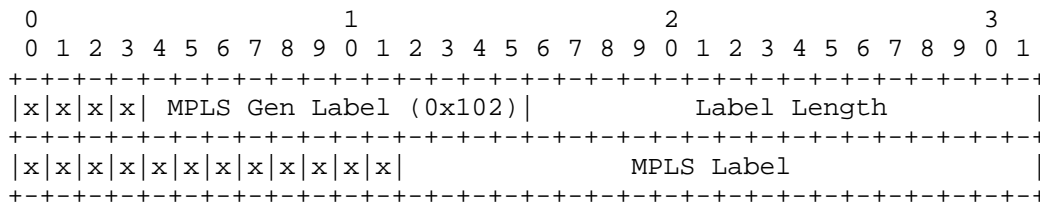
```
0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x| MPLS Gen Label (0x102)|          Label Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|x|x|x|x|x|x|x|x|x|x|              MPLS Label                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

      Min MPLS Label, Max MPLS Label
         Specify a range of MPLS label values, Min MPLS Label to Max
         MPLS Label inclusive. The Max and Min MPLS label fields are 20
         bits each.

8.2.1.4 PortType Specific data for PortType=FEC

   The Default Label Range Block for PortTypes using FEC labels is not
   used. The Label Range Count and Label Range Length fields defined in
   [8.2.1] should be set to 0.

8.3 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      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |           Transaction Identifier              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|      SubMessage Number      |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x x x x x x x x x x x x x|       Number of Records       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                         Port Records                          ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Note: Fields and Parameters that have been explained in the
      description of the general messages will not be explained in
      this section. Please refer to section 3.1 for details.

   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 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                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Event Sequence Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Event Flags           |      Port Attribute Flags      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    PortType    |S|x|x|x|x|x|x|x|     Data Fields Length        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                    PortType Specific Data                     ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x x x x x x x x x x x x x|    Number of Service Specs     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
~                      Service Specs List                       ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   The definition of the fields in the Port Record is exactly the same
   as that of the Port Configuration message [section 8.2].

8.4 Service Configuration Message

   The Service Configuration message requests the switch for the
   configuration information of the Services that are supported. The
   Service Configuration message is:

      Message Type = 67

The Service 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      |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 | Partition ID   |            Transaction Identifier             |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |I|      SubMessage Number        |             Length            |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |x x x x x x x x x x x x x x x x|   Number of Service Records   |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                                                               |
 ~                        Service Records                        ~
 |                                                               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Note: Fields and Parameters that have been explained in the
      description of the general messages will not be explained in
      this section. Please refer to section 3.1 for details.

   Number of Service Records
      Field gives the total number of Service Records to be returned
      in the Service Records field.

   Service Records
      A sequence of zero or more Service Records. The switch returns
      one Service Record for each Service that it supports on any of
      its ports. A Service record contains the configuration data of
      the specified Service. Each Service 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
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |           Service ID            |  Number of Cap. Set. Records  |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                                                               |
 ~                     Capability Set Records                    ~
 |                                                               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Service ID
      The Service ID Field identifies the Service supported by the
      port. The Services are defined with their Service ID values as
      described in section 10.2.

Number of Cap. Set. Records
    Field gives the total number of Capability Set Records to be
    returned in the Service Record field.

Capability Set Records
    The switch returns one or more Capability Set Records in each
    Service Record. A Capability Set contains a set of parameters
    that describe the QoS parameter values and traffic controls
    that apply to an instance of the Service. Each Capability Set
    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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Cap. Set ID          |         Traffic Controls      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    CLR      |                    CTD                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Frequency  |                    CDV                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
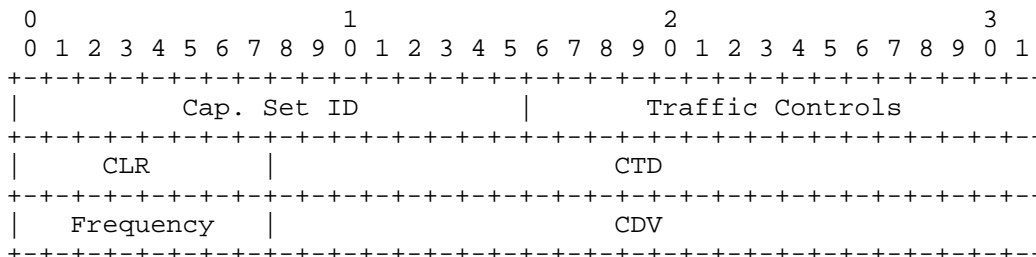
Capability Set ID
    The value in this Field defines a Capability Set ID supported
    by the switch. The values of a Capability Set ID are assigned
    by the switch and used in Port Configuration messages to
    identify Capability Sets supported by individual ports. Each
    Capability Set Record within a Service Record MUST have a
    unique Capability Set ID.

Traffic Controls
    Field identifies the availability of Traffic Controls within
    the Capability Set. Traffic Controls are defined as part of
    the respective Service definition, see Chapter 10. Some or all
    of the Traffic Controls may be undefined for a given Service,
    in which case the corresponding Flag is ignored by the
    controller. The Traffic Controls field is formatted into
    Traffic Control Sub-fields as follows:

```
     0                   1
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    | U | D | I | E | S | V |x x x x|
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
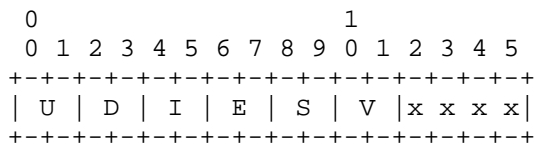
Traffic Control Sub-fields have the following encoding:

    0b00 Indicates that the Traffic Control is not available in
         the Capability Set.

0b01 Indicates that the Traffic Control is applied to all
     connections that use the Capability Set.

0b10 Indicates that the Traffic Control is available for
     application to connections that use the Capability Set
     on a per connection basis.

0b11 Reserved

Traffic Control Sub-fields:

U: Usage Parameter Control
   The Usage Parameter Control sub-field indicates the
   availability of Usage Parameter Control for the
   specified Service and Capability Set.

D: Packet Discard
   The Packet Discard sub-field indicates the availability
   of Packet Discard for the specified Service and
   Capability Set.

I: Ingress Shaping
   The Ingress Shaping sub-field indicates the
   availability of Ingress Traffic Shaping to the Peak
   Cell Rate and Cell Delay Variation Tolerance for the
   specified Service and Capability Set.

E: Egress Shaping, Peak Rate
   The Egress Shaping, Peak Rate sub-field indicates the
   availability of Egress Shaping to the Peak Cell Rate
   and Cell Delay Variation Tolerance for the specified
   Service and Capability Set.

S: Egress Traffic Shaping, Sustainable Rate
   The Egress Shaping, Sustainable Rate sub-field, if set,
   indicates that Egress Traffic Shaping to the
   Sustainable Cell Rate and Maximum Burst Size is
   available for the specified Service and Capability Set.

V: VC Merge
   The VC Merge sub-field indicates the availability of
   ATM Virtual Channel Merge (i.e., multipoint to point
   ATM switching with a traffic control to avoid AAL5 PDU
   interleaving) capability for the specified Service and
   Capability Set.

QoS Parameters
     The remaining four fields in the Capability Set Record contain
     the values of QoS Parameters. QoS Parameters are defined as
     part of the respective Service definition, see Chapter 9.6.
     Some or all of the QoS Parameters may be undefined for a given
     Service, in which case the corresponding field is ignored by
     the controller.

