# 7 FC-BB_E Structure and Concepts

### 7.5a VN_Port MAC addresses

ENodes may support Fabric Provided MAC Addresses (FPMAs) and/or Server Provided MAC Addresses as VN_Port MAC addresses. The FIP protocol is used to negotiate between ENodes and FCFs which kind of VN_Port MAC addresses are used (see 7.7.3.1).

FPMAs are assigned by FCFs while assigning an N_Port_ID to a VN_Port (see 7.7.3.1). A properly formed FPMA is one in which the 24 most significant bits equal the Fabric's FC-MAP value and the least significant 24 bits equal the N_Port_ID assigned to the VN_Port by the FCF. This guarantees that FPMAs are unique within the Fabric. The FC-MAP value is checked by the FIP Discovery protocol (see 7.7.2) to ensure it is consistent across the Fabric.

SPMAs are assigned by ENodes and validated by FCFs. SPMAs should be globally assigned, not locally generated (i.e., they should have the U/L bit set to zero, see IEEE 802.3-2008). SPMAs should be used only for FCoE and FIP traffic, not for other Ethernet protocols.

## 7.7 FC-BB_E device initialization

### 7.7.1 FCoE Initialization Protocol (FIP) overview

The FCoE Initialization Protocol (FIP) is used to perform the functions of FC-BB_E device discovery, initialization, and maintenance. To perform these functions, encapsulated FIP operations (see 7.7.6.2) are specified.

The FIP Ethertype (see 7.7.6.1) is different than the FCoE Ethertype (see 7.6) to enable the distinction of discovery, initialization, and maintenance traffic from other FCoE traffic.

FIP messages are used to perform the following protocols:

a) FIP Discovery (see 7.7.2);
b) FCoE Virtual Link instantiation (see 7.7.3);
c) FCoE Virtual Link maintenance (see 7.7.4); and
d) FIP VLAN Discovery (see 7.7.5).

All FIP protocols are performed on a per-VLAN basis. It is recommended to use the FIP VLAN Discovery protocol on the default VLAN (see IEEE 802.1Q-2005). All other FIP protocols shall be performed in each VLAN that provides FC-BB_E services.

In order to provide FC-BB_E services on a VLAN, FCoE and FIP protocols other than FIP VLAN Discovery shall be both performed on that VLAN. Support for multiple Fabrics per VLAN is outside the scope of this standard.

On ENodes, the ENode MAC address shall be used for all FIP operations. On FCFs, the FCF-MAC address shall be used for all FIP operations.

ENode MACs shall listen to the All-ENode-MACs group address, FCF-MACs shall listen to the All-FCF-MACs group address, and both ENode MACs and FCF-MACs shall listen to the All-FCoE-MACs group address.

### 7.7.2 FIP Discovery protocol

#### 7.7.2.1 ENode/FCF discovery

The FCoE Controller of a VF_Port capable FCF-MAC shall periodically transmit multicast Discovery Advertisements (see 7.7.7.3) to the All-ENode-MACs group address every FKA_ADV_PERIOD. The FKA_ADV_PERIOD period shall be randomized with a random delay uniformly distributed between 0 and 100 ms to avoid large bursts of multicast traffic within the Ethernet network. The FCoE Controller of a VF_Port capable FCF-MAC should begin transmitting Discovery Advertisements on completion of Fabric configuration (see FC-SW-5).

On receiving Discovery Advertisements, the FCoE Controller of an ENode MAC verifies the VN_Port addressing capabilities of the advertising FCF-MAC (i.e., the values of the FP and SP flags, see table 27) against its VN_Port addressing capabilities. The FCoE Controller of an ENode MAC discards incompatible Discovery Advertisements and creates an entry per each compatible FCF-MAC in an internal FCF list, by default ordered on the basis of the value provided in the Priority descriptor in the Discovery Advertisements.

Each entry in the FCF list has the following flags:

a) ‘Max FCoE Size Verified’ - set to zero for entries created from multicast Discovery Advertisements, set to one when a solicited unicast Discovery Advertisement is received; and
b) ‘Available for Login’ - reflects the value of the A bit provided by the most recently received Discovery Advertisement from that VF_Port capable FCF-MAC.

The FCoE Controller of an ENode MAC selects for Login a subset of the FCF-MACs in the FCF list having the ‘Available for Login’ flag set to one (i.e., the FCF Login Set) on the basis of a local policy, by default the one(s) with higher priority (i.e., lower priority value). A FIP FLOGI may be performed with an FCF-MAC in the FCF Login Set only if its ‘Max FCoE Size Verified’ flag is set to one. In order to perform a FIP FLOGI with an FCF-MAC in the FCF Login Set with the ‘Max FCoE Size Verified’ flag set to zero, the FCoE Controller of an ENode MAC shall transmit a unicast Discovery Solicitation (see 7.7.7.2) to that FCF-MAC address and receive a solicited unicast Discovery Advertisement in response.

The periodic reception of unsolicited multicast Discovery Advertisements allows the FCoE Controller of ENode MACs to continuously verify FCF-MAC connectivity. The Available for Login (A) bit in received Discovery Advertisements provides the information that the transmitting FCF-MAC is available for FIP FLOGI/FDISC, and this information is updated in the FCF list and FCF Login Set on reception of Discovery Advertisements. The A bit is informational and shall have no effect on existing logins.

When the FCoE Controller of an ENode MAC becomes operational it should discover VF_Port capable FCF-MACs with which it may perform FIP FLOGI by transmitting a Discovery Solicitation to the All-FCF-MACs group address. In response to a Discovery Solicitation from an ENode MAC, a VF_Port capable FCF-MAC shall transmit a solicited unicast Discovery Advertisement to the soliciting ENode MAC if its VN_Port addressing modes are compatible with the ones of the ENode MAC (see table 27) and if it is configured to allow a FIP FLOGI from that ENode. The solicited unicast Discovery Advertisement shall be transmitted to the MAC address field value specified in the MAC address descriptor in the received Discovery Solicitation. The solicited unicast Discovery Advertisement shall be transmitted within ADV_TOV (see table 47) upon reception of the Discovery Solicitation. Discovery Advertisements transmitted in response to a multicast Discovery Solicitation should be delayed by a random time uniformly distributed between 0 and 100 ms to avoid large bursts of multicast traffic within the Ethernet network. Solicited unicast Discovery Advertisements should not be transmitted until Fabric configuration is completed (see FC-SW-5). Receiving a

solicited unicast Discovery Advertisement from an FCF-MAC sets to one the 'Max FCoE Size Verified' flag in the entry for that FCF-MAC in the FCF Login Set of an ENode MAC.

A Discovery Solicitation shall carry in the Max FCoE Size descriptor the maximum size the ENode MAC intends to use for FCoE traffic (see 7.7.6.3.7). The Encapsulated FIP frame (see table 24) in a solicited unicast Discovery Advertisement shall be padded to the value carried in the Max FCoE Size descriptor of the soliciting Discovery Solicitation (see 7.7.7.3). An ENode MAC that does not receive a solicited unicast Discovery Advertisement in response to a Discovery Solicitation may generate an additional Discovery Solicitation carrying a different Max FCoE Size value.

An FCF may receive a multicast Discovery Solicitation from the same ENode MAC on multiple FCF-MACs. In this case, a separate solicited unicast Discovery Advertisement shall be transmitted by each of the FCF-MACs that received the Discovery Solicitation. The ENode MAC that transmitted the multicast Discovery Solicitation may determine that it received multiple solicited unicast Discovery Advertisements from the same FCF since the value of the Name_Identifer field in the Name_Identifier descriptor is the same in each of the solicited unicast Discovery Advertisements (see 7.7.7.3). In this case the ENode MAC should select the FCF-MAC for Fabric login with that FCF based on the value of the Priority descriptor in the Discovery Advertisements.

#### 7.7.2.2 FCF/FCF discovery

The FCoE Controller of a VE_Port capable FCF-MAC shall periodically transmit multicast Discovery Advertisements (see 7.7.7.3) to the All-FCF-MACs group address every FKA_ADV_PERIOD. The FKA_ADV_PERIOD period shall be randomized with a random delay uniformly distributed between 0 and 100 ms to avoid large bursts of multicast traffic within the Ethernet network.

On receiving Discovery Advertisements, the FCoE Controller of a VE_Port capable FCF-MAC creates an entry per FCF-MAC in an internal FCF list, by default ordered on the basis of the value provided in the Priority descriptor in the Discovery Advertisements.

Each entry in the FCF list has the following flags:

a) 'Max FCoE Size Verified' - set to zero for entries created from multicast Discovery Advertisements, set to one when a solicited unicast Discovery Advertisement is received; and
b) 'Available for ELP' - reflects the value of the A bit provided by the most recently received Discovery Advertisement from that VE_Port capable FCF-MAC.

A FIP ELP may be performed with an FCF-MAC in the FCF list only if its 'Max FCoE Size Verified' flag is set to one. In order to perform a FIP ELP with an FCF-MAC in the FCF list with the 'Max FCoE Size Verified' flag set to zero, the FCoE Controller of a VE_Port capable FCF-MAC shall transmit a unicast Discovery Solicitation (see 7.7.7.2) to that FCF-MAC address and receive a solicited unicast Discovery Advertisement in response.

