

```

/*
 * Protocol Header 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   |   Type   |   Message Length   |
 *      +-----+-----+-----+-----+-----+-----+-----+-----+
 *      |                                     Transaction ID                                     |
 *      +-----+-----+-----+-----+-----+-----+-----+-----+
 *
 * Version
 *     Indicates version of OpenFlow protocol.
 *
 * Type
 *     Indicates type of OpenFlow protocol message.
 *     0 Hello
 *     1 Error
 *     2 Echo Request
 *     3 Echo Reply
 *     4 Vendor
 *     5 Features Request
 *     6 Features Reply
 *     7 Get Config Request
 *     8 Get Config Reply
 *     9 Set Config
 *    10 Packet Input Notification
 *    11 Flow Removed Notification
 *    12 Port Status Notification
 *    13 Packet Output
 *    14 Flow Modification
 *    15 Port Modification
 *    16 Stats Request
 *    17 Stats Reply
 *    18 Barrier Request
 *    19 Barrier Reply
 *
 * Message Length
 *     Length of total message (header + payloads), in octets.
 *
 * Transaction ID
 *     Transaction ID used to control transaction of packets and matching
 *     of requests and responses. Transaction ID associated with this
packet.
 *     Reply messages use the same ID as was in the request to facilitate
 *     pairing.

```

\*/

/\*

\* Protocol Payload Format - Hello

\*

```
*      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
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  | <Arbitrary Data> ...
*  +-----+-----+-----+-----+-----+-----+-----+-----+
```

\*

\* Arbitrary Data

\* TBD (but must be ignored by receiver)

\*/

/\*

\* Protocol Payload Format - Error

\*

```
*      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
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  |           Type           |           Code           |
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  | <Data> ...
*  +-----+-----+-----+-----+-----+-----+-----+-----+
```

\*

\* Type

\* TBD

\* 0 Hello protocol failed.

\* 1 Request was not understood.

\* 2 Error in action description.

\* 3 Problem modifying flow entry.

\*

\* Code

\* TBD

\* Type 0: 0 No compatible version.

\* Type 0: 1 Permissions error.

\* Type 1: 0 ofp\_header.version not supported.

\* Type 1: 1 ofp\_header.type not supported.

\* Type 1: 2 ofp\_stats\_request.type not supported.

\* Type 1: 3 Vendor not supported.

\* Type 1: 4 Vendor subtype not supported.

\* Type 1: 5 Permissions error.

\* Type 2: 0 Unknown action type.

\* Type 2: 1 Length problem in actions.

\* Type 2: 2 Unknown vendor id specified.

```

*   Type 2: 3   Unknown action type for vendor ID.
*   Type 2: 4   Problem validating output action.
*   Type 2: 5   Bad action argument.
*   Type 2: 6   Permissions error.
*   Type 3: 0   Flow not added because of full tables.
*   Type 3: 1   Attempted to add overlapping flow with CHECK_OVERLAP flag
set.
*   Type 3: 2   Permissions error.
*   Type 3: 3   Flow not added because of non-zero idle/hard.
*
*   Data
*   Interpreted based on the type and code.
*/

```

```

/*
*   Protocol Payload Format - Echo Request
*                               Echo Reply
*
*       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
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   | <Arbitrary Data> ...
*   +-----+-----+-----+-----+-----+
*
*   Arbitrary Data
*   TBD (but must be replied to sender)
*/

```

```

/*
*   Protocol Payload Format - Vendor
*
*       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
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                               Vendor ID                               |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   | <Vendor Defined Arbitrary Data> ...
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*
*   Vendor ID
*   TBD
*
*   Vendor Defined Arbitrary Data
*   TBD
*/

```



```

* Switch Capability Flags
*   See Payload Element <Switch Capability Flags>
*