     CLR: Cell Loss Ratio
          The Cell Loss Ratio parameter indicates the CLR
          guaranteed by the switch for the specified Service. A
          cell loss ratio is expressed as an order of magnitude
          n, where the CLR takes the value of ten raised to the
          power of -n, i.e., log(CLR)=-n. The value n is coded
          as a binary integer, having a range of 1 <= n <= 15.
          In addition, the value 0b1111 1111 indicates that no
          CLR guarantees are given.

     Frequency
          The frequency field is coded as an 8 bit unsigned
          integer. Frequency applies to the MPLS CR-LDP Service
          (see Section 10.4.3). Valid values of Frequency are:

          0 - Very frequent
          1 - Frequent
          2 - Unspecified

     CTD: Cell Transfer Delay
          The CTD value is expressed in units of microseconds.
          It is coded as a 24-bit integer.

     CDV: Peak-to-peak Cell Delay Variation
          The CDV value is expressed in units of microseconds.
          It is coded as a 24-bit integer.

9. Event Messages

   Event messages allow the switch to inform the controller of certain
   asynchronous events. By default the controller does not acknowledge
   event messages unless ReturnReceipt is set in the Result field. The
   Code field is only used in case of Adjacency Update message,
   otherwise it is not used and SHOULD be set to zero. Event messages
   are not sent during initialisation. Event messages have the
   following format:
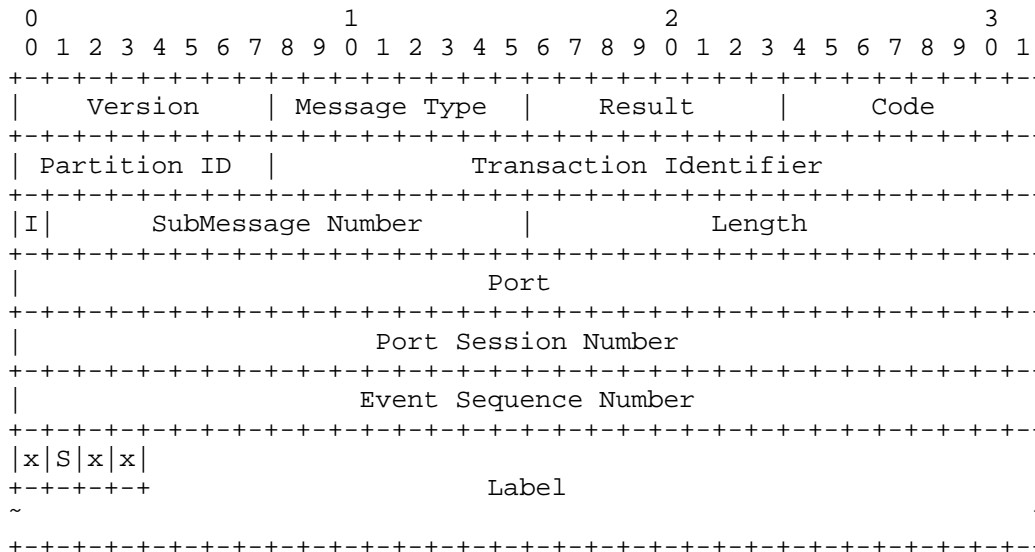
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Version    | Message Type  |    Result     |     Code      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |           Transaction Identifier              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|I|      SubMessage Number      |             Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Port                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Port Session Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Event Sequence Number                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x|S|x|x|                                                       |
+-+-+-+-+                      Label                            |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Note: Fields and Parameters that have been explained in the
      description of the general messages will not be explained in
      this section. Please refer to section 3.1 for details.

   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 initialised. 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.

   Label
      Field gives the Label 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 sends an Event message it MUST set the Event Flag for that
port corresponding to the Event type. If Flow Control is activated
for this Event type for this Port then the switch MUST NOT send
another Event message of the same type for that port 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.

9.1 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 Label
field is not used and is set to zero. The Port Up message is:

     Message Type = 80

9.2 Port Down Message

The Port Down message informs the controller that the Line Status of
a port has changed from the Up state or Test 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 Label field is not used and is set to zero. The
Port Down message is:

     Message Type = 81

9.3 Invalid Label Message

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

     Message Type = 82

9.4 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 Label field is not used and is set to zero. The New
   Port message is:

        Message Type = 83

9.5 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 Label
   fields are not used and are set to zero. The Dead Port message is:

        Message Type = 84

9.6 Adjacency Update Message

   The Adjacency Update message informs the controller when adjacencies,
   i.e., other controllers controlling a specific partition, are joining
   or leaving. When a new adjacency has been established, the switch
   sends an Adjacency Update message to every controller with an
   established adjacency to that partition. The Adjacency Update
   message is also sent when adjacency is lost between the partition and
   a controller, provided that there are any remaining adjacencies with
   that partition. The Code field is used to indicate the number of
   adjacencies known by the switch partition. The Label field is not
   used and SHOULD be set to zero. The Adjacency Update message is:

        Message Type = 85

10. Service Model Definition

10.1 Overview

   In the GSMP Service Model a controller may request the switch to
   establish a connection with a given Service. The requested Service
   is identified by including a Service ID in the Add Branch message or
   the Reservation Message. The Service ID refers to a Service
   Definition provided in this chapter of the GSMP specification.

A switch that implements one or more of the Services, as defined
below, advertises the availability of these Services in the Service
Configuration message response (see Section 8.4). Details of the
switch's implementation of a given Service that are important to the
controller (e.g., the value of delay or loss bounds or the
availability of traffic controls such as policers or shapers) are
reported in the form of a Capability Set in the Service Configuration
message response.

Thus a switch's implementation of a Service is defined in two parts:
the Service Definition, which is part of the GSMP specification, and
the Capability Set, which describes attributes of the Service
specific to the switch. A switch may support more than one
Capability Set for a given Service. For example if a switch supports
one Service with two different values of a delay bound it could do
this by reporting two Capability Sets for that Service.

The Service Definition is identified in GSMP messages by the Service
ID, a sixteen-bit identifier. Assigned numbers for the Service ID
are given with the Service Definitions in Section 10.4. The
Capability Set is identified in GSMP messages by the Capability Set
ID, a sixteen-bit identifier. Numbers for the Capability Set ID are
assigned by the switch and are advertised in the Service
Configuration message response.

The switch reports all its supported Services and Capability Sets in
the Service Configuration message response. The subset of Services
and Capability Sets supported on an individual port is reported in
the Port Configuration message response or in the All Ports
Configuration message response. In these messages the Services and
Capability Sets supported on the specified port are indicated by a
list of {Service ID, Capability Set ID} number pairs.

10.2 Service Model Definitions

   Terms and objects defined for the GSMP Service Model are given in
   this section.

10.2.1 Original Specifications

   Services in GSMP are defined largely with reference to Original
   Specifications, i.e., the standards or implementation agreements
   published by organisations such as ITU-T, IETF, and ATM Forum that
   originally defined the Service. This version of GSMP refers to 4
   original specifications: [8], [9], [10] and [11].

10.2.2 Service Definitions

   Each Service Definition in GSMP includes definition of:

      Traffic Parameters
         Traffic Parameter definitions are associated with Services
         while Traffic Parameter values are associated with connections.