The periodic reception of unsolicited multicast Discovery Advertisements allow the FCoE Controller of VE_Port capable FCF-MACs to continuously verify the FCF-MACs connectivity. The 'Available for Login' (A) bit in received Discovery Advertisements provides the information that the transmitting FCF-MAC is available for FIP ELP, and this information is updated in the FCF list on reception of Advertisements. The A bit is informational and shall have no effect on existing VE_Port to VE_Port Virtual Links.

When the FCoE Controller for a VE_Port capable FCF-MAC becomes operational it should discover other VE_Port capable FCF-MACs by transmitting a Discovery Solicitation to the All-FCF-MACs group address. In response to a Discovery Solicitation from an FCF-MAC, a VE_Port capable FCF-MAC shall transmit a solicited unicast Discovery Advertisement to the soliciting FCF-MAC if the

FC-MAP value carried in the Solicitation is compatible with the FC-MAP configured on the FCF and if it is configured to allow a Virtual Link with that FCF. The solicited unicast Discovery Advertisement shall be transmitted to the MAC address field value specified in the MAC address descriptor in the received Discovery Solicitation. The solicited unicast Discovery Advertisement shall be transmitted within ADV_TOV (see table 47) upon reception of the Discovery Solicitation. Discovery Advertisements transmitted in response to a multicast Discovery Solicitation should be delayed by a random time uniformly distributed between 0 and 100 ms to avoid large bursts of multicast traffic within the Ethernet network. Receiving a solicited unicast Discovery Advertisement from an FCF-MAC sets to one the 'Max FCoE Size Verified' flag in the entry for that FCF-MAC in the FCF list of the receiving VE_Port capable FCF-MAC.

A Discovery Solicitation shall carry the in the Max FCoE Size descriptor the maximum size the VE_Port capable FCF-MAC intends to use for FCoE traffic (see 7.7.6.3.7). The Encapsulated FIP frame (see table 24) in a solicited unicast Discovery Advertisement shall be padded to the value carried in the Max FCoE Size descriptor of the soliciting Discovery Solicitation. A VE_Port capable FCF-MAC that does not receive a solicited unicast Discovery Advertisement in response to a Discovery Solicitation may generate an additional Discovery Solicitation carrying a different Max FCoE Size value.

An FCF may receive multicast Discovery Solicitations from the same VE_Port capable FCF-MAC on multiple FCF-MACs. In this case, a separate solicited unicast Discovery Advertisement shall be transmitted by each of the FCF-MACs that received the Discovery Solicitation. The VE_Port capable FCF-MAC that transmitted the multicast Discovery Solicitation may determine that it received multiple solicited unicast Discovery Advertisements from the same FCF since the value of the Name_Identifer field in the Name_Identifier descriptor is the same in each of the solicited unicast Discovery Advertisements (see 7.7.7.3).

After receiving a Discovery Solicitation originated by an FCF (i.e., the F bit is set to one), an FCF-MAC shall perform the following verification steps:

a) the Name_Identifier field value in the Discovery Solicitation is different than the Switch_Name of the recipient FCF (see 7.7.7.2.2); and
b) either:
   A) the FP bit is set to one (see 7.7.6.2) and the FC-MAP value in the FC-MAP descriptor in the Discovery Solicitation is the same as the FC-MAP value of the recipient FCF; or
   B) the FP bit is set to zero, the SP bit is set to one (see 7.7.6.2), and the FC-MAP value in the FC-MAP descriptor in the Discovery Solicitation is zero.

If any verification step is false, then the Discovery Solicitation shall be discarded.

After receiving a Discovery Advertisement, an FCF-MAC shall perform the following verification steps:

a) the Name_Identifier field value in the Discovery Advertisement is different than the Switch_Name of the recipient FCF (see 7.7.7.3); and
b) either:
   A) the FP bit is set to one (see 7.7.6.2) and the FC-MAP value in the Fabric descriptor in the Discovery Advertisement is the same as the FC-MAP value of the recipient FCF; or
   B) the FP bit is set to zero, the SP bit is set to one (see 7.7.6.2), and the FC-MAP value in the Fabric descriptor in the Discovery Advertisement is zero.

NOTE 1 – It is possible for an FCF to receive a multicast Discovery Solicitation or a multicast Discovery Advertisement that it originated because messages sent to the All-FCF-MACs group address may be forwarded to other ports on the same FCF by intermediate Ethernet bridges.

### 7.7.3 FCoE Virtual Link instantiation protocol

#### 7.7.3.1 VN_Port to VF_Port Virtual Links

The FCoE Controller of an ENode MAC instantiates VN_Port to VF_Port Virtual Links on successful completion of a FIP Fabric login request. Fabric login (i.e., FLOGI, NPIV FDISC) shall be performed using the FIP frame format (see table 24) and the associated FIP descriptor type (see table 29). Fabric login (i.e., FLOGI, NPIV FDISC) shall not be performed using the FCoE frame format.

In addition to providing Fabric login, the FIP Fabric login provides a method to assign a MAC address for the VN_Port (see 7.7.7.4.2).

When the FCoE Controller of an ENode MAC transmits a FIP FLOGI Request or FIP NPIV FDISC Request it shall indicate the addressing mode it intends to use (i.e., FPMA, SPMA, or both, see table 27). The MAC address returned by the FCF in a FIP FLOGI LS_ACC or FIP NPIV FDISC LS_ACC shall be used as the VN_Port MAC address (see 7.5a).

If the SP bit is set to one in a FIP FLOGI Request or NPIV FDISC Request (see table 27) and the FCF selects to use SPMA, the FCF shall return the MAC address specified in the FIP FLOGI Request or NPIV FDISC Request in the FIP FLOGI LS_ACC or FIP NPIV FDISC LS_ACC.

If the FP bit is set to one in a FIP FLOGI Request or NPIV FDISC Request (see table 27) and the FCF selects to use FPMA, the FCF shall return a properly formed FPMA MAC address in the FIP FLOGI LS_ACC or FIP NPIV FDISC LS_ACC (see 7.5a).

If both the FCF and ENode support both SPMA and FPMA, the FCF may assign an address of either form.

Explicit VN_Port to VF_Port Virtual Link de-instantation is performed by an ENode MAC by performing Fabric logout. Fabric logout (i.e., LOGO) shall be performed by an ENode using the FIP frame format (see table 24) and the associated FIP descriptor type (see table 29). Fabric logout shall not be performed using the FCoE frame format.

In addition to providing Fabric logout, the FIP Fabric logout provides a method to de-assign a MAC address for the VN_Port (see 7.7.7.4.3).

#### 7.7.3.2 VE_Port to VE_Port Virtual Links

The FCoE Controller of a VE_Port capable FCF-MAC instantiates VE_Port to VE_Ports Virtual Links on successful completion of a FIP ELP request. ELP shall be performed using the FIP frame format (see table 24) and the associated FIP descriptor type (see table 29). ELP shall not be performed using the FCoE frame format.

In addition to providing ELP, the FIP ELP provides a method to communicate the MAC address for the VE_Port (see 7.7.7.4.4).

### 7.7.4 FCoE Virtual Link maintenance protocol

#### 7.7.4.1 VN_Port to VF_Port Virtual Links

As shown in figure 27, VN_Port to VF_Port Virtual Links overlay over a Lossless Ethernet network. The Virtual Link maintenance protocol specified in this subclause defines how to deal with faults that may happen in that Lossless Ethernet network.

To deal with local physical layer faults, an ENode MAC shall de-instantiate all its VN_Ports to VF_Port Virtual Links upon detecting that its physical layer is no more operational. This condition shall be handled as an implicit Fabric Logout (see FC-LS-2) for the involved VN_Ports. A VF_Port capable FCF-MAC shall de-instantiate all its VF_Ports upon detecting that its physical layer is no more operational.

To deal with non-local faults, the FCoE Controllers of an ENode MAC and of a VF_Port capable FCF-MAC shall continuously verify the state of the VN_Port to VF_Port Virtual Link by transmitting appropriate FIP messages and by verifying received FIP messages.

The FCoE Controller of an ENode MAC shall transmit a unicast FIP Keep Alive message on behalf of the ENode MAC (i.e., with the ENode MAC address as source MAC address and without a Vx_Port Identification descriptor in the FIP Descriptor list, see table 25) to each VF_Port capable FCF-MAC with which it has VN_Ports logged in. This ENode FIP Keep Alive message shall be transmitted every FKA_ADV_PERIOD. The FKA_ADV_PERIOD is obtained from the Discovery Advertisements received from the VF_Port capable FCF-MACs with which the ENode MAC has VN_Ports logged in. In addition, the ENode MAC FCoE Controller shall transmit a unicast FIP Keep Alive message on behalf of each VN_Port (i.e., with the VN_Port MAC address as source MAC address and containing a Vx_Port Identification descriptor for that VN_Port in the FIP Descriptor list, see table 25) to the VF_Port capable FCF-MAC with which that VN_Port is logged in. This VN_Port FIP Keep Alive message shall be transmitted every FKA_VN_PERIOD.