```

```

* Action Capability Flags
*   TBD
*   0x00000001  Output to switch port
*   0x00000002  Set 802.1Q VID
*   0x00000004  Set 802.1Q PCP
*   0x00000008  Strip 802.1Q tag
*   0x00000010  Set Ethernet source address
*   0x00000020  Set Ethernet destination address
*   0x00000040  Set IPv4 source address
*   0x00000080  Set IPv4 destination address
*   0x00000100  Set IPv4 DSCP
*   0x00000200  Set TCP/UDP source port
*   0x00000400  Set TCP/UDP destination port
*

```

```

* Port Descriptors
*   See Payload Element <Port Descriptor>
*/

```

```

/*
* Protocol Payload Format - Get Config Request
*
*   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
*   +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*   |
*   +---+---
*
* There is no payload for Get Config Request
*/

```

```

/*
* Protocol Payload Format - Get Config Reply
*                               Set Config
*
*   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
*   +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*   | <Switch Configuration Flags> |           Miss Send Length           |
*   +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*
* Switch Configuration Flags
*   See Payload Element <Switch Configuration Flags>
*

```

```

* Miss Send Length
*   Indicates maximum octets of new flow should send to the controller.
*   Default value is 128.
*/

```

```

/*
* Protocol Payload Format - Packet Input Notification
*
*   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
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                                     Packet Buffer ID                                     |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |   Ethernet Frame Length   |   Ingresss <Port Number>   |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |   Reason   |   Reserved   |                                     |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                                     Ethenret Frame                                     +
*   |                                     |
*   ~                                     ~
*   |                                     |
*
* Packet Buffer ID
*   TBD
*
* Ethernet Frame Length
*   TBD
*
* Ingress Port Number
*   See Payload Element <Port Number>
*
* Reason
*   TBD
*   0 No matching flow.
*   1 Action explicitly output to controller.
*
* Reserved
*   Must be zero.
*
* Ethernet Frame
*   TBD
*/

```

```

/*
* Protocol Payload Format - Flow Removed Notification
*
*   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
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  |                                                                 |
*  ~                               <Flow Match Descriptor>          ~
*  |                                                                 |
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  |           Priority           |           Reason           | Reserved |
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  |                               Lifetime Duration            |
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  |           Soft Lifetime           |                               |
*  +-----+-----+-----+-----+-----+-----+-----+ Reserved +
*  |                                                                 |
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  |                                                                 |
*  +                               Number of Packets Transferred    |
*  |                                                                 |
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  |                                                                 |
*  +                               Number of Octets Transferred      |
*  |                                                                 |
*  +-----+-----+-----+-----+-----+-----+-----+-----+

```

```

* Flow Match Descriptor
*   See Payload Element <Flow Match Descriptor>

```

```

* Priority
*   TBD
*   Default value is 32768.

```

```

* Reason
*   TBD
*   0 Flow idle time exceeded soft lifetime.
*   1 Time exceeded hard lifetime.
*   2 Evicted by a DELETE flow mod.

```

```

* Reserved
*   Must be zero.

```

```

* Lifetime Duration
*   TBD

```

```

* Soft Lifetime
*   TBD

```

```

* Reserved

```

```

*      Must be zero.
*
*      Number of Packets Transferred
*      TBD
*
*      Number of Octets Transferred
*      TBD
*/

```

```

/*
*      Protocol Payload Format - Port Status Notification
*
*      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
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |          Reason          |                                     |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |                                     Reserved                                     |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |                                     <Port Descriptor>                                     |
*      ~                                     ~
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*
*      Reason
*      TBD
*      0  Indicates the port was attached.
*      1  Indicates the port was detached.
*      2  Indicates the port configuration was modified.
*
*      Reserved
*      Must be zero.
*
*      Port Descriptor
*      See Payload Element <Port Descriptor>
*/

```

```

/*
*      Protocol Payload Format - Packet Output
*
*      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
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |                                     Packet Buffer ID                                     |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |      Ingress <Port Number>      | Length of Action Descriptors |