         Traffic Parameters quantitatively describe a connection's
         requirements on the Service. For example, Peak Cell Rate is a
         Traffic Parameter of the Service defined by the ATM Forum
         Constant Bit Rate Service Category.

         Some Traffic Parameters are mandatory and some are optional,
         depending on the Service.

         Semantics of Traffic Parameters are defined by reference to
         Original Specifications.

      QoS Parameters
         QoS Parameters and their values are associated with Services.

         QoS Parameters express quantitative characteristics of a
         switch's support of a Service. They include, for example,
         quantitative bounds on switch induced loss and delay.

         Some QoS Parameters will be mandatory and some will be
         optional.

         Semantics of QoS Parameters are defined by reference to
         Original Specifications.

      Traffic Controls
         The implementation of some Services may include the use of
         Traffic Controls. Traffic Controls include, for example
         functions such as policing, input shaping, output shaping,
         tagging and marking, frame vs. cell merge, frame vs. cell
         discard.

         Switches are not required to support Traffic Controls. Any
         function that is always required in the implementation of a
         Service is considered part of the Service and is not considered
         a Traffic Control.

         If a switch supports a Traffic Control then the control may be
         applied either to all connections that use a given Capability
         Set (see below) or to individual connections.

The definition of a Traffic Control is associated with a
Service. Traffic Controls are defined, as far as possible, by
reference to Original Specifications.

10.2.3 Capability Sets

For each Service that a switch supports the switch MUST also support
at least one Capability Set. A Capability Set establishes
characteristics of a switch's implementation of a Service. It may be
appropriate for a switch to support more than one Capability Set for
a given Service.

A Capability Set may contain, depending on the Service definition,
QoS Parameter values and an indication of availability of Traffic
Controls.

If a switch reports QoS Parameter values in a Capability Set then
these apply to all the connections that use that Capability Set.

For each Traffic Control defined for a given Service the switch
reports availability of that control as one of the following:

   Not available in the Capability Set,

   Applied to all connections that use the Capability Set, or

   Available for application to connections that use the Capability
   Set on a per connection basis. In this case, a controller may
   request application of the Traffic Control in connection
   management messages.

10.3 Service Model Procedures

A switch's Services and Capability Sets are reported to a controller
in a Service Configuration message. A Service Configuration message
response includes the list of Services defined for GSMP that the
switch supports and, for each Service, a specification of the
Capability Sets supported for the Service. Services are referred to
by numbers standardised in the GSMP specification. Capability Sets
are referred to by a numbering system reported by the switch. Each
Capability Set within a given Service includes a unique identifying
number together with the switch's specification of QoS Parameters and
Traffic Controls.

A switch need not support all the defined Services and Capability
Sets on every port. The supported Services and Capability Sets are
reported to the controller on a per port basis in port configuration
messages. Port configuration response messages list the supported

Services using the standardised identifying numbers and the
Capability Sets by using the identifying numbers established in the
switch Service configuration messages.

GSMP does not provide a negotiation mechanism by which a controller
may establish or modify Capability Sets.

When a controller establishes a connection, the connection management
message includes indication of the Service and the Capability Set.
Depending on these the connection management message may additionally
include Traffic Parameter values and Traffic Control flags.

A connection with a given Service can only be established if both the
requested Service and the requested Capability Set are available on
all of the connection's input and output ports.

Refresh of an extant connection is permitted but the add branch
message requesting the message MUST NOT include indication of
Service, Capability Sets or Traffic Parameters.

An extant connection's Traffic Parameters may be changed without
first deleting the connection. The Service and Capability Sets of an
extant connection cannot be changed.

Move branch messages may be refused on the grounds of resource
depletion.

10.4 Service Definitions

This section sets forth the definition of Services. The following
Service Identifiers are defined:

```
     ID           Service Type

     1            CBR= 1
     2            rt-VBR.1
     3            rt-VBR.2
     4            rt-VBR.3
     5            nrt-VBR.1
     6            nrt-VBR.2
     7            nrt-VBR.3
     8            UBR.1
     9            UBR.2
     10-11        Reserved
     12           GFR.1
     13           GFR.2
     14-19        Reserved
     20           Int-Serv Controlled Load
```

```
         21-24         Reserved
         25            MPLS CR-LDP QoS
         26-29         Reserved
         30            Frame Relay Service
         31-49         Reserved
         50-69         Reserved GMPLS
         70-65535      Reserved
```

   Each Service will be defined in its own subsection. Each Service
   definition includes the following definitions:

      Service Identifier
         The reference number used to identify the Service in GSMP
         messages.

      Service Characteristics
         A definition of the Service.

      Traffic Parameters
         A definition of the Traffic Parameters used in connection
         management messages.

      QoS Parameters
         A definition of the QoS Parameters that are included in the
         Capability Set for instances of the Service.

      Traffic Controls
         A definition of the Traffic Controls that may be supported by
         an instance of the Service.

   Descriptive text is avoided wherever possible in order to minimise
   any possibility of semantic conflict with the Original
   Specifications.

10.4.1 ATM Forum Service Categories

10.4.1.1 CBR

   Service Identifier:
      CBR.1 - Service ID = 1

   Service Characteristics:
      Equivalent to ATM Forum CBR.1 Service, see [8].

   Traffic Parameters:
      - Peak Cell Rate
      - Cell Delay Variation Tolerance

   QoS Parameters:
      - Cell Loss Ratio
      - Maximum Cell Transfer Delay
      - Peak-to-peak Cell Delay Variation

   Traffic Controls:
      - (U) Usage Parameter Control
      - (I) Ingress Traffic Shaping to the Peak Cell Rate
      - (E) Egress Traffic Shaping to the Peak Cell Rate and Cell Delay
            Variation Tolerance
      - (D) Packet Discard

10.4.1.2 rt-VBR

   Service Identifier:
      rt-VBR.1 - Service ID = 2
      rt-VBR.2 - Service ID = 3
      rt-VBR.3 - Service ID = 4

   Service Characteristics:
      Equivalent to ATM Forum rt-VBR Service, see [8].

   Traffic Parameters:
      - Peak Cell Rate
      - Cell Delay Variation Tolerance
      - Sustainable Cell Rate
      - Maximum Burst Size

   QoS Parameters:
      - Cell Loss Ratio
      - Maximum Cell Transfer Delay
      - Peak-to-peak Cell Delay Variation

   Traffic Controls:
      - (U) Usage Parameter Control
      - (I) Ingress Traffic Shaping to the Peak Cell Rate
      - (E) Egress Traffic Shaping to the Peak Cell Rate and Cell Delay
            Variation Tolerance
      - (S) Egress Traffic Shaping to the Sustainable Cell Rate and
            Maximum Burst Size
      - (P) Packet Discard
      - (V) VC Merge

10.4.1.3 nrt-VBR

    Service Identifier:
       nrt-VBR.1 - Service ID = 5
       nrt-VBR.2 - Service ID = 6
       nrt-VBR.3 - Service ID = 7

    Service Characteristics:
       Equivalent to ATM Forum nrt-VBR Service, see [8].