The FCoE Controller of an ENode MAC shall monitor the status of a VF_Port with which it has VN_Ports logged in by verifying reception of multicast FIP Discovery Advertisements from that VF_Port capable FCF-MAC. Unsolicited multicast Discovery Advertisements are expected to be received every FKA_ADV_PERIOD. If unsolicited multicast Discovery Advertisements are not received within 2,5 * FKA_ADV_PERIOD, all the VN_Port to VF_Port Virtual Links with that VF_Port shall be implicitly de-instantiated. This condition shall be handled as an implicit Fabric Logout (see FC-LS-2) for the involved VN_Ports. That FCF-MAC shall be removed from the FCF Login Set (see 7.7.2.1). A subsequent FIP Fabric Login may be performed with an FCF-MAC in the current FCF Login Set as specified in 7.7.2.1.

The FCoE Controller of a VF_Port capable FCF-MAC shall transmit an unsolicited Discovery Advertisement to the All-ENode-MACs group address every FKA_ADV_PERIOD.

The FCoE Controller of a VF_Port capable FCF-MAC shall monitor the status of an ENode MAC with which it has active Virtual Links by verifying the reception of FIP Keep Alive messages from that ENode MAC and its VN_Ports. VN_Port FIP Keep Alive messages (i.e., those containing a Vx_Port Identification descriptor) are expected to be received every FKA_VN_PERIOD and ENode FIP Keep Alive messages (i.e., those not containing a Vx_Port Identification descriptor) are expected to be received every FKA_ADV_PERIOD.

If VN_Port FIP Keep Alive messages are not received within 2,5 * FKA_VN_PERIOD, the associated VN_Port to VF_Port Virtual Link shall be explicitly de-instantiated (i.e., a FIP Clear Virtual Links message listing the unreachable VN_Port shall be generated). This condition shall be handled as an implicit Fabric Logout (see FC-LS-2) for the involved VN_Port. If ENode FIP Keep Alive messages are not received within 2,5 * FKA_ADV_PERIOD, all associated VN_Port to VF_Port Virtual Links shall be explicitly de-instantiated (i.e., a FIP Clear Virtual Links message listing all the unreachable VN_Ports shall be generated). This condition shall be handled as an implicit Fabric Logout (see FC-LS-2) for the involved VN_Ports.

NOTE 2 – The use of a faster FKA_ADV_PERIOD rate for ENode FIP Keep Alive messages allows fast response times against loss of connectivity in the Ethernet realm with limited overhead. The use of VN_Port FIP

Keep Alive messages transmitted at a slower FKA_VN_PERIOD rate allows the clearing of state associated with each individual VN_Port when that VN_Port becomes not operational.

Explicit VN_Port to VF_Port Virtual Link de-instantation is invoked by a VF_Port capable FCF-MAC by transmitting a FIP Clear Virtual Links message (see 7.7.7.6). A FIP Clear Virtual Links message transmitted to an ENode MAC with logged in VN_Ports provides the list of VN_Ports to be removed. An ENode MAC shall de-instantiate the VN_Ports listed in a FIP Clear Virtual Link message upon reception of the message. This condition shall be handled as an implicit Fabric Logout (see FC-LS-2) for the involved VN_Ports.

The size of a FIP Clear Virtual Links message shall not exceed the standard Ethernet MAC Client Data size (i.e., 1 500 bytes for basic frames and 1 504 bytes for Q-tagged frames, see IEEE 802.3-2008). If the list of VN_Ports to be removed does not fit in a single FIP message, multiple FIP messages may be transmitted.

On receiving a VN_Port FIP Keep Alive message coming from a not logged in VN_Port, the FCoE Controller of a VF_Port capable FCF-MAC shall transmit a FIP Clear Virtual Links message listing that VN_Port.

On receiving an ENode FIP Keep Alive message coming from a not logged in ENode MAC, the FCoE Controller of a VF_Port capable FCF-MAC shall transmit a FIP Clear Virtual Links message listing no VN_Ports. A FIP Clear Virtual Links message listing no VN_Ports shall be handled by an ENode MAC by de-instantiating all VN_Port to VF_Port Virtual Links with that VF_Port capable FCF-MAC. This condition shall be handled as an implicit Fabric Logout (see FC-LS-2) for the involved VN_Ports.

FIP Clear Virtual Links messages may be generated by FCFs whenever appropriate to speed-up faults recovery.

NOTE 3 – As an example, in constrained configurations an FCF may generate a FIP Clear Virtual Links message to de-instantiate the VN_Port to VF_Port Virtual Links affected by a local physical layer fault on other ports upon detection of that fault.

#### 7.7.4.2 VE_Port to VE_Port Virtual Links

As shown in figure 28, VE_Port to VE_Port Virtual Links overlay over a Lossless Ethernet network. The Virtual Link maintenance protocol specified in this subclause defines how to deal with faults that may happen in that Lossless Ethernet network.

To deal with local physical layer faults, a VE_Port capable FCF-MAC shall de-instantiate all its VE_Port to VE_Port Virtual Links upon detecting that its physical layer is no more operational.

To deal with non-local faults, the FCoE Controllers for VE_Port capable FCF-MACs shall continuously verify the state of a VE_Port to VE_Port Virtual Link by transmitting unsolicited multicast FIP Discovery Advertisements and by verifying received unsolicited multicast FIP Discovery Advertisements.

The FCoE Controller for a VE_Port capable FCF-MAC shall transmit a FIP Discovery Advertisement to the All-FCF-MACs group address every FKA_ADV_PERIOD.

The FCoE Controller for a VE_Port capable FCF-MAC shall monitor the status of a VE_Port to VE_Port Virtual Link by verifying the reception of unsolicited multicast FIP Discovery Advertisements. FIP Discovery Advertisements are expected to be received every FKA_ADV_PERIOD. If unsolicited mutlicast Discovery Advertisements are not received within 2,5 * FKA_ADV_PERIOD, the VE_Port to VE_Port Virtual Link associated with that FCF-MAC shall be explicitly de-instantiated along with the associated VE_Port.

Explicit VE_Port to VE_Port Virtual Link de-instantation is performed by transmitting a FIP Clear Virtual Links message from a VE_Port capable FCF-MAC. A FIP Clear Virtual Links message transmitted to a VE_Port capable FCF-MAC provides the destination FCF-MAC address in the Vx_Port Identification descriptor. A VE_Port capable FCF-MAC shall de-instantiate the VE_Port listed in a FIP Clear Virtual Link message upon reception of the message.

### 7.7.5 FIP VLAN Discovery protocol

When becoming operational, an ENode MAC or an FCF-MAC may invoke the FIP VLAN Discovery protocol to discover the VLANs in the Lossless Ethernet network that provide FC-BB_E services.

An ENode MAC may send a FIP VLAN Request message to the MAC address All-FCF-MACs over an available VLAN (e.g., the default VLAN). VF_Port capable FCF-MACs that receive a FIP VLAN Request message shall respond with a unicast FIP VLAN Notification message over the same VLAN. The FIP VLAN Notification message carries the list of VLAN IDs over which the originating FCF offers FC-BB_E services. The ENode MAC that received a FIP VLAN Notification message may enable one or more of these VLANs for subsequent operations.

NOTE 4 – FCFs may limit the number of VLAN IDs listed in a FIP Notification message on a per-requester basis.

A VE_Port capable FCF-MAC may send a FIP VLAN Request message to the MAC address All-FCF-MACs over an available VLAN (e.g., the default VLAN). VE_Port capable FCF-MACs that receive a FIP VLAN Request message shall respond with a unicast FIP VLAN Notification message over the same VLAN. The FIP VLAN Notification message carries the list of VLAN IDs over which the originating FCF offers FC-BB_E services. The VE_Port capable FCF-MAC that received a FIP VLAN Notification message may enable one or more of these VLANs for subsequent operations.

FCF-MACs shall listen to the All-FCF-MACs group address in the default VLAN and in other VLANs that ENodes or FCFs may use to invoke this protocol.

### 7.7.6 FIP messages

#### 7.7.6.1 FIP frame format

Ethernet frames that carry FIP operations shall be formatted in accordance with IEEE 802.3-2008 and the MAC Client Data field within the IEEE 802.3 frame shall contain the encapsulated FIP frame. The use of an IEEE 802.1Q tag header is optional and additional IEEE 802.1 defined tags may be present in the Ethernet frame prior to the encapsulated FIP frame. The format of an encapsulated FIP frame is specified in table 24. An Ethernet frame carrying an encapsulated FIP frame is called a FIP message. See Annex B for examples of FIP messages.

**Table 24 – Encapsulated FIP frame format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = FIP_TYPE | | | | | | | | | | | | | | | | Version | | | | Reserved | | | | | | | | | | | |
| 1 | Encapsulated FIP operation (n words) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| n | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

The Type field in the Ethernet header shall be set to FIP_TYPE (see table 47).

The Version field shall be set to FIP_FRAME_VER (see table 47).

The Encapsulated FIP operation field shall be as specified in 7.7.6.2.

If a FIP message is received with no encapsulated FIP operation, the FIP message shall be discarded.

### 7.7.6.2 Encapsulated FIP operation

The format of the encapsulated FIP operation is specified in table 25.