```



```

* +-----+
* | <Action Descriptors> ...
* +-----+
* | <Packet Data> ...
* +-----+
*
* Packet Buffer ID
*   TBD
*
* Ingress Port Number
*   See Payload Element <Port Number>
*
* Length of Action Descriptors
*   TBD
*
* Action Descriptors
*   See Payload Element <Action Descriptor>
*
* Packet Data
*   TBD
*/

```

```
/*
```

```

* Protocol Payload Format - Flow Modification
*
*   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
* +-----+
* |                                           |
* ~                               <Flow Match Descriptor>                               ~
* |                                           |
* +-----+
* |           Command           |           Soft Lifetime           |
* +-----+
* |           Hard Lifetime      |           Priority                 |
* +-----+
* |           Packet Buffer ID   |
* +-----+
* |   Egress <Port Number>   |           CU           |IE|O|IR|
* +-----+
* |           Reserved           |
* +-----+
* | <Action Descriptors> ...
* +-----+
*
* Flow Match Descriptor

```

```

*   See Payload Element <Flow Match Descriptor>
*
* Command
*   TBD
*   0 Add new flow.
*   1 Modify all matching flows.
*   2 Modify entry strictly matching wildcard flows.
*   3 Delete all matching flows.
*   4 Delete Strictly match wildcards and priority.
*
* Soft Lifetime
*   TBD
*
* Hard Lifetime
*   TBD
*
* Priority
*   TBD
*   Default value is 32768.
*
* Packet Buffer ID
*   TBD
*
* Egress Port Number
*   See Payload Element <Port Number>.
*
* CU (currently unused)
*   Must be zero.
*
* E
*   Remark this is for emergency.
*
* O
*   Check for overlapping entries first.
*
* R
*   Send flow removed message when flow expires or is deleted.
*
* Reserved
*   Must be zero.
*
* Action Descriptors
*   See Payload Element <Action Descriptor>
*/
/*

```

## \* Protocol Payload Format - Port Modification

\*

```

*      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 Number>               |
*      +-----+-----+-----+-----+-----+-----+ Ethernet Address +
*      |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |               <Port Configuration Flags>               |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |               <Port Configuration Flags> Mask               |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |               <Port Feature Flags>               |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |               Reserved               |
*      +-----+-----+-----+-----+-----+-----+-----+-----+

```

\* Port Number

\* See Payload Element <Port Number>.

\*

\* Ethernet Address

\* TBD

\*

## \* Port Configuration Flags

\* See Payload Element <Port Configuration Flags>.

\*

\* Port Configuration Flags Mask

\* See Payload Element <Port Configuration Flags>.

\*

- \* Port Feature Flags

\* See Payload Element <Port Feature Flags>.

\*

\* Reserved

\* Must be zero.

**\* /**

/\*

### \* Protocol Payload Format - Stats Request

\*

[illegible]

```

* +---+---+---+---+---+---+
*
* Type
*   TBD
*   0 Description of this OpenFlow switch.
*   1 Individual flow statistical information.
*   2 Aggregate flow statistical information.
*   3 Flow table statistical information.
*   4 Port statistical information.
*   65535 Vendor extension.
*
* Flags
*   TBD
*   Must be zero.
*
* Option
*   TBD
*   See Payload <Stats Option>.
*
* Possible Option
*   <Flow Stats Request>
*   <Aggregate Flow Stats Request>
*/

/*
* Protocol Payload Format - Stats Reply
*
*   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
*   +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*   |                               |                               |                               |
*   |                               Type                               |                               Flags                               |
*   +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*   | <Stats Option> ...
*   +---+---+---+---+---+---+
*
* Type
*   TBD
*   0 Description of this OpenFlow switch.
*   1 Individual flow statistical information.
*   2 Aggregate flow statistical information.
*   3 Flow table statistical information.
*   4 Port statistical information.
*   65535 Vendor extension.
*
* Flags
*   TBD