    Traffic Parameters:
       - Peak Cell Rate
       - Cell Delay Variation Tolerance
       - Sustainable Cell Rate
       - Maximum Burst Size

    QoS Parameter:
       - Cell Loss Ratio

    Traffic Controls:
       - (U) Usage Parameter Control
       - (I) Ingress Traffic Shaping to the Peak Cell Rate
       - (E) Egress Traffic Shaping to the Peak Cell Rate and Cell Delay
             Variation Tolerance
       - (S) Egress Traffic Shaping to the Sustainable Cell Rate and
             Maximum Burst Size
       - (P) Packet Discard
       - (V) VC Merge

10.4.1.4 UBR

    Service Identifier:
       UBR.1 - Service ID = 8
       UBR.2 - Service ID = 9

    Service Characteristics:
       Equivalent to ATM Forum UBR Service, see [8].

    Traffic Parameters:
       - Peak Cell Rate
       - Cell Delay Variation Tolerance

    QoS Parameter:
       None

    Traffic Controls:
       - (U) Usage Parameter Control
       - (I) Ingress Traffic Shaping to the Peak Cell Rate

             - (E) Egress Traffic Shaping to the Peak Cell Rate and Cell Delay
                    Variation Tolerance
             - (P) Packet Discard
             - (V) VC Merge

10.4.1.5 ABR

   ABR is not supported in this version of GSMP.

10.4.1.6 GFR

   Service Identifier:
      GFR.1 - Service ID = 12
      GFR.2 - Service ID = 13

   Service Characteristics:
      Equivalent to ATM Forum GFR Service, see [8].

   Traffic Parameters:
      - Peak Cell Rate
      - Cell Delay Variation Tolerance
      - Minimum Cell Rate
      - Maximum Burst Size
      - Maximum Frame Size

   QoS Parameter:
      - Cell Loss Ratio

   Traffic Controls:
      - (U) Usage Parameter Control
      - (I) Ingress Traffic Shaping to the Peak Cell Rate
      - (E) Egress Traffic Shaping to the Peak Cell Rate and Cell Delay
             Variation Tolerance
      - (V) VC Merge

10.4.2 Integrated Services

10.4.2.1 Controlled Load

   Service Identifier:
      Int-Serv Controlled Load - Service ID = 20

   Service Characteristics:
      See [9].

      Traffic Parameters:
         - Token bucket rate (r)
         - Token bucket depth (b)
         - Peak rate (p)
         - Minimum policed unit (m)
         - Maximum packet size (M)

      QoS Parameter:
         None.

      Traffic Controls:
         None.

10.4.3 MPLS CR-LDP

      Service Identifier:
         MPLS CR-LDP QoS - Service ID = 25

      Service Characteristics:
         See [10].

      Traffic Parameters:
         - Peak Data Rate
         - Peak Burst Size
         - Committed Data Rate
         - Committed Burst Size
         - Excess Burst Size
         - Weight

      QoS Parameter:
         - Frequency

      Traffic Controls:
         None currently defined.

10.4.4 Frame Relay

      Service Identifier:
         Frame Relay Service - Service ID = 30

      Service Characteristics:
         Equivalent to Frame Relay Bearer Service, see [11].

      Traffic Parameters:
         - Committed Information Rate
         - Committed Burst Rate
         - Excess Burst Rate

   QoS Parameters:
      None.

   Traffic Controls:
      - Usage Parameter Control
      - Egress Traffic Shaping to the Committed Information Rate and
        Committed Burst Size

10.4.5 DiffServ

   DiffServ is not supported in this version of GSMP.

10.5 Format and encoding of the Traffic Parameters

   Connection management messages that use the GSMP Service Model (i.e.,
   those that have IQS or OQS set to 0b10) include the Traffic
   Parameters Block that specifies the Traffic Parameter values of a
   connection. The required Traffic Parameters of a given Service are
   given in Section 10.4. The format and encoding of these parameters
   are given below.

10.5.1 Traffic Parameters for ATM Forum Services

   The Traffic Parameters:

      - Peak Cell Rate

      - Cell Delay Variation Tolerance

      - Sustainable Cell Rate

      - Maximum Burst Size

      - Minimum Cell Rate

      - Maximum Frame Size

   are defined in [8]. These Parameters are encoded as 24-bit unsigned
   integers. Peak Cell Rate, Sustainable Cell Rate, and Minimum Cell
   Rate are in units of cells per second. Cell Delay Variation
   Tolerance is in units of microseconds. Maximum Burst Size and
   Maximum Frame Size are in units of cells. In GSMP messages, the
   individual Traffic Parameters are encoded as follows:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x x x x x|              24 bit unsigned integer           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The format of the Traffic Parameters Block in connection management
messages depends on the Service. It is a sequence of the 32 bit
words (as shown above) corresponding to the Traffic Parameters as
specified in the Service Definitions given in Section 10.4.1 in the
order given there.

10.5.2 Traffic Parameters for Int-Serv Controlled Load Service

    The Traffic Parameters:

        - Token bucket rate (r)

        - Token bucket size (b)

        - Peak rate (p)

    are defined in [9]. They are encoded as 32-bit IEEE single-precision
    floating point numbers. The Traffic Parameters Token bucket rate (r)
    and Peak rate (p) are in units of bytes per seconds. The Traffic
    Parameter Token bucket size (b) is in units of bytes.

    The Traffic Parameters:

        - Minimum policed unit (m)

        - Maximum packet size (M)

    are defined in [9]. They are encoded as 32 integer in units of
    bytes.

The Traffic Parameters Block for the Int-Serv Controlled Load Service
is as follows:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Token bucket rate (r)                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Token bucket size (b)                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Peak rate (p)                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Minimum policed unit (m)                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Maximum packet size (M)                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
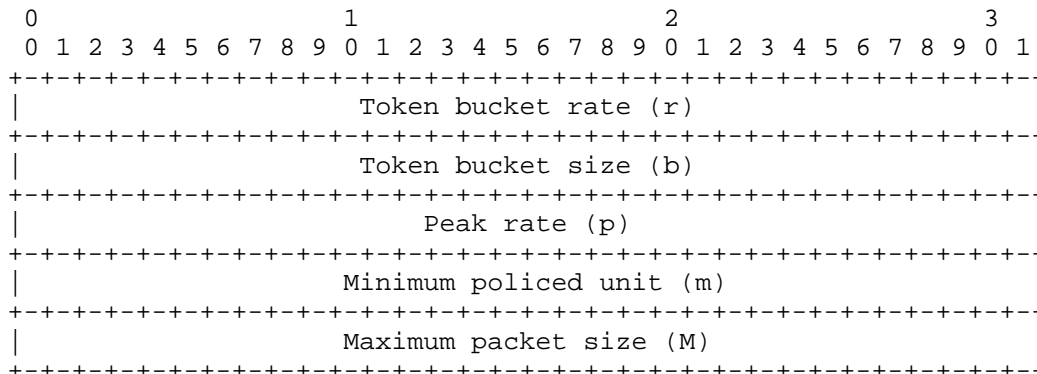
10.5.3 Traffic Parameters for CRLDP Service

   The Traffic Parameters:

      - Peak Data Rate

      - Peak Burst Size

      - Committed Data Rate

      - Committed Burst Size

      - Excess Burst Size

   are defined in [10] to be encoded as a 32-bit IEEE single-precision
   floating point number. A value of positive infinity is represented
   as an IEEE single-precision floating-point number with an exponent of
   all ones (255) and a sign and mantissa of all zeros. The values Peak
   Data Rate and Committed Data Rate are in units of bytes per second.
   The values Peak Burst Size, Committed Burst Size and Excess Burst
   Size are in units of bytes.