**Table 25 – Encapsulated FIP operation format**

| Word \ Bit | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | FIP Operation Code | | | | | | | | | | | | | | | | Reserved | | | | | | | | FIP Subcode | | | | | | | |
| 1 | FIP Descriptor List Length | | | | | | | | | | | | | | | | FP | SP | Reserved | | | | | | | | | | | A | S | F |
| 2 | FIP Descriptor List (m words) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| n-1 | FIP_Pad (n-m-2 words) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

The FIP Operation Code and FIP Subcode field values and operations are specified in table 26.

**Table 26 – FIP Operation Code and FIP Subcode field values and protocols**

| FIP Operation Code | FIP Subcode | FIP Protocol Messages | Reference |
|---|---|---|---|
| 0001h | 01h | Discovery Solicitation | 7.7.7.2 |
| | 02h | Discovery Advertisement | 7.7.7.3 |
| 0002h | 01h | Virtual Link Instantiation Request | 7.7.7.4 |
| | 02h | Virtual Link Instantiation Reply | 7.7.7.4 |
| 0003h | 01h | FIP Keep Alive | 7.7.7.5 |
| | 02h | FIP Clear Virtual Links | 7.7.7.6 |
| 0004h | 01h | FIP VLAN Request | 7.7.7.7 |
| | 02h | FIP VLAN Notification | 7.7.7.8 |
| FFF8h .. FFFEh | 00h .. FFh | Vendor Specific | 7.7.7.9 |
| All others | All others | Reserved | |

The FIP Descriptor List Length field shall be set to the length in words of all FIP descriptor(s) that follow.

The Fabric Provided (FP) bit and Server Provided (SP) bit settings are dependent on the FIP operation and shall be set as specified in table 27

**Table 27 – FP bit and SP bit setting**

| Bit | FIP operation | Setting |
|---|---|---|
| FP | Discovery Solicitation[a]<br>Discovery Advertisement[a] | Set to one if originating device supports FPMA.<br>Set to zero if originating device does not support FPMA. |
| | FLOGI Request[b]<br>NPIV FDISC Request[b] | Set to one if FPMA is requested.<br>Set to zero if FPMA is not requested. |
| | FLOGI LS_ACC[c]<br>NPIV FDISC LS_ACC[c] | Set to one if FPMA is granted.<br>Set to zero if FPMA is not granted. |
| | All others | Reserved |
| SP | Discovery Solicitation[a]<br>Discovery Advertisement[a] | Set to one if originating device supports SPMA.<br>Set to zero if originating device does not support SPMA. |
| | FLOGI Request[b]<br>NPIV FDISC Request[b] | Set to one if SPMA is requested.<br>Set to zero if SPMA is not requested. |
| | FLOGI LS_ACC[c]<br>NPIV FDISC LS_ACC[c] | Set to one if SPMA is granted.<br>Set to zero if SPMA is not granted. |
| | All others | Reserved |

[a] Solicitation or Advertisement messages with the FP and SP bits both set to zero should not generated and such messages shall be ignored on reception.

[b] Both the FP bit and SP bit may be set to one in a FLOGI Request or NPIV FDISC Request, but at least one of the bits shall be set to one.

[c] Only one of the FP bit and SP bit shall be set to one in a FLOGI LS_ACC or NPIV FDISC LS_ACC. They shall not have the same value.

The Solicited (S) bit shall be set to one in solicited unicast Discovery Advertisements (i.e., Discovery Advertisements transmitted in response to a Discovery Solicitation). The S bit shall be set to zero in unsolicited multicast Discovery Advertisements (i.e., Discovery Advertisements not transmitted in response to a Discovery Solicitation). The S bit is reserved for all other FIP operations.

The FCF (F) bit shall be set to one in a Discovery Solicitation or Discovery Advertisement or in a FIP VLAN Request if the originating device is an FCF. The F bit shall be set to zero in a Discovery Solicitation or Discovery Advertisement or in a FIP VLAN Request if the originating device is not an FCF. The F bit is reserved for all other FIP operations.

The Available for Login (A) bit shall be set to one in a Discovery Advertisement if the originating FCF is available to process FIP FLOGI, FIP NPIV FDISC, or FIP ELP Requests (see 7.7.2). The A bit shall be set to zero in a Discovery Advertisement if the originating FCF is not available to process FIP FLOGI, FIP NPIV FDISC, or FIP ELP Requests. The A bit is reserved for all other FIP operations.

The FIP Descriptor(s) field contains one or more FIP descriptors (see 7.7.6.3).

The FIP_Pad field shall be used in solicited unicast Discovery Advertisements to extend the Encapsulated FIP frame (see table 24) to have a length that matches the Max_FCoE_Size field value in the

Max FCoE Size descriptor in the Discovery Solicitation to which the Discovery Advertisement is responding (see 7.7.7.3). The FIP_Pad field shall be of zero length (i.e., not present) for all other FIP operations.

#### 7.7.6.3 FIP descriptors

##### 7.7.6.3.1 FIP descriptor overview

FIP descriptors are specified using a TLV format (i.e., Type, Length, Value). The length field value shall be specified as the number of words in the FIP descriptor including the TLV format. FIP descriptor type values are split into two ranges, critical and non-critical, as specified in table 28.

**Table 28 – FIP descriptor type value ranges**

| Range | Value | Description |
|---|---|---|
| Critical | 0 .. 127 | An FCoE Controller that receives a FIP message with an unknown critical descriptor shall discard the FIP message. |
| Non-critical | 128 .. 255 | An FCoE Controller that receives a FIP message with one or more unknown non-critical descriptors shall ignore the unknown descriptors and continue to process the FIP message. |

The FIP descriptor types are specified in table 29.

**Table 29 – FIP descriptor types**

| Range | Type | FIP Descriptor | Reference |
|---|---|---|---|
| Critical | 0 | Reserved | |
| | 1 | Priority | 7.7.6.3.2 |
| | 2 | MAC address | 7.7.6.3.3 |
| | 3 | FC-MAP | 7.7.6.3.4 |
| | 4 | Name_Identifier | 7.7.6.3.5 |
| | 5 | Fabric | 7.7.6.3.6 |
| | 6 | Max FCoE Size | 7.7.6.3.7 |
| | 7 | FLOGI[a] | 7.7.6.3.8 |
| | 8 | NPIV FDISC[a] | 7.7.6.3.9 |
| | 9 | LOGO[a] | 7.7.6.3.10 |
| | 10 | ELP[a] | 7.7.6.3.11 |
| | 11 | Vx_Port Identification | 7.7.6.3.12 |
| | 12 | FKA_ADV_Period | 7.7.6.3.13 |
| | 13 | Vendor_ID | 7.7.6.3.14 |
| | 14 | VLAN | 7.7.6.3.15 |
| | 15 .. 127 | Reserved | |
| Non-critical | 128 .. 240 | Reserved | |
| | 241 .. 254 | Vendor Specific | 7.7.6.3.16 |
| | 255 | Reserved | |

a The FC CRC, SOF, and EOF shall not be included in the FIP descriptor.

#### 7.7.6.3.2 FIP Priority descriptor

The FIP Priority descriptor is used in FIP operations as shown in table 45. An ENode may use the value provided in the Priority descriptor of received Discovery Advertisements to select the FCF-MAC to which to perform FIP FLOGI. The default value for the Priority field is DEFAULT_FIP_PRIORITY (see table 47). The highest priority value is 0 and the lowest priority value is 255 (i.e., lower numerical values indicate higher priorities).

The FIP Priority descriptor format shall be as specified in table 30.

**Table 30 – FIP Priority descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 01h | | | | | | | | Length = 01h | | | | | | | | Reserved | | | | | | | | Priority | | | | | | | |

**Priority:** the Priority value associated with the sending FCF-MAC.

#### 7.7.6.3.3 FIP MAC address descriptor

The FIP MAC address descriptor is used in FIP operations as shown in table 45.

The FIP MAC address descriptor format shall be as specified in table 31.

**Table 31 – FIP MAC address descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 02h | | | | | | | | Length = 02h | | | | | | | | MSB | | | | | | | | | | | | | | | |
| 1 | MAC address | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | LSB | |

**MAC address:** the MAC address carried in the descriptor.

#### 7.7.6.3.4 FIP FC-MAP descriptor

The FIP FC-MAP descriptor is used in FIP operations as shown in table 45.

The FIP FC-MAP descriptor format shall be as specified in table 32.

**Table 32 – FIP FC-MAP descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 03h | | | | | | | | Length = 02h | | | | | | | | Reserved | | | | | | | | | | | | | | | |
| 1 | Reserved | | | | | | | | MSB | | | | | | | | FC-MAP | | | | | | | | | | | | | | LSB | |

**FC-MAP:** the value to be used as the most significant 24 bits in FPMAs (see 7.5a).

#### 7.7.6.3.5 FIP Name_Identifier descriptor

The FIP Name_Identifier descriptor is used in FIP operations as shown in table 45.

The FIP Name_Identifier descriptor format shall be as specified in table 33.

**Table 33 – FIP Name_Identifier descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 04h | | | | | | | | Length = 03h | | | | | | | | Reserved | | | | | | | | | | | | | | | |
| 1 | MSB | | | | | | | | Name_Identifier | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | LSB | |

**Name_Identifier:** the Name_Identifier (see FC-FS-3) carried in the descriptor.

#### 7.7.6.3.6 FIP Fabric descriptor

The FIP Fabric descriptor is used in FIP operations as shown in table 45.