```





```

* +                               Port Description                               +
* |                               |                               |
* +                               +                               +
* |                               |                               |
* +-----+-----+-----+-----+-----+-----+-----+-----+-----+
* |                               <Port Configuration Flags>                               |
* +-----+-----+-----+-----+-----+-----+-----+-----+-----+
* |                               <Port Status Flags>                               |
* +-----+-----+-----+-----+-----+-----+-----+-----+-----+
* |                               Current <Port Feature Flags>                               |
* +-----+-----+-----+-----+-----+-----+-----+-----+-----+
* |                               Advertising <Port Feature Flags>                               |
* +-----+-----+-----+-----+-----+-----+-----+-----+-----+
* |                               Supported <Port Feature Flags>                               |
* +-----+-----+-----+-----+-----+-----+-----+-----+-----+
* |                               Link Layer Neighbor Advertising <Port Feature Flags>                               |
* +-----+-----+-----+-----+-----+-----+-----+-----+-----+
*
* Port Number
*   See Payload Element <Port Number>.
*
* Ethernet Address
*   TBD
*
* Port Description
*   TBD
*
* Port Configuration Flags
*   See Payload Element <Port Configuration Flags>.
*
* Port Status Flags
*   See Payload Element <Port Status Flags>.
*
* Current Port Feature Flags
*   See Payload Element <Port Feature Flags>.
*
* Advertising Port Feature Flags
*   See Payload Element <Port Feature Flags>.
*
* Supported Port Feature Flags
*   See Payload Element <Port Feature Flags>.
*
* Link Layer Neighbor Advertising Port Feature Flags
*   See Payload Element <Port Feature Flags>.
*/

```

```

/*
 * Protocol Payload Element Format - Port Number
 *
 *      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 Number           |
 *      +-----+-----+-----+-----+
 *
 * Port Prefix  0x00 - 0xfe  Indicates switch ports
 *              0xff       Indicates output action ports
 *
 * Range          M/O  Description
 *
 *-----
 * 0x0000          M   Reserved
 * 0x0001 - 0xfeff  M   Switch ports
 * 0xff00          M   Reserved, Maximum number of switch ports
 * 0xff01 - 0xffff7 M   Reserved
 * 0xffff8         M   IN_PORT, Send the packet out the ingress port.
 * 0xffff9         M   TABLE, Perform actions in flow table, only for
 *                     PACKET_OUT message.
 * 0xffffa         O   NORMAL, Process the packet using the traditional
 *                     L2/L3 switching.
 * 0xffffb         O   FLOOD, Flood the packet except ingress port.
 * 0xffffc         M   ALL, Send the packet out all ports except ingress
 *                     and non-xSTP ports.
 * 0xffffd         M   CONTROLLER, Send the packet to the controller.
 * 0xffffe         M   LOCAL, Send the packet to switch local port such
 *                     as bridge/switch virtual interface.
 * 0xfffff         M   NONE, TBD
 */

```

```

/*
 * Protocol Payload Element Format - Port Configuration Flags
 *
 *      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
 *      +-----+-----+-----+-----+
 *      |                                           IPIFIFIDIDISIAI
 *      |                               CU           I I W I L I C I D I T I S I
 *      |                                           I N I D I P I P I T I
 *      +-----+-----+-----+-----+
 *
 * CU (currently unused)
 * Must be zero.

```



```

*
* PIN
*   TBD
*   Indicates please o not send packet-in msgs for port.
*
* FWD
*   TBD
*   Indicates forwarded packets to port will be dropped.
*
* FLD
*   TBD
*   Inidcates please do not include this port when flooding.
*
* DCP
*   TBD
*   Indicates received 802.1D STP packets (BPDU) will be dropped.
*
* DDP
*   TBD
*   Indicates all packets will be dropped except 802.1D spanning tree
*   packets.
*
* STP
*   TBD
*   Indicates IEEE 802.1D spanning tree status will be disabled.
*
* AST
*   TBD
*   Indicates port administratevely status.
*/