   The Traffic Parameter

      - Weight

   is defined in [10] to be an 8-bit unsigned integer indicating the
   weight of the CRLSP. Valid weight values are from 1 to 255. The
   value 0 means that weight is not applicable for the CRLSP.

The Traffic Parameters Block for the CRLDP Service is as follows:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Peak Data Rate                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Peak Burst Size                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Committed Data Rate                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Committed Burst Size                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Excess Burst Size                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x x x x x x x x x x x x x x x x x x x x x|    Weight     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

10.5.4 Traffic Parameters for Frame Relay Service

   The Traffic Parameters:

      - Committed Information Rate

      - Committed Burst Size

      - Excess Burst Size

   are defined in [11]. Format and encoding of these parameters for
   frame relay signalling messages are defined in [12]. (Note than in
   [12] the Committed Information Rate is called "Throughput".) GSMP
   uses the encoding defined in [12] but uses a different format.

   The format of the Traffic Parameters Block for Frame Relay Service is
   as follows:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x x x x x x x x x| Mag |x x x x x|    CIR Multiplier     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x x x x x x x x x| Mag |x x|      CBS Multiplier         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|x x x x x x x x x x x x| Mag |x x|      EBS Multiplier         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   Mag
      This field is an unsigned integer in the range from 0 to 6.
      The value 7 is not allowed. Mag is the decimal exponent for
      the adjacent multiplier field (which itself functions as a
      mantissa).

   CIR Multiplier
      This field is an unsigned integer. It functions as the
      mantissa of the Committed Information Rate Traffic Parameter.

   CBS Multiplier
   EBS Multiplier
      These fields are unsigned integers. They function as the
      mantissas of the Committed Burst Size and Excess Burst Size
      Traffic Parameters respectively.

The Traffic Parameter Values are related to their encoding in GSMP
messages as follows:

   Committed Information Rate = $10^{(Mag)}$ * (CIR Multiplier)

   Committed Burst Size = $10^{(Mag)}$ * (CBS Multiplier)

   Excess Burst Size = $10^{(Mag)}$ * (EBS Multiplier)

10.6 Traffic Controls (TC) Flags

The TC Flags field in Add Branch messages for connections using the
Service Model are set by the controller to indicate that specific
traffic controls are requested for the requested connection. The TC
Flags field is shown below:

            0 1 2 3 4 5 6 7
           +-+-+-+-+-+-+-+-+
           |U|D|I|E|S|V|P|x|
           +-+-+-+-+-+-+-+-+
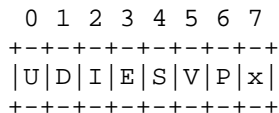
   U: Usage Parameter Control
         When set, this flag indicates that Usage Parameter Control
         is requested.

   D: Packet Discard
         When set, this flag indicates that Packet Discard is
         requested.

   I: Ingress Shaping
        When set, this flag indicates the availability of Ingress
        Traffic Shaping to the Peak Rate and Delay Variation
        Tolerance is requested.

   E: Egress Shaping, Peak Rate
        When set, this flag indicates that Egress Shaping to the
        Peak Rate and Delay Variation Tolerance is requested.

   S: Egress Traffic Shaping, Sustainable Rate
        When set, this flag indicates that Egress Traffic Shaping to
        the Sustainable Rate and Maximum Burst Size is requested.

   V: VC Merge
        When set, this flag indicates that ATM Virtual Channel Merge
        (i.e., multipoint to point ATM switching with a traffic
        control to avoid AAL5 PDU interleaving) is requested.

   P: Port
        When set indicates that traffic block pertains to Ingress
        Port.

   x: Reserved

The controller may set (to one) the flag corresponding to the
requested Traffic Control if the corresponding Traffic Control has
been indicated in the Service Configuration response message (Section
8.4) as available for application to connections that use the
requested Capability Set on a per connection basis. (The requested
Capability Set is indicated by the Capability Set ID the least
significant byte of the Service Selector field of the Add Branch
message.) If the Traffic Control has been indicated in the Service
Configuration response message as either not available in the
Capability Set or applied to all connections that use the Capability
Set then the controller sets the flag to zero and the switch ignores
the flag.

11. Adjacency Protocol

The adjacency protocol is used to synchronise 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
synchronisation.

11.1 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                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| PType | PFlag |              Sender Instance                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Partition ID  |             Receiver Instance                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
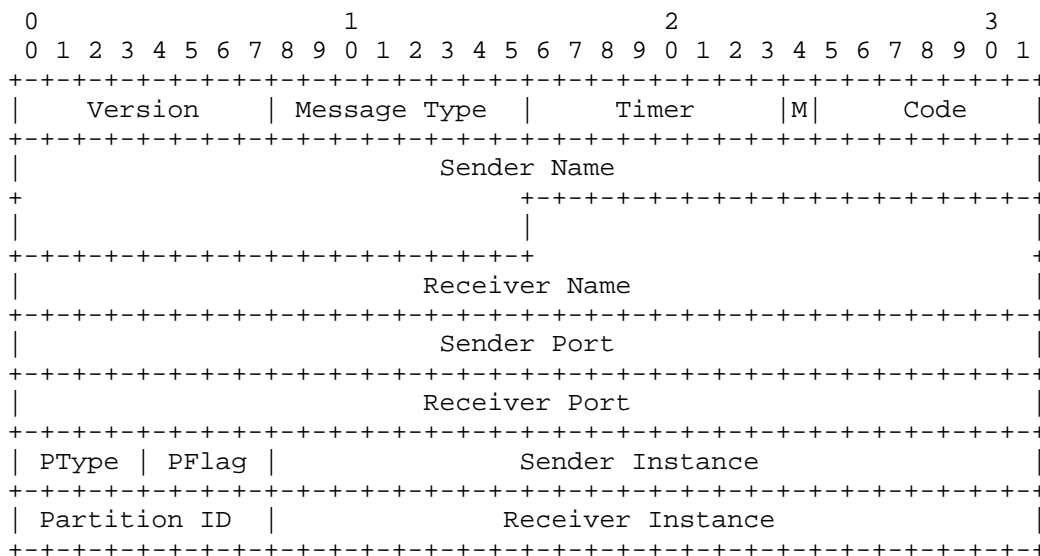
   Version
      In the adjacency protocol the Version field is used for version
      negotiation. The version negotiation is performed before
      synchronisation is achieved. In a SYN message the Version
      field always contains the highest version understood by the
      sender. A receiver receiving 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
      synchronised. 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 = 3.

   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 synchronising 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.

PType
    PType is used to specify if partitions are used and how the
    Partition ID is negotiated.

            Type of partition being requested.
            0 No Partition
            1 Fixed Partition Request
            2 Fixed Partition Assigned

PFlag
    Used to indicate the type of partition request.

            1 - New Adjacency.
                In the case of a new adjacency, the state of the
                switch will be reset.

            2 - Recovered Adjacency.
                In the case of a recovered adjacency, the state of
                the switch will remain, and the Switch Controller
                will be responsible for confirming that the state
                of the switch matches the desired state.

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
    24-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.

        Partition ID
             Field used to associate the message with a specific switch
             partition.

        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.