The FIP Fabric descriptor format shall be as specified in table 34.

**Table 34 – FIP Fabric descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 05h | | | | | | | | Length = 04h | | | | | | | | VF_ID | | | | | | | | | | | | | | | |
| 1 | Reserved | | | | | | | | MSB | | | | | | | | FC-MAP | | | | | | | | | | | | | | LSB | |
| 2 | MSB | | | | | | | | Fabric_Name | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | LSB | |

**VF_ID:** the VF_ID (see FC-FS-3) associated with the Fabric, if any.

**FC-MAP:** the value to be used as the most significant 24 bits in FPMAs (see 7.5a).

**Fabric_Name:** the Fabric_Name (see FC-FS-3) identifying the Fabric.

#### 7.7.6.3.7 FIP Max FCoE Size descriptor

The FIP Max FCoE Size descriptor is used in FIP operations as shown in table 45.

The FIP Max FCoE Size descriptor format shall be as specified in table 35.

**Table 35 – FIP Max FCoE Size descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 06h | | | | | | | | Length = 01h | | | | | | | | Max_FCoE_Size | | | | | | | | | | | | | | | |

**Max_FCoE_Size:** the size in bytes to which the Encapsulated FIP frame (see table 24) in a solicited unicast Discovery Advertisement is requested to be padded.

#### 7.7.6.3.8 FIP FLOGI descriptor

The FIP FLOGI descriptor is used in FIP operations as shown in table 45.

The FIP FLOGI descriptor format shall be as specified in table 36.

**Table 36 – FIP FLOGI descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 07h | | | | | | | | Length | | | | | | | | Reserved | | | | | | | | | | | | | | | |
| 1 | MSB | | | | | | | | FLOGI Request or FLOGI LS_ACC/LS_RJT | | | | | | | | | | | | | | | | | | | | | | | |
| n | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | LSB | |

**Length:** shall be set to 36 for a FLOGI Request and a FLOGI LS_ACC, or to 9 for a FLOGI LS_RJT.

**FLOGI Request or FLOGI LS_ACC/LS_RJT:** an encapsulated FLOGI Request, FLOGI LS_ACC, or FLOGI LS_RJT shall be a complete Fibre Channel frame with a Fibre Channel Frame_Header and an ELS payload but without the CRC field. In an FLOGI Request or FLOGI LS_ACC, the Payload bit shall be set to zero (see FC-LS-2).

#### 7.7.6.3.9 FIP NPIV FDISC descriptor

The FIP NPIV FDISC descriptor is used in FIP operations as shown in table 45.

The FIP NPIV FDISC descriptor format shall be as specified in table 37.

**Table 37 – FIP NPIV FDISC descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 08h | | | | | | | | Length | | | | | | | | Reserved | | | | | | | | | | | | | | | |
| 1 | MSB | | | | | | | | NPIV FDISC Request or NPIV FDISC LS_ACC/LS_RJT | | | | | | | | | | | | | | | | | | | | | | | |
| n | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | LSB | |

**Length:** shall be set to 36 for an FDISC Request and FDISC LS_ACC, or to 9 for an FDISC LS_RJT.

**NPIV FDISC Request or NPIV FDISC LS_ACC/LS_RJT:** an encapsulated FDISC Request, FDISC LS_ACC, or FLOGI LS_RJT shall be a complete Fibre Channel frame with a Fibre Channel Frame_Header and an ELS payload but without the CRC field. In an FLOGI Request or FLOGI LS_ACC, the Payload bit shall be set to zero (see FC-LS-2).

#### 7.7.6.3.10 FIP LOGO descriptor

The FIP LOGO descriptor is used in FIP operations as shown in table 45.

The FIP LOGO descriptor format shall be as specified in table 38.

**Table 38 – FIP LOGO descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 09h | | | | | | | | Length | | | | | | | | Reserved | | | | | | | | | | | | | | | |
| 1 | MSB | | | | | | | | LOGO Request or LOGO LS_ACC/LS_RJT | | | | | | | | | | | | | | | | | | | | | | | |
| n | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | LSB | |

**Length:** shall be set to 11 for a LOGO Request, 8 for a LOGO LS_ACC, or to 9 for a LOGO LS_RJT.

**LOGO Request or LOGO LS_ACC/LS_RJT:** an encapsulated LOGO Request, LOGO LS_ACC, or LOGO LS_RJT shall be a complete Fibre Channel frame with a Fibre Channel Frame_Header and an ELS payload but without the CRC field (see FC-LS-2).

#### 7.7.6.3.11 FIP ELP descriptor

The FIP ELP descriptor is used in FIP operations as shown in table 45.

The FIP ELP descriptor format shall be as specified in table 39.

**Table 39 – FIP ELP descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 0Ah | | | | | | | | Length | | | | | | | | Reserved | | | | | | | | | | | | | | | |
| 1 | MSB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| n | ELP Request or ELP SW_ACC/SW_RJT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | LSB | |

**Length:** shall be set to 33 for an ELP Request and ELP SW_ACC, or to 9 for an ELP SW_RJT.

**ELP Request or ELP SW_ACC/SW_RJT:** an encapsulated ELP Request, ELP SW_ACC, or ELP SW_RJT shall be a complete Fibre Channel frame with a Fibre Channel Frame_Header and an SW_ILS payload but without the CRC field (see FC-SW-5).

#### 7.7.6.3.12 FIP Vx_Port Identification descriptor

The FIP Vx_Port Identification descriptor is used in FIP operations as shown in table 45.

The FIP Vx_Port Identification descriptor format shall be as specified in table 40.

**Table 40 – FIP Vx_Port Identification descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 0Bh | | | | | | | | Length = 05h | | | | | | | | MSB | | | | | | | | | | | | | | | |
| 1 | MAC address | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | LSB | |
| 2 | Reserved | | | | | | | | MSB | | | | | | | | Address Identifier | | | | | | | | | | | | | | LSB | |
| 3 | MSB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Port_Name | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | LSB | |

**MAC address: t**he MAC address associated with the referred VN_Port or VE_Port.

**Address Identifier:** the address identifier associated with the referred VN_Port or the value FFFFFDh for a VE_Port.

**Port_Name:** the N_Port_Name of the referred VN_Port or the E_Port_Name of the referred VE_Port.

#### 7.7.6.3.13 FIP FKA_ADV_Period descriptor

The FIP FKA_ADV_Period descriptor is used in FIP operations as shown in table 45.

The FIP FKA_ADV_Period descriptor format shall be as specified in table 41.

**Table 41 – FIP FKA_ADV_Period descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 0Ch | | | | | | | | Length = 02h | | | | | | | | Reserved | | | | | | | | | | | | | | | |
| 1 | FKA_ADV_PERIOD | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**FKA_ADV_PERIOD:** the value of the advertised FKA_ADV_PERIOD (see table 47).

#### 7.7.6.3.14 FIP Vendor_ID descriptor

The FIP Vendor_ID descriptor is used in FIP operations as shown in table 45.

The FIP Vendor_ID descriptor format shall be as specified in table 42.

**Table 42 – FIP Vendor_ID descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 0Dh | | | | | | | | Length = 03h | | | | | | | | Reserved | | | | | | | | | | | | | | | |
| 1 | MSB | | | | | | | | Vendor_ID | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | LSB | |

**Vendor_ID:** the vendor's Vendor_ID value.

#### 7.7.6.3.15 FIP VLAN descriptor

The FIP VLAN descriptor is used in FIP operations as shown in table 45.

The FIP VLAN descriptor format shall be as specified in table 43.

**Table 43 – FIP VLAN descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type = 0Eh | | | | | | | | Length = 01h | | | | | | | | Reserved | | | | FCoE VID | | | | | | | | | | | |

**FCoE VID:** the VLAN ID of a VLAN where FCoE services may be available.

#### 7.7.6.3.16 FIP Vendor Specific descriptors

FIP Vendor Specific descriptors are non-critical and may be used in any FIP message. An FC-BB_E device shall not require use of any FIP Vendor Specific descriptor in order to operate in accordance with this standard.

The FIP Vendor Specific descriptor format shall be as specified in table 44.

**Table 44 – FIP Vendor Specific descriptor format**

| Bit / Word | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Type | | | | | | | | Length | | | | | | | | Reserved | | | | | | | | | | | | | | | |
| 1 | MSB | | | | | | | | Vendor_ID | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | LSB | |
| 3 | MSB | | | | | | | | Vendor Specific Information | | | | | | | | | | | | | | | | | | | | | | | |
| n | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | LSB | |

**Type:** the FIP Vendor Specific descriptors are identified by a type value in the range 241 .. 254, inclusive.

**Length:** shall be set to the length in words of the descriptor.

**Vendor_ID:** the vendor's Vendor_ID value.

**Vendor Specific Information:** defined by the vendor.

### 7.7.7 FIP operations

#### 7.7.7.1 FIP operations overview

Table 45 specifies the FIP descriptors required in each FIP operation and the recommended order in which they should be encapsulated by a transmitting FCoE Controller. In certain cases, as indicated, strict ordering is required. Additional descriptors (e.g., FIP Vendor Specific descriptors) may be present. A receiving FCoE Controller shall process unknown descriptors according to the criticality of the FIP descriptor (see 7.7.6.3.1). Unless otherwise specified (e.g., for a FIP FLOGI Request), a receiving FCoE Controller shall be able to process the FIP descriptors in any order.