```

```
/*
```

```

* Protocol Payload Element Format - Port Status Flags
*

```

```

*      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
*  +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*  |                                         ISISISI                                         IOI
*  |                               CU          IBIFILI          CU          ISI
*  |                                         ILIWINI                                         ITI
*  +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

```

* CU (currently unseud)
*   Must be zero.
*

```

```

* SBL

```

```

*   TBD
*   Not part of spanning tree.
*
*   SFW
*   TBD
*   Learning and relaying frames.
*
*   SLN
*   TBD
*   Learning but not relaying frames.
*
*   CU (currently unseud)
*   Must be zero.
*
*   OST
*   Indicates operational status.
*/

```

```

/*
*   Protocol Payload Element Format - Port Feature Flags
*
*   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
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                                           IPIPIAIFICITIGIGIFIFIEIEI
*   |                               CU           IAIAINIBIPIGIEIEIEITITI
*   |                                           ISIUIGIRIRIFIFIHIFIHIFIH
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*
*   CU (currently unusd)
*   Must be zero.
*
*   PAS
*   TBD
*   Asymmetric pause.
*
*   PAU
*   TBD
*   Pause.
*
*   ANG
*   TBD
*   Auto-negotiation.
*
*   FBR
*   TBD

```

```

*   Fiber medium.
*
*   CPR
*   TBD
*   Copper medium.
*
*   TGF
*   TBD
*   10Gbps full-duplex rate support.
*
*   GEF
*   TBD
*   1Gbps full-duplex rate support.
*
*   GEH
*   TBD
*   1Gbps half-duplex rate support.
*
*   FEF
*   TBD
*   100Mbps full-duplex rate support.
*
*   FEH
*   TBD
*   100Mbps half-duplex rate support.
*
*   ETF
*   TBD
*   10Mbps full-duplex rate support.
*
*   ETH
*   TBD
*   10Mbps half-duplex rate support.
*/

```

```
/*
```

```

*   Protocol Payload Element Format - Output Action Descriptor
*

```

```

*   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
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                                         |                                         |
*   |                                         Type                                         |
*   |                                         |                                         |
*   |                                         Length                                         |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                                         |                                         |
*   |                                         Egress <Port Number>                                         |
*   |                                         |                                         |
*   |                                         Max Length                                         |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*

```

```

*   Type
*   0
*
*   Length
*   8
*
*   Egress Port Number
*   TBD
*   See Payload Element <Port Number>
*
*   Max Length
*   Indicates maximum octets of new flow should send to the controller.
*   Default value is 128.
*/

```

```

/*
*   Protocol Payload Element Format - VLAN VID Action Descriptor
*
*   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
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                                         |                                         |
*   |                                         Type                                         |
*   |                                         |                                         Length                                         |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   | CU | 802.1Q VID |                                         Reserved                                         |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*
*   Type
*   1
*
*   Length
*   8
*
*   CU (currently unused)
*   Must be zero.
*
*   802.1Q VID
*   IEEE 802.1Q VLAN Identifier.
*
*   Reserved
*   Must be zero.
*/

```

```

/*
*   Protocol Payload Element Format - VLAN PCP Action Descriptor
*
*   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
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  |                                         |                                         |
*  |                                         Type                                         |
*  |                                         |                                         |
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  |  CU  | PCP |                                         Reserved                                         |
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*
*
*  Type
*  2
*
*  Length
*  8
*
*  CU (currently unused)
*  Must be zero.
*
*  PCP
*  IEEE 802.1Q PCP (Priority Code Point).
*
*  Reserved
*  Must be zero.
*/

```

```

/*
*  Protocol Payload Element Format - Strip VLAN tag Action Descriptor
*

```

```

*  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
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  |                                         |                                         |
*  |                                         Type                                         |
*  |                                         |                                         |
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*  |                                         Reserved                                         |
*  +-----+-----+-----+-----+-----+-----+-----+-----+
*
*
*  Type
*  3
*
*  Length
*  8
*
*  Reserved
*  Must be zero.
*/

```