11.2 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, Sender Name and
      Partition ID 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, Sender Name and Partition
           ID 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, Receiver Name and
           Partition ID fields in the incoming message match the values
           of the Sender Instance, Sender Port, Sender Name and
           Partition ID 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 synchronisation 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
      synchronisation is achieved, will be discarded.

11.2.1 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 synchronisation more quickly.

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

11.3 Partition Information State

     Each instance of a [switch controller-switch partition] pair will
     need to establish adjacency synchronisation independently.

     Part of the process of establishing synchronisation when using
     partition will be to establish the assignment of partition
     identifiers. The following scenarios are provided for:

         - A controller can request a specific partition ID by setting the
            PType to Fixed Partition Request.

         - A controller can let the switch decide whether it wants to
            assign a fixed partition ID or not, by setting the PType to No
            Partition.

         - A switch can assign the specific Partition ID to the session by
            setting the PType to Fixed Partition Assigned. A switch can
            specify that no partitions are handled in the session by
            setting the PType to No Partition.

     The assignment is determined by the following behaviour:

         - An adjacency message from a controller with PType = 1 and
            Code = SYN SHOULD be treated as a partition request.

         - An adjacency message from a switch with PType = 2 and
            Code = SYN SHOULD be treated as a partition assignment.

         - An adjacency message from a controller or a switch with
            PType = 2 and Code = (SYNACK || ACK) SHOULD be treated as a
            success response, the partition is assigned.

         - An adjacency message from a controller with PType = 0 and
            Code = SYN indicates that the controller has not specified if
            it requests partitions or not.

-   An adjacency message from a switch with PType = 0 and
    Code = SYN indicates that the switch does not support
    partitions.

-   An adjacency message from a controller or a switch with
    PType = 0 and Code = (SYNACK || ACK) indicates that the session
    does not support partitions.

-   An adjacency message from a controller or a switch with
    PType = (1 || 2) and Code = RSTACK indicates that requested
    Partition ID is unavailable.

-   An adjacency message from a controller or a switch with
    PType = 0 and Code = RSTACK indicates that an unidentified
    error has occurred. The session SHOULD be reset.

All other combinations of PType and Code are undefined in this
version of GSMP.

11.4 Loss of Synchronisation

If after synchronisation 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 synchronisation may be declared.

While re-establishing synchronisation with a controller, a switch
SHOULD maintain its connection state, deferring the decision about
resetting the state until after synchronisation is re-established.

Once synchronisation is re-established the decision about resetting
the connection state SHOULD be made on the following basis:

-   If PFLAG = 1, then a new adjacency has been established and the
    state SHOULD be reset

-   If PFLAG = 2, then adjacency has been re-established and the
    connection state SHOULD be retained. Verification that
    controller and connection state are the same is the
    responsibility of the controller.

11.5 Multiple Controllers per switch partition

Multiple switch controllers may jointly control a single switch
partition. The controllers may control a switch partition either in
a primary/standby fashion or as part of multiple controllers
providing load-sharing for the same partition. It is the
responsibility of the controllers to co-ordinate their interactions

with the switch partition. In order to assist the controllers in
tracking multiple controller adjacencies to a single switch
partition, the Adjacency Update message is used to inform a
controller that there are other controllers interacting with the same
partition. It should be noted that the GSMP does not include
features that allow the switch to co-ordinate cache synchronization
information among controllers. The switch partition will service
each command it receives in turn as if it were interacting with a
single controller. Controller implementations without controller
entity synchronisation SHOULD NOT use multiple controllers with a
single switch partition.

11.5.1 Multiple Controller Adjacency Process

The first adjacency for a specific partition is determined by the
procedures described in section 11.2 and an Adjacency Update message
will be sent. The next adjacencies to the partition are identified
by a new partition request with the same Partition ID as the first
one but with the different Sender Name. Upon establishing adjacency
the Adjacency count will be increased and an Adjacency Update message
will be sent.

When adjacency between one partition and a controller is lost, the
adjacency count will be decremented and an Adjacency Update message
will be sent.

Example:

A switch partition has never been used. When the first controller
(A) achieves adjacency, an adjacency count will be initiated and (A)
will get an Adjacency Update message about itself with Code field =
1. Since (A) receives an adjacency count of 1 this indicates that it
is the only controller for that partition.

When a second adjacency (B), using the same Partition ID, achieves
adjacency, the adjacency counter will be increased by 1. Both (A)
and (B) will receive an Adjacency Update message indicating an
adjacency count of 2 in the Code field. Since the count is greater
than 1, this will indicate to both (A) and (B) that there is another
controller interacting with the switch; identification of the other
controller will not be provided by GSMP, but will be the
responsibility of the controllers.

If (A) looses adjacency, the adjacency count will be decreased and an
Adjacency Update message will be sent to (B) indicating an adjacency
count of 1 in the Code field. If (B) leaves as well, the partition
is regarded as idle and the adjacency count may be reset.

12. Failure Response Codes

12.1 Description of Failure and Warning 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.

   A warning response message is a success response (Result = 3) with
   the Code field specifying the warning code. The warning code
   specifies a warning that was generated during the successful
   operation.

   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 a
   changed state.)

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

       - Invalid Message

       - General Message Failure

       - Specific Message Failure A failure response specified in the
          text defining the message type.

       - Connection Failures

       - Virtual Path Connection Failures

       - Multicast Failures

       - QoS Failures

       - General Failures

       - Warnings

   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 and warning 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.

        4:   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.

        5:   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.

        7: Invalid Partition ID
                The value given in the Partition ID field is not legal for
                this partition.

    General Message Failure

        10: The meaning of this failure is dependent upon the
                particular message type and is specified in the text
                defining the message.

    Specific Message Failure - A failure response that is only used by a
                specific message type

    - Failure response messages used by the Label Range message

        40: Cannot support one or more requested label ranges.

        41: Cannot support disjoint label ranges.

        42: Specialised multipoint labels not supported.

    - Failure response messages used by the Set Transmit Data Rate
                function of the Port Management message

        43: The transmit data rate of this output port cannot be changed.

44: Requested transmit data rate out of range for this output
      port.
      The transmit data rate of the requested output port can be
      changed, but the value of the Transmit Data Rate field is
      beyond the range of acceptable values.

- Failure response message of the Port Management message

   45: Connection Replace mechanism not supported on switch.
         The R-flag SHOULD be reset in the Response Port Management
         message.

- Failure response message range reserved for the ARM extension

   128-159: These failure response codes will be interpreted
         according to definitions provided by the model
         description.

Connection Failures

   11: The specified connection does not exist.
         An operation that expects a connection to be specified
         cannot locate the specified connection. A connection is
         specified by the input port and input label on which it
         originates. An ATM virtual path connection is specified
         by the input port and input VPI on which it originates.

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

   13: One or more of the specified Input Labels is invalid.

   14: One or more of the specified Output Labels is invalid.

   15: Point-to-point bi-directional connection already exists.
         The connection specified by the Input Port and Input Label
         fields already exists, and the bi-directional Flag in the
         Flags field is set.

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

17: Insufficient resources for QoS Profile.
    The resources requested by the QoS Profile in the Service
    Selector field are not available.

18: Insufficient Resources.
    Switch resources needed to establish a branch are not
    available.

20: Reservation ID out of Range
    The numerical value of Reservation ID is greater than the
    value of Max Reservations (from the Switch Configuration
    message).

21: Mismatched reservation ports
    The value of Input Port differs from the input port
    specified in the reservation or the value of Output Port
    differs from the output port specified in the reservation.