NOTE 5 – The ability to process FIP descriptors in any order is to provide flexibility for future protocol extensions,

A FIP operation shall contain the expected critical descriptors and may contain additional non-critical descriptors. If some critical descriptors are missing or unexpected, the FIP operation shall be discarded and it should be reported in a vendor specific way.

**Table 45 – FIP operation descriptors and order**

| FIP Operation | Originator | Descriptors and order |
|---|---|---|
| Discovery Solicitation (see 7.7.7.2.1) | ENode | 1) MAC address<br>2) Name_Identifier<br>3) Max FCoE Size |
| Discovery Solicitation (see 7.7.7.2.2) | FCF | 1) MAC address<br>2) FC-MAP<br>3) Name_Identifier<br>4) Max FCoE Size |
| Discovery Advertisement (see 7.7.7.2) | FCF | 1) Priority<br>2) MAC address<br>3) Name_Identifier<br>4) Fabric<br>5) FKA_ADV_Period |
| FIP FLOGI Request[a] (see 7.7.7.4.2) | ENode | 1) FLOGI<br>2) MAC address |
| FIP FLOGI LS_ACC[a] (see 7.7.7.4.2) | FCF | 1) FLOGI<br>2) MAC address |
| FIP FLOGI LS_RJT[a] (see 7.7.7.4.2) | FCF | 1) FLOGI |
| FIP NPIV FDISC Request[a] (see 7.7.7.4.2) | ENode | 1) NPIV FDISC<br>2) MAC address |
| FIP NPIV FDISC LS_ACC[a] (see 7.7.7.4.2) | FCF | 1) NPIV FDISC<br>2) MAC address |
| FIP NPIV FDISC LS_RJT[a] (see 7.7.7.4.2) | FCF | 1) NPIV FDISC |
| FIP Fabric LOGO[a] (see 7.7.7.4.3) | ENode[b] | 1) LOGO<br>2) MAC address |

[a] Strict ordering of the FIP descriptors is required in transmission. A receiving FCoE controller is not required to be able to process these FIP operations in any order other than that specified here.

[b] FCFs are allowed to generate FIP LOGO, however a FIP Clear Virtual Link is the recommended way for an FCF to de-instantiate a Virtual Link, except for the specific cases where LOGO is required (see FC-SP).

[c] The Vx_Port Identification descriptor is present only in VN_Port FIP Keep Alive operations, it is not present in ENode FIP Keep Alive operations.

[d] A FIP Clear Virtual Links operation intended to de-instantiate VN_Port to VF_Port Virtual Links contains zero or more Vx_Port Identification descriptors. A FIP Clear Virtual Links operation intended to de-instantiate a VE_Port to VE_Port Virtual Link contains one Vx_Port Identification descriptor.

**Table 45 – FIP operation descriptors and order (Continued)**

| FIP Operation | Originator | Descriptors and order |
|---|---|---|
| FIP Fabric LOGO LS_ACC[a] (see 7.7.7.4.3) | FCF[b] | 1) LOGO<br>2) MAC address |
| FIP Fabric LOGO LS_RJT[a] (see 7.7.7.4.3) | FCF[b] | 1) LOGO |
| FIP ELP Request[a] (see 7.7.7.4.4) | FCF | 1) ELP<br>2) MAC address |
| FIP ELP SW_ACC[a] (see 7.7.7.4.4) | FCF | 1) ELP<br>2) MAC address |
| FIP ELP SW_RJT[a] (see 7.7.7.4.4) | FCF | 1) ELP |
| FIP Keep Alive (see 7.7.7.5) | ENode | 1) MAC address<br>2) Vx_Port Identification[c] |
| FIP Clear Virtual Links (see 7.7.7.6) | FCF | 1) MAC address<br>2) Name_Identifier<br>3) Vx_Port Identification(s)[d] |
| FIP VLAN Request (see 7.7.7.7) | ENode or FCF | 1) MAC address |
| FIP VLAN Notification (see 7.7.7.8) | FCF | 1) MAC address<br>2) VLAN(s) |
| FIP Vendor Specific (see 7.7.7.9) | ENode or FCF | 1) Vendor_ID<br>2) Descriptor(s) |

[a] Strict ordering of the FIP descriptors is required in transmission. A receiving FCoE controller is not required to be able to process these FIP operations in any order other than that specified here.

[b] FCFs are allowed to generate FIP LOGO, however a FIP Clear Virtual Link is the recommended way for an FCF to de-instantiate a Virtual Link, except for the specific cases where LOGO is required (see FC-SP).

[c] The Vx_Port Identification descriptor is present only in VN_Port FIP Keep Alive operations, it is not present in ENode FIP Keep Alive operations.

[d] A FIP Clear Virtual Links operation intended to de-instantiate VN_Port to VF_Port Virtual Links contains zero or more Vx_Port Identification descriptors. A FIP Clear Virtual Links operation intended to de-instantiate a VE_Port to VE_Port Virtual Link contains one Vx_Port Identification descriptor.

### 7.7.7.2 FIP Discovery Solicitation

#### 7.7.7.2.1 ENode FIP Discovery Solicitation

As shown in table 45, a Discovery Solicitation operation originated by the FCoE Controller of an ENode MAC contains a MAC address descriptor (see 7.7.6.3.3), a Name_Identifier descriptor (see 7.7.6.3.5) and a Max FCoE Size descriptor (see 7.7.6.3.7).

A Discovery Solicitation message may be unicast (i.e., addressed to a specific FCF-MAC) or multicast (i.e., addressed to the All-FCF-MACs group address).

The MAC address field in the MAC address descriptor shall be set to the MAC address to use for subsequent solicited Discovery Advertisements from VF_Port capable FCF-MACs.

The Name_Identifier field in the Name_Identifier descriptor shall be set to the Node_Name of the ENode or to zero.

NOTE 6 – The Name_Identifer field may be set to zero if the Node_Name is ambiguous or not yet available when the Solicitation is sent.

The Max_FCoE_Size field in the Max FCoE Size descriptor shall be set to the maximum size the ENode MAC intends to use for FCoE traffic. The Max_FCoE_Size value shall be specified as the number of octets starting with and including the Version field, up to and including the Reserved field following the EOF field (see table 21).

#### 7.7.7.2.2 FCF FIP Discovery Solicitation

As shown in table 45, a Discovery Solicitation operation originated by the FCoE Controller of a VE_Port capable FCF-MAC contains a MAC address descriptor (see 7.7.6.3.3), an FC-MAP descriptor (see 7.7.6.3.4), a Name_Identifier descriptor (see 7.7.6.3.5), and a Max FCoE Size descriptor (see 7.7.6.3.7).

A Discovery Solicitation message may be unicast (i.e., addressed to a specific FCF-MAC) or multicast (i.e., addressed to the All-FCF-MACs group address).

The MAC address field in the MAC address descriptor shall be set to the MAC address to use for subsequent solicited Discovery Advertisements from VE_Port capable FCF-MACs.

For FCF-MACs that support FPMA, the FC-MAP field in the FC-MAP descriptor shall be set to the FC-MAP value the FCF-MAC is using. If the FC-MAP value is not administratively configured, then the FC-MAP value shall be set to DEFAULT_FC-MAP (see table 47).

For FCF-MACs that only support SPMA, the FC-MAP field in the FC-MAP descriptor shall be set to zero.

The Name_Identifier field in the Name_Identifier descriptor shall be set to the Switch_Name of the FCF.

The Max_FCoE_Size field in the Max FCoE Size descriptor shall be set to the maximum size the VE_Port capable FCF-MAC intends to use for FCoE traffic. The Max_FCoE_Size value shall be specified as the number of octets starting with and including the Version field, up to and including the Reserved field following the EOF field (see table 21).

### 7.7.7.3 FIP Discovery Advertisements

As shown in table 45, a Discovery Advertisement operation contains a Priority descriptor (see 7.7.6.3.2), a MAC address descriptor (see 7.7.6.3.3), a Name_Identifier descriptor (see 7.7.6.3.5), a Fabric descriptor (see 7.7.6.3.6), and a FKA_ADV_Period descriptor (see 7.7.6.3.13).

When a Discovery Advertisement message is solicited, it shall be unicast (i.e., addressed to a specific ENode MAC or FCF-MAC address). When a Discovery Advertisement message is unsolicited, it shall be multicast (i.e., addressed to the All-ENode-MACs or to the All-FCF-MACs group addresses).

The Priority field in the Priority descriptor shall be set to the value the originating FCF-MAC is using. If the priority value is not administratively configured, then the priority value shall be set to DEFAULT_FIP_PRIORITY (see table 47).

The MAC address field in the MAC address descriptor shall be set to the originating FCF-MAC address.

The Name_Identifier field in the Name_Identifier descriptor shall be set to the Switch_Name of the originating FCF.