```

/*
*  Protocol Payload Element Format - Ethernet Address Action Descriptor

```

```

*
*      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
*      +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*      |                                     |                                     |
*      +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*      |                                     |                                     |
*      +      Ethernet Address              +---+---+---+---+---+---+---+---+
*      |                                     |                                     |
*      +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*      |                                     |                                     |
*      +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*
*      Type
*      4 - 5
*      4  Set Ethernet source address.
*      5  Set Ethernet destination address.
*
*      Length
*      16
*
*      Ethernet Address
*      TBD
*
*      Reserved
*      Must be zero.
*/

```

```

/*
*      Protocol Payload Element - IPv4 Address Action Descriptor
*
*      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
*      +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*      |                                     |                                     |
*      +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*      |                                     |                                     |
*      +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*
*      Type
*      6 - 7
*      6  Set IPv4 source address.
*      7  Set IPv4 destination address.
*
*      Length
*      8

```

```

*
* IPv4 Address
*   TBD
*/

/*
* Protocol Payload Element - IPv4 DSCP Action Descriptor
*
*   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
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                                         |                                         |
*   |                                         Type                                         |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   | IPv4 DSCP |CU |                                         Reserved                                         |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*
*   Type
*   8
*
*   Length
*   8
*
*   IPv4 DSCP (DiffServ Code Point)
*   TBD
*
*   CU (currently unused)
*   Must be zero.
*
*   <IPv4 ToS = IPv4 DSCP + CU>
*
*   Reserved
*   Must be zero.
*/

```

```

/*
* Protocol Payload Element - TCP/UDP Port Action Descriptor
*
*   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
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                                         |                                         |
*   |                                         Type                                         |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                                         Port                                         |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*
*   Type

```

```

*    9 - 10
*    9  Set TCP/UDP source port.
*    10 Set TCP/UDP destination port.
*
* Length
*    8
*
* Port
*    TBD
*
* Reserved
*    Must be zero.
*/

```

```

/*
* Protocol Payload Element - Vendor Action Descriptor
*
*    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
* +-----+-----+-----+-----+-----+-----+-----+-----+
* |                                     |                                     |
* |                                     Type                                     |
* |                                     |                                     Length
* |                                     |                                     |
* |                                     Vendor ID                             |
* |                                     |                                     |
* +-----+-----+-----+-----+-----+-----+-----+-----+
*
* Type
*    65535
*
* Length
*    8
*
* Vendor ID
*    TBD
*    Vendor ID, which takes the same form as in Vendor Message.
*/

```

```

/*
* Protocol Payload Element - Flow Match Descriptor
*
*    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
* +-----+-----+-----+-----+-----+-----+-----+-----+
* |                                     <Flow Wildcard>
* |                                     |
* |                                     |
* | Ingress <Port Number> |
* |                                     |
* +-----+-----+-----+-----+-----+-----+-----+-----+
* |                                     Ethernet Source Address
* |                                     |

```



```

* |
* +-----+
* |
* + Ethernet Destination Address +-----+
* |                               | VD | 802.1Q VID |
* +-----+
* | CU | PCP | Reserved | Ethernet Type/Length |
* +-----+
* | IPv4 Protocol | Reserved |
* +-----+
* | IPv4 Source Address |
* +-----+
* | IPv4 Destination Address |
* +-----+
* | Source Port | Destination Port |
* +-----+
*
* Flow Wildcard
*   See Protocol Payload Element <Flow Wildcard>
*
* Ingress Port Number
*   See Protocol Payload Element <Port Number>
*
* Ethernet Source Address
*   TBD
*
* Ethernet Destination Address
*   TBD
*
* VD (VLAN Designator)
*   0x0 (0000) Indicates IEEE 802.1Q tag exists.
*   0xf (1111) Indicates no IEEE 802.1Q tag exists.
*
* 802.1Q VID
*   IEEE 802.1Q VLAN Identifier.
*
* <VD + 802.1Q VID>
*   0x0000 - 0x0fff Indicates IEEE 802.1Q tag exists.
*   0xffff          Indicates no IEEE 802.1Q tag exists.
*
* CU (currently unused)
*   TBD
*
* 802.1Q PCP
*   IEEE 802.1Q PCP (Priority Code Point).
*

```