22: Reservation ID in use
    The value of Reservation ID matches that of an extant
    Reservation.

23: Non-existent reservation ID
    No reservation corresponding to Reservation ID exists.

36: Replace of connection is not activated on switch.
    Only applicable for Add Branch messages. The Replace
    Connection mechanism has not been activated on port by the
    Port Management message.

37: Connection replacement mode cannot be combined with Bi-
    directional or Multicast mode. The R flag MUST NOT be
    used in conjunction with either the M flag or the B flag.

ATM Virtual Path Connections

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

    25: Point-to-multipoint ATM 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 ATM virtual path
          connections.

    26: Attempt to add an ATM 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 ATM virtual path
          connections on the same point-to-multipoint connection.

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

    28: ATM Virtual path switching is not supported on non-ATM ports.
          One or both of the requested input and output ports is not
          an ATM port. ATM virtual path switching is only supported
          on ATM ports.

  Multicast Failures

    29: 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.

    30: The limit on the maximum number of multicast connections that
          the switch can support has been reached.

    31: The limit on the maximum number of branches that the specified
          multicast connection can support has been reached.

    32: Cannot label each output branch of a point-to-multipoint tree
          with a different label.
          Some switch designs, require all output branches of a
          point-to-multipoint connection to use the same value of
          Label.

    33: Cannot add multi-point branch to bi-directional connection.
          It is an error to attempt to add an additional branch to
          an existing connection with the bi-directional flag set.

34: Unable to assign the requested Label value to the requested
        branch on the specified multicast connection.
        Although the requested Labels are valid, the switch is
        unable to support the request using the specified Label
        values for some reason not covered by the above failure
        responses. This message implies that a valid value of
        Labels exists that the switch could support. For example,
        some switch designs restrict the number of distinct Label
        values available to a multicast connection. (Most switch
        designs will not require this message.)

35: General problem related to the manner in which multicast 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.)

QoS Failures

60-79: These failure response codes will be interpreted according
        to definitions provided by the model description.

80: Switch does not support different QoS parameters for different
        branches within a multipoint connection.

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.

19: 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.

     Warnings

          46: One or more labels are still used in the previous Label Range.

12.2 Summary of Failure Response Codes and Warnings

     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: One or more of the specified ports does not exist.
          5: Invalid Port Session Number.
          6: One or more of the specified ports is down.
          7: Invalid Partition ID.
         10: General message failure. (The meaning of this failure code
                depends upon the Message Type. It is defined within the
                description of any message that uses it.)
         11: The specified connection does not exist.
         12: The specified branch does not exist.
         13: One or more of the specified Input Labels is invalid.
         14: One or more of the specified Output Labels is invalid.
         15: Point-to-point bi-directional connection already exists.
         16: Invalid service selector field in a connection management
                message.
         17: Insufficient resources for QoS profile.
         18: Insufficient resources.
         19: Out of resources (e.g., memory exhausted, etc.).
         20: Reservation ID out of Range
         21: Mismatched reservation ports
         22: Reservation ID in use
         23: Non-existent reservation ID
         24: ATM virtual path switching is not supported on this input
                port.
         25: Point-to-multipoint ATM virtual path connections are not
                supported on either the requested input port or the
                requested output port.
         26: Attempt to add an ATM virtual path connection branch to an
                existing virtual channel connection.
         27: Attempt to add an ATM virtual channel connection branch to
                an existing virtual path connection.
         28: ATM Virtual Path switching is not supported on non-ATM
                ports.

29: 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.
30: The limit on the maximum number of point-to-multipoint
        connections that the switch can support has been
        reached.
31: The limit on the maximum number of branches that the
        specified point-to-multipoint connection can support has
        been reached.
32: Cannot label each output branch of a point-to-multipoint
        tree with a different label.
33: Cannot add multi-point branch to bi-directional
        connection.
34: Unable to assign the requested Label value to the
        requested branch on the specified point-to-multipoint
        connection.
35: General problem related to the manner in which point-to-
        multipoint is supported by the switch.
36: Replace of connection is not activated on switch.
37: Connection replacement mode cannot be combined with Bi-
        directional or Multicast mode.
40: Cannot support one or more requested label ranges.
41: Cannot support disjoint label ranges.
42: Specialised multipoint labels not supported.
43: The transmit data rate of this output port cannot be
        changed.
44: Requested transmit data rate out of range for this output
        port.
45: Connection Replace mechanism not supported on switch.
46: Labels are still used in the existing Label Range.
60-79: Reserved for QoS failures.
80: Switch does not support different QoS parameters for
        different branches within a multipoint connection.
128-159: Reserved for the ARM extensions.

13. Security Considerations

   The security of GSMP's TCP/IP control channel has been addressed in
   [15]. For all uses of GSMP over an IP network it is REQUIRED that
   GSMP be run over TCP/IP using the security considerations discussed
   in [15].

Appendix A   Summary of Messages

```
   Message Name                        Message Number  Status

   Connection Management Messages
        Add Branch ........................16
           ATM Specific - VPC.............26
        Delete Tree.......................18
        Verify Tree.......................19              Obsoleted
        Delete All Input..................20
        Delete All Output.................21
        Delete Branches...................17
        Move Output Branch................22
             ATM Specific - VPC...........27
        Move Input Branch.................23
             ATM Specifc  - VPC...........28

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

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

   Configuration Messages
        Switch Configuration..............64
        Port Configuration................65
        All Ports Configuration...........66
        Service Configuration.............67

   Reservation Messages
        Reservation Request...............70
        Delete Reservation................71
        Delete All Reservations...........72

   Event Messages
        Port Up...........................80
        Port Down.........................81
        Invalid Label.....................82
        New Port..........................83
        Dead Port.........................84
```

         Abstract and Resource Model Extension Messages
              Reserved.........................200-249

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

Appendix B   IANA Considerations

   Following the policies outlined in "Guidelines for Writing an IANA
   Considerations Section in RFCs" (RFC 2434 [19]), the following name
   spaces are defined in GSMPv3.

       - Message Type Name Space [Appendix A]

       - Label Type Name Space [3.1.3]

       - Result Name Space [3.1.1]

       - Failure Response Message Name Space [3.1.4],[11]

       - Adaptation Type Name Space [4.1]

       - Model Type Name Space [8.1]

       - Port Type Name Space [8.2]

       - Service ID Name Space [10.4]

       - Traffic Control Name Space [8.4]

       - Event Flag Name Space [6.1]

B.1. Message Type Name Space

   GSMPv3 divides the name space for Message Types into four ranges.
   The following are the guidelines for managing these ranges.

       - Message Types 0-99.
              Message Types in this range are part of the GSMPv3 base
              protocol. Message types in this range are allocated
              through an IETF consensus action [19].

       - Message Types 100-199.
              Message Types in this range are Specification Required
              [19]. Message Types using this range must be documented
              in an RFC or other permanent and readily available
              references.

- Message Types 200-249.
        Message Types in this range are Specification Required
        [19] and are intended for Abstract and Resource Model
        Extension Messages. Message Types using this range must
        be documented in an RFC or other permanent and readily
        available references.

- Message Types 250-255.
        Message Types in this range are reserved for vendor
        private extensions and are the responsibility of
        individual vendors. IANA management of this range of the
        Message Type Name Space is unnecessary.