Discovery Advertisements shall only provide a single Fabric descriptor. All Discovery Advertisements from an FCF in a certain VLAN shall provide the same single Fabric descriptor. The VF_ID field in the Fabric descriptor shall be set to the VF_ID (see FC-FS-3) identifying the advertised FC Fabric. If a VF_ID is not defined for the advertised FC Fabric, the VF_ID field shall be set to zero. For FCFs that support FPMA, the FC-MAP field in the Fabric descriptor shall be set to the FC-MAP value the FCF is using. If the FC-MAP value is not administratively configured, then the FC-MAP value shall be set to DEFAULT_FC-MAP (see table 47). For FCFs that only support SPMA, the FC-MAP field in the Fabric descriptor shall be set to zero. The Fabric_Name field in the Fabric descriptor shall be set to the Fabric_Name for the originating FCF.

The FKA_ADV_PERIOD field in the FKA_ADV_Period descriptor shall be set to the FKA_ADV_PERIOD value the FCF is advertising (see table 47).

The FIP_Pad field shall be used to extend the Encapsulated FIP frame (see table 24) to have a length that matches the Max_FCoE_Size field value in the Max FCoE Size descriptor in the Discovery Solicitation to which the Discovery Advertisement is responding. The FIP_Pad field value shall be set to zero and not checked in reception. For an unsolicited Discovery Advertisement, the FIP_Pad field shall be of zero length (i.e., not present).

#### 7.7.7.4 FIP Virtual Link Instantiation Requests and Replies

##### 7.7.7.4.1 FIP Virtual Link Instantiation Requests and Replies overview

FIP Virtual Link Instantiation Requests and Replies encapsulates an ELS or an SW_ILS. The encapsulated ELS or SW_ILS shall be a single-frame Sequence. FIP Virtual Link Instantiation Requests and Replies have a FIP operation code of 0002h (see table 26) and are used to perform:

a) Fabric login between ENode MACs and VF_Port capable FCF-MACs (see 7.7.7.4.2);
b) Fabric logout between ENode MACs and VF_Port capable FCF-MACs (see 7.7.7.4.3);
c) Exchange Link Parameters between VE_Port capable FCF-MACs (see 7.7.7.4.4).

##### 7.7.7.4.2 Fabric login

As shown in table 45:

a) a FIP FLOGI Request operation contains a FLOGI descriptor (see 7.7.6.3.8) and a MAC address descriptor (see 7.7.6.3.3);
b) a FIP FLOGI LS_ACC operation contains a FLOGI descriptor (see 7.7.6.3.8) and a MAC address descriptor (see 7.7.6.3.3); and
c) a FIP FLOGI LS_RJT operation contains a FLOGI descriptor (see 7.7.6.3.8).

As shown in table 45:

a) a FIP NPIV FDISC Request operation contains a NPIV FDISC descriptor (see 7.7.6.3.9) and a MAC address descriptor (see 7.7.6.3.3);
b) a FIP NPIV FDISC LS_ACC operation contains a NPIV FDISC descriptor (see 7.7.6.3.9) and a MAC address descriptor (see 7.7.6.3.3); and
c) a FIP NPIV FDISC LS_RJT operation contains a NPIV FDISC descriptor (see 7.7.6.3.9).

The FLOGI or NPIV FDISC descriptor shall be the first descriptor in the operation.

NOTE 7 – In this way the encapsulated Fibre Channel ELS results at an offset in the FIP frame equal to the offset it would have if it was encapsulated in a FCoE frame.

The FIP Subcode field (see 7.7.6.2) shall be set to:

a) 01h for FIP FLOGI Request and FIP NPIV FDISC Request operations;
b) 02h for FIP FLOGI LS_ACC and FIP NPIV FDISC LS_ACC operations; and
c) 02h for FIP FLOGI LS_RJT and FIP NPIV FDISC LS_RJT operations.

The FLOGI or NPIV FDISC descriptor shall contain:

a) a complete Fibre Channel frame with a Fibre Channel Frame_Header (see FC-FS-3) and an FLOGI Request payload or an NPIV FDISC Request payload (see FC-LS-2) but without the CRC field (see FC-FS-3) for FIP FLOGI Request or NPIV FDISC Request operations. The Payload bit in the FLOGI Request payload or NPIV FDISC Request payload shall be set to zero (see FC-LS-2);
b) a complete Fibre Channel frame with a Fibre Channel Frame_Header (see FC-FS-3) and an FLOGI LS_ACC payload or an NPIV FDISC LS_ACC payload (see FC-LS-2) but without the CRC field (see FC-FS-3) for FIP FLOGI LS_ACC or FIP NPIV FDISC LS_ACC operations. The Payload bit in the FLOGI LS_ACC payload shall be set to zero (see FC-LS-2); and
c) a complete Fibre Channel frame with a Fibre Channel Frame_Header (see FC-FS-3) and an FLOGI LS_RJT payload or an NPIV FDISC LS_RJT payload (see FC-LS-2) but without the CRC field (see FC-FS-3) for FIP FLOGI LS_RJT or FIP NPIV FDISC LS_RJT operations.

The MAC address field in the MAC address descriptor of a FIP FLOGI Request operation or a FIP NPIV FDISC Request operation shall contain:

a) the proposed MAC address to use as VN_Port MAC address if the ENode is requesting to use SPMA (see table 27);
b) all zeroes to indicate no MAC address is proposed if the ENode is requesting to use FPMA (see table 27);
c) the proposed MAC address to use as VN_Port MAC address if the ENode supports both SPMA and FPMA and leaves the decision of which addressing scheme to use to the FCF (i.e., if both the FP and SP bits are set to one, see table 27).

The MAC address field in the MAC address descriptor of a FIP FLOGI LS_ACC operation or a FIP NPIV FDISC LS_ACC operation shall contain the MAC address that the FCF granted for use as VN_Port MAC address. The FP and SP bits shall be set as shown in table 27. If the FCF granted an SPMA, the granted MAC address shall be the same as the one carried in the MAC address descriptor of the corresponding FIP FLOGI Request operation or FIP NPIV FDISC Request operation. If the FCF granted an FPMA, the granted MAC address shall be a properly formed FPMA (see 7.5a).

A successful FIP FLOGI operation instantiates a VF_Port, a VN_Port, and a Virtual Link between them. Subsequent FIP NPIV FDISC operations from the same ENode MAC Address as the FIP FLO-

GI operation associate additional VN_Ports to the same VF_Port that was instantiated by the FIP FLOGI operation.

FCFs shall reject FIP FLOGI Requests and NPIV FDISC Requests with the SP bit set to one and the FP bit set to zero when the MAC address descriptor contains a MAC address that is not a unicast address. In addition, FCFs shall reject FIP FLOGI Requests and NPIV FDISC Requests for an addressing mode (i.e., SPMA or FPMA) not supported by the FCF. If the FCF supports both FPMA and SPMA, the FCF shall reject FIP FLOGI and NPIV FDISC Requests with the SP bit set to one and the FP bit set to zero when the MAC address descriptor contains a MAC address in which the 24 most significant bits match the FC-MAP in use by the FCF. Rejections of FIP FLOGI Requests and NPIV FDISC Requests are handled with the LS_RJT Reason Codes and Reason Code Explanations shown in table 46.

**Table 46 – FIP Fabric Login Rejections**

| Error Condition | Reason Code (see FC-LS-2) | Reason Code Explanation (see FC-LS-2) |
|---|---|---|
| The MAC addressing mode in the FIP FLOGI/FDISC Request is not supported | FIP Error (i.e., 20h) | MAC addressing mode not supported (i.e., 60h) |
| The MAC address proposed in the MAC address descriptor of a FIP FLOGI/FDISC Request is incorrect for the requested addressing mode | FIP Error (i.e., 20h) | Proposed MAC address incorrectly formed (i.e., 61h) |

#### 7.7.7.4.3 Fabric logout

As shown in table 45:

a) a FIP Fabric LOGO Request operation contains a LOGO descriptor (see 7.7.6.3.10) and a MAC address descriptor (see 7.7.6.3.3);
b) a FIP Fabric LOGO LS_ACC operation contains a LOGO descriptor (see 7.7.6.3.10) and a MAC address descriptor (see 7.7.6.3.3); and
c) a FIP Fabric LOGO LS_RJT operation contains a LOGO descriptor (see 7.7.6.3.10).

The LOGO descriptor shall be the first descriptor in the operation.

NOTE 8 – In this way the encapsulated Fibre Channel ELS results at an offset in the FIP frame equal to the offset it would have if it was encapsulated in a FCoE frame.

The FIP Subcode field (see 7.7.6.2) shall be set to:

a) 01h for FIP Fabric LOGO Request operations;
b) 02h for FIP Fabric LOGO LS_ACC operations; and
c) 02h for FIP Fabric LOGO LS_RJT operations.