```

*   Reserved
*   Must be zero.
*
*   Ethernet Type/Length
*   TBD
*
*   IPv4 Protocol
*   TBD
*
*   Reserved
*   Must be zero.
*
*   IPv4 Source Address
*   TBD
*
*   IPv4 Destination Address
*   TBD
*
*   TCP/UDP Source Port
*   TBD
*
*   TCP/UDP Destination Port
*   TBD
*/

```

```
/*
```

```

*   Protocol Payload Element Format - Flow Wildcard
*
*   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
*   +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*   |                               IPI IPv4 Dst | IPv4 Src |L|L|L|L|L|L|L|L|V|I|I|
*   |                               |C|  Address |  Address |4|4|3|2|2|2|I|N|I|
*   |                               |P|WildcardMsk|WildcardMsk|DIS|IPIPIDISIDIPI|
*   +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
*
*   CU (currently unused)
*   Must be zero.
*
*   PCP
*   TBD
*   IEEE 802.1Q PCP.
*
*   IPv4 Destination Address Wildcard Mask
*   TBD
*   IPv4 destination address wildcard bit count. 0 is exact match,

```

\* 1 ignores the LSB of IPv4 address, 2 ignores the 2 least-significant  
 \* bits, ..., 32 and higher wildcard the entire field. This is the  
 \* \*opposite\* of the usual convention where e.g. /24 indicates that 8

bits

\* (not 24 bits) are wildcarded.  
 \* e.g.,  
 \* Wildcard Mask Address/PfxLen  
 \* 0 255.255.255.255 a.b.c.d/32 (exact match)  
 \* 1 255.255.255.254 a.b.c.d/31  
 \* 2 255.255.255.252 a.b.c.d/30  
 \* 3 255.255.255.248 a.b.c.d/29  
 \* 4 255.255.255.240 a.b.c.d/28  
 \* :  
 \* 8 255.255.255.0 a.b.c.d/24  
 \* :  
 \* 28 240.0.0.0 a.b.c.d/4  
 \* 29 224.0.0.0 a.b.c.d/3  
 \* 30 192.0.0.0 a.b.c.d/2  
 \* 31 128.0.0.0 a.b.c.d/1  
 \* 32 - 63 0.0.0.0 a.b.c.d/0  
 \*

\* IPv4 Source Address Wildcard Mask

\* TBD

\*

\* L4D

\* TBD

\* TCP/UDP destination port.

\*

\* L4S

\* TBD

\* TCP/UDP source port.

\*

\* L3P

\* TBD

\* IPv4 protocol.

\*

\* L2P

\* TBD

\* Ethernet frame type.

\*

\* L2D

\* TBD

\* Ethernet destination address.

\*

\* L2S

\* TBD



```

* | |
* ~ <Flow Match Descriptor> ~
* | |
* +-----+
* | Table ID | Reserved | Egress Port Number |
* +-----+
*
* Flow Match Descriptor
* See Payload Element <Flow Match Descriptor>
*
* Table ID
* TBD
* 0 - 253 Normal Flow Table
* 254 Emergency Flow Table
* 255 All Normal Flow Table
*
* Reserved
* Must be zero.
*
* Egress Port Number
* See Payload Element <Port Numver>
*/

```

```

/*
* Protocol Payload Stats Option Format - Description of Switch
*
* 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
* +-----+
* | |
* ~ Manufacturer Description ~
* | |
* +-----+
* | |
* ~ Hardware Description ~
* | |
* +-----+
* | |
* ~ Software Description ~
* | |
* +-----+
* | Serial Number Description |
* +-----+
*
* Manufacturer Description
* TBD

```