B.2. Label Type Name Space

   GSMPv3 divides the name space for Label Types into three ranges. The
   following are the guidelines for managing these ranges.

- Label Types 0x000-0xAFF.
        Label Types in this range are part of the GSMPv3 base
        protocol. Label Types in this range are allocated through
        an IETF consensus action [19].

- Label Types 0xB00-0xEFF.
        Label Types in this range are Specification Required [19].
        Label Types using this range must be documented in an RFC
        or other permanent and readily available reference.

- Label Types 0xF00-0xFFF.
        Label Types in this range are reserved for vendor private
        extensions and are the responsibility of individual
        vendors. IANA management of this range of the Label Type
        Name Space is unnecessary.

B.3. Result Name Space

   The following is the guideline for managing the Result Name Space:

- Result values 0-255.
        Result values in this range need an expert review, i.e.,
        approval by a Designated Expert is required [19].

B.4. Failure Response Name Space

   GSMPv3 divides the name space for Failure Responses into three
   ranges. The following are the guidelines for managing these ranges:

- Failure Responses 0-59, 80-127, 160-255.
      Failure responses in these ranges are part of the GSMPv3
      base protocol. Failure Responses in these ranges are
      allocated through an IETF consensus action [19].

- Failure Responses 60-79, 128-159.
      Failure responses in these ranges are reserved for vendor
      private extensions and are the responsibility of
      individual vendors. IANA management of these ranges of
      the Failure Response Name Space are unnecessary.

B.5. Adaptation Type Name Space

   GSMPv3 divides the name space for Adaptation Types into two ranges.
   The following are the guidelines for managing these ranges:

- Adaptation Type 0x000-0x2FF.
      Adaptation Types in this range are part of the GSMPv3 base
      protocol. Adaptation Types in this range are allocated
      through an IETF consensus action [19].

- Adaptation Type 0x300-0xFFF.
      Adaptation Types in this range are allocated by the first
      come first served principle [19].

B.6. Model Type Name Space

   GSMPv3 divides the name space for Model Types into three ranges. The
   following are the guidelines for managing these ranges:

- Model Type 0.
      Model Types in this range are part of the GSMPv3 base
      protocol. Model Types in this range are allocated through
      an IETF consensus action [19].

- Model Type 1-200.
      Model Types in this range are Specification Required [19].
      Message Types using this range must be documented in an
      RFC or other permanent and readily available references.

- Model Type 201-255.
      Model Types in this range are reserved for vendor private
      extensions and are the responsibility of individual
      vendors. IANA management of these ranges of the Model
      Type Name Space are unnecessary.

B.7. Port Type Name Space

   GSMPv3 divides the name space for Port Types into two ranges. The
   following are the guidelines for managing these ranges:

      - Port Type 0-127.
              Port Types in this range are part of the GSMPv3 base
              protocol. Port Types in this range are allocated through
              an IETF consensus action [19].

      - Port Type 128-255.
              Port Types in this range are Specification Required [19].
              Port Types using this range must be documented in an RFC
              or other permanent and readily available references.

B.8. Service ID Name Space

   GSMPv3 divides the name space for Service IDs into two ranges. The
   following are the guidelines for managing these ranges:

      - Service ID 0-1023.
              Service ID's in this range are part of the GSMPv3 base
              protocol. Service ID's in this range are allocated
              through an IETF consensus action [19].

      - Service ID 1024-65535.
              Service ID's in this range are Specification Required
              [19]. Service ID's using this range must be documented in
              an RFC or other permanent and readily available
              references.

B.9. Traffic Control Name Space

   The following are the guidelines for managing Traffic Control Flags
   in GSMPv3:

      - All Traffic Control Flags are allocated through an expert
         review, i.e., approval by a Designated Expert [19].

B.10. Event Flag Name Space

   The following are the guidelines for managing Event Flags in GSMPv3:

      - All Event Flags are allocated through an expert review, i.e.,
         approval by a Designated Expert [19].

   The TCP port for establishing GSMP connections has been defined as
   6068.

References

   [1]   "B-ISDN ATM Layer Specification", International
         Telecommunication Union, ITU-T Recommendation I.361, Feb. 1999.

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

   [3]   "B-ISDN ATM Adaptation Layer specification: Type 5 AAL",
         International Telecommunication Union, ITU-T, Recommendation
         I.363.5, Aug. 1996.

   [4]   Sjostrand, H., Buerkle, J. and B. Srinivasan, "Definitions of
         Managed Objects for the General Switch Management Protocol
         (GSMP)", RFC 3295, June 2002.

   [5]   IANA Assigned Port Numbers, http://www.iana.org

   [6]   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.

   [7]   Newman, P., Edwards, W., Hinden, R., Hoffman, E., Ching Liaw,
         F., Lyon, T. and G. Minshall, "Ipsilon's General Switch
         Management Protocol Specification Version 2.0", RFC 2297, March
         1998.

   [8]   ATM Forum Technical Committee, "Traffic Management Specification
         Version 4.1", af-tm-0121.000, 1999.

   [9] Wroclawski, J., "Specification of the Controlled-Load Network
         Element Service", RFC 2211, September 1997.

   [10] Jamoussi, B., Andersson, L., Callon, R., Dantu, R., Wu, L.,
         Doolan, P., Worster, T., Feldman, N., Fredette, A., Girish, M.,
         Gray, E., Heinanen, J., Kilty, T. and A. Malis, "Constraint-
         Based LSP Setup using LDP", RFC 3212, January 2002.

   [11] ITU-T Recommendation I.233 Frame Mode Bearer Services, ISDN
         frame relaying bearer services and ISDN switching bearer
         service, Nov. 1991.

   [12] ITU-T Recommendation Q.933, Integrated Services Digital Network
         (ISDN) Digital Subscriber Signaling System No. 1 (DSS 1)
         Signaling Specifications For Frame Mode Switched And Permanent
         Virtual Connection Control And Status Monitoring, 1995.

   [13] ITU-T Recommendation Q.922, Integrated Services Digital Network
        (ISDN) Data Link Layer Specification For Frame Mode Bearer
        Services, 1992

   [14] Rosen, E., Tappan, D., Fedorkow, G., Rekhter, Y., Farinacci, D.,
        Li, T. and A. Conta, "MPLS Label Stack Encoding", RFC 3032,
        January 2001.

   [15] Worster, T., Doria, A. and J. Buerkle, "General Switch
        Management Protocol (GSMP) Packet Encapsulations for
        Asynchronous Transfer Mode (ATM), Ethernet and Transmission
        Control Protocol (TCP)", RFC 3293, June 2002.

   [16] Doria, A. and K. Sundell, "General Switch Management Protocol
        Applicability", RFC 3294, June 2002.

   [17] IANAifType - MIB DEFINITIONS, http://www.iana.org, January 2001.

   [18] Anderson, L., Doolan, P., Feldman, N., Fredette, A. and B.
        Thomas, "LDP Specification", RFC 3036, January 2001.

   [19] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA
        Considerations Section in RFCs", BCP 26, RFC 2434, October 1998.

   [20] Bradner, S., "Key words for use in RFCs to Indicate Requirement
        Levels", BCP 14, RFC 2119, March 1997.

   [21] Conta, A., Doolan, P. and A. Malis, "Use of Label Switching on
        Frame Relay Networks Specification", RFC 3034, January 2001.

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