The LOGO descriptor shall contain:

a) a complete Fibre Channel frame with a Fibre Channel Frame_Header (see FC-FS-3) and a Fabric LOGO Request payload (see FC-LS-2) but without the CRC field (see FC-FS-3) for FIP Fabric LOGO Request operations;

b) a complete Fibre Channel frame with a Fibre Channel Frame_Header (see FC-FS-3) and a Fabric LOGO LS_ACC payload (see FC-LS-2) but without the CRC field (see FC-FS-3) for FIP Fabric LOGO LS_ACC operations; and
c) a complete Fibre Channel frame with a Fibre Channel Frame_Header (see FC-FS-3) and a Fabric LOGO LS_RJT payload (see FC-LS-2) but without the CRC field (see FC-FS-3) for FIP Fabric LOGO LS_RJT operations.

The MAC address field in the MAC address descriptor of a FIP Fabric LOGO Request and a FIP Fabric LOGO LS_ACC operation shall be set to the MAC address assigned to the VN_Port that is being logged out.

#### 7.7.7.4.4 Exchange Link Parameters

As shown in table 45:

a) a FIP ELP Request operation contains a ELP descriptor (see 7.7.6.3.11) and a MAC address descriptor (see 7.7.6.3.3);
b) a FIP ELP SW_ACC operation contains a ELP descriptor (see 7.7.6.3.11) and a MAC address descriptor (see 7.7.6.3.3); and
c) a FIP ELP SW_RJT operation contains a ELP descriptor (see 7.7.6.3.11).

The ELP descriptor shall be the first descriptor in the operation.

NOTE 9 – In this way the encapsulated Fibre Channel SW_ILS results at an offset in the FIP frame equal to the offset it would have if it was encapsulated in a FCoE frame.

The FIP Subcode field (see 7.7.6.2) shall be set to:

a) 01h for FIP ELP Request operations;
b) 02h for FIP ELP SW_ACC operations; and
c) 02h for FIP ELP SW_RJT operations.

The LOGO descriptor shall contain:

a) a complete Fibre Channel frame with a Fibre Channel Frame_Header (see FC-FS-3) and a ELP Request payload (see FC-SW-5) but without the CRC field (see FC-FS-3) for FIP ELP Request operations;
b) a complete Fibre Channel frame with a Fibre Channel Frame_Header (see FC-FS-3) and a ELP SW_ACC payload (see FC-SW-5) but without the CRC field (see FC-FS-3) for FIP ELP SW_ACC operations; and
c) a complete Fibre Channel frame with a Fibre Channel Frame_Header (see FC-FS-3) and a ELP SW_RJT payload (see FC-SW-5) but without the CRC field (see FC-FS-3) for FIP ELP SW_RJT operations.

The MAC address field in the MAC address descriptor of a FIP ELP Request and a FIP ELP SW_ACC operation shall be set to the MAC address of the destination FCF-MAC.

### 7.7.7.5 FIP Keep Alive

As shown in table 45, a FIP Keep Alive operation contains a MAC address descriptor (see 7.7.6.3.3) and zero or one Vx_Port Identification descriptor (see 7.7.6.3.12).

ENode FIP Keep Alive operations (see 7.7.4.1) contains only a MAC address descriptor. VN_Port FIP Keep Alive operations (see 7.7.4.1) contain a MAC address descriptor and a Vx_Port Identification descriptor.

ENode FIP Keep Alive messages shall have the originating ENode MAC address as source address. The MAC address field in the MAC address descriptor shall be set to the originating ENode MAC address.

VN_Port FIP Keep Alive messages shall have the VN_Port MAC address as source address. The MAC address field in the MAC address descriptor shall be set to the originating ENode MAC address. In the Vx_Port Identification descriptor, the MAC address field shall be set to the VN_Port MAC address, the Address Identifier field shall be set to the VN_Port N_Port_ID, and the Port_Name field shall be set to the VN_Port N_Port_Name.

#### 7.7.7.6 FIP Clear Virtual Links

##### 7.7.7.6.1 FIP Clear Virtual Links to an ENode

The FCoE Controller of a VF_Port capable FCF-MAC may de-instantiate one or more VN_Port to VF_Port Virtual Links by transmitting a FIP Clear Virtual Links to an ENode MAC. As shown in table 45, this FIP Clear Virtual Links message shall contain one MAC address descriptor (see 7.7.6.3.3), one Name_Identifier descriptor (see 7.7.6.3.5), and a list of Vx_Port Identification descriptors (see 7.7.6.3.12), one for each VN_Port the Virtual Link with it is requested to be de-instantiated.

The MAC address field in the MAC address descriptor shall be set to the FCF-MAC address of the originating FCF-MAC. The Name_Identifier field in the Name_Identifier descriptor shall be set to the Switch_Name of the originating FCF. For each Vx_Port Identification descriptor, the MAC address field shall be set to the VN_Port MAC address, the Address Identifier field shall be set to the VN_Port N_Port_ID, and the Port_Name field shall be set to the VN_Port N_Port_Name. The FCoE Controller of a receiving ENode MAC shall ignore a Vx_Port Identification descriptor not matching any of its instantiated VN_Ports.

##### 7.7.7.6.2 FIP Clear Virtual Links to an FCF

The FCoE Controller for a VE_Port capable FCF-MAC may de-instantiate a VE_Port to VE_Port Virtual Link by sending a FIP Clear Virtual Links to a VE_Port capable FCF-MAC. As shown in table 45, this FIP Clear Virtual Links message shall contain one MAC address descriptor (see 7.7.6.3.3), one Name_Identifier descriptor (see 7.7.6.3.5), and one Vx_Port Identification descriptor (see 7.7.6.3.12).

The MAC address field in the MAC address descriptor shall be set to the FCF-MAC address of the originating FCF-MAC. The Name_Identifier field in the Name_Identifier descriptor shall be set to the Switch_Name of the originating FCF. In the Vx_Port Identification descriptor, the MAC address field shall be set to the remote FCF-MAC address, the Address Identifier field shall be set to FFFFFDh, and the Port_Name field shall be set to the remote E_Port_Name.

#### 7.7.7.7 FIP VLAN Request

As shown in table 45, a FIP VLAN Request operation contains a MAC address descriptor (see 7.7.6.3.3). A FIP VLAN Request message may be generated by an ENode MAC or by an FCF-MAC.

When generated by an ENode MAC, the FIP VLAN Request message shall have the F flag set to zero and the MAC address field in the MAC address descriptor shall be set to the originating ENode MAC address.

When generated by an FCF-MAC, the FIP VLAN Request message shall have the F flag set to one and the MAC address field in the MAC address descriptor shall be set to the originating FCF-MAC address.

#### 7.7.7.8 FIP VLAN Notification

As shown in table 45, a FIP VLAN Request operation contains a MAC address descriptor (see 7.7.6.3.3) and one or more VLAN descriptors (see 7.7.6.3.15). A FIP VLAN Notification message is generated by an FCF-MAC.

The MAC address field in the MAC address descriptor shall be set to the originating FCF-MAC address. The FCoE VID field of each of the FIP VLAN descriptors shall be set to a VID over which the FCF-MAC is offering FC-BB_E services.

#### 7.7.7.9 FIP Vendor Specific messages

FIP Vendor Specific messages may be transmitted by both ENodes and FCFs. As shown in table 45, a FIP Vendor Specific message shall include a Vendor_ID descriptor (see 7.7.6.3.16) as the first descriptor, followed by one or more additional descriptors. An unknown received Vendor Specific message shall be discarded. An FC-BB_E device shall not require use of any Vendor Specific message in order to operate in accordance with this standard.

### 7.8 Timers and constants

FC-BB_E timers and constants are specified in table 47.

**Table 47 – FC-BB_E timers and constants**

| Timer/Constant | Value | Description | Reference |
|---|---|---|---|
| FIP_TYPE | 8914h | The value specified in the IEEE 802.3 Type field for a FIP frame. | 7.7.6.1 |
| FCoE_TYPE | 8906h | The value specified in the IEEE 802.3 Type field for an FCoE frame. | 7.6 |
| FIP_FRAME_VER | 0001b | The value specified in the Version field for an FIP frame. | 7.7.6.1 |
| FCoE_FRAME_VER | 0000b | The value specified in the Version field for an FCoE frame. | 7.6 |
| All-FCoE-MACs | 01-10-18-01-00-00 | The group address for all FCoE devices. | 7.7.1 |
| All-ENode-MACs | 01-10-18-01-00-01 | The group address for all ENodes. | 7.7.1 |
| All-FCF-MACs | 01-10-18-01-00-02 | The group address for all FCFs. | 7.7.1 |
| DEFAULT_FIP_PRIORITY | 128 | The default value specified in the FIP Priority descriptor. | 7.7.6.3.2 |
| DEFAULT_FC-MAP | 0EFC00h | The default value for the FC-MAP field in a FIP FC-MAP descriptor. | 7.7.6.3.4 |
| ADV_TOV | 2 | The interval in seconds within which solicited Discovery Advertisements are transmitted, if the FCF chooses so, upon reception of a Discovery Solicitation. | 7.7.2 |
| FKA_ADV_PERIOD | 8000 | The default interval in milliseconds between periodic Discovery Advertisements and ENodes FIP Keep Alive messages. | 7.7.2, 7.7.4 |
| FKA_VN_PERIOD | 90 | The interval in seconds between periodic VN_Ports FIP Keep Alive messages. | 7.7.4 |

[a] This value has been chosen as appropriate to keep updated the forwarding tables of intermediate Lossless Ethernet bridges.