```

*   256 octets
*
*   Hardware Description
*   TBD
*   256 octets
*
*   Software Description
*   TBD
*   256 octets
*
*   Serial Number Description
*   TBD
*/

```

```

/*
*   Protocol Payload Stats Option Format - Individual Flow Stats
*
*   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
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                               Length                               | Table ID | Reserved |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                               <Flow Match Descriptor>                               |
*   ~                               ~
*   |                               |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                               Lifetime Duration                               |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                               Priority                               | Soft Lifetime |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                               Hard Lifetime                               | Reserved |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                               |
*   +                               Number of Packets Transferred                               +
*   |                               |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   |                               |
*   +                               Number of Octets Transferred                               +
*   |                               |
*   +-----+-----+-----+-----+-----+-----+-----+-----+
*   | <Action Descriptors> ...
*   +-----+-----+-----+-----+-----+-----+
*/

```

```

/*
*   Protocol Payload Stats Option Format - Aggregate Flow Stats

```

```

*
*      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
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |
*      +               Number of Packets Transferred               +
*      |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |
*      +               Number of Octets Transferred               +
*      |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |               Number of Flows                             |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |               Reserved                                    |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*/

```

```

/*
* Protocol Payload Stats Option Format - Table Stats
*
*      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
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |  Table ID  |               Reserved               |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |
*      +               +
*      |               |
*      +               Table Description String               +
*      |               |
*      +               +
*      |               |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |               <Flow Wildcard>                     |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |               Maximum Number of Flows Supported     |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |               Number of Flows Installed             |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |               Number of Packets Looked up           |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*      |               Number of Packets Matched             |
*      +-----+-----+-----+-----+-----+-----+-----+-----+
*/

```

```

/*
 * Protocol Payload Stats Option Format - Port Stats
 *
 *      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
 *      +-----+-----+-----+-----+-----+-----+-----+-----+
 *      |                                                                 |
 *      +                  Number of Pakctes Received                  +
 *      |                                                                 |
 *      +-----+-----+-----+-----+-----+-----+-----+-----+
 *      |                                                                 |
 *      +                  Number of Pakctes Transmitted                +
 *      |                                                                 |
 *      +-----+-----+-----+-----+-----+-----+-----+-----+
 *      |                                                                 |
 *      +                  Number of Octets Received                    +
 *      |                                                                 |
 *      +-----+-----+-----+-----+-----+-----+-----+-----+
 *      |                                                                 |
 *      +                  Number of Octets Transmitted                 +
 *      |                                                                 |
 *      +-----+-----+-----+-----+-----+-----+-----+-----+
 *      |                                                                 |
 *      +                  Number of Packets Dropped in Reception        +
 *      |                                                                 |
 *      +-----+-----+-----+-----+-----+-----+-----+-----+
 *      |                                                                 |
 *      +                  Number of Packets Dropped in Transmission     +
 *      |                                                                 |
 *      +-----+-----+-----+-----+-----+-----+-----+-----+
 *      |                                                                 |
 *      +                  Number of Errors in Reception                 +
 *      |                                                                 |
 *      +-----+-----+-----+-----+-----+-----+-----+-----+
 *      |                                                                 |
 *      +                  Number of Errors in Transmission              +
 *      |                                                                 |
 *      +-----+-----+-----+-----+-----+-----+-----+-----+
 *      |                                                                 |
 *      +                  Number of Alignment Errors                    +
 *      |                                                                 |
 *      +-----+-----+-----+-----+-----+-----+-----+-----+
 *      |                                                                 |
 *      +                  Number of Overrun Errors                      +
 *      |                                                                 |
 *      +-----+-----+-----+-----+-----+-----+-----+-----+

```



```
* |
* +
* |
* +-----+
* |
* +
* |
* +-----+
*/
```

Number of CRC Errors

Number of Collision Errors