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1 Locally Unique N_Port_IDs

1.1 Overview

Figure 1 shows the VN_Port to VN_Port reference model. ENode MACs supporting VN_Port to VN_Port Virtual Links (i.e., VN2VN ENode MACs) shall have a VN_Port dedicated to the instantiation of VN_Port to VN_Port Virtual Links. This VN_Port is called in this document VN2VN_Port. FCoE frames originated by a VN2VN_Port are transported over the Lossless Ethernet network to the VN2VN_Ports the originating VN2VN_Port is logged in with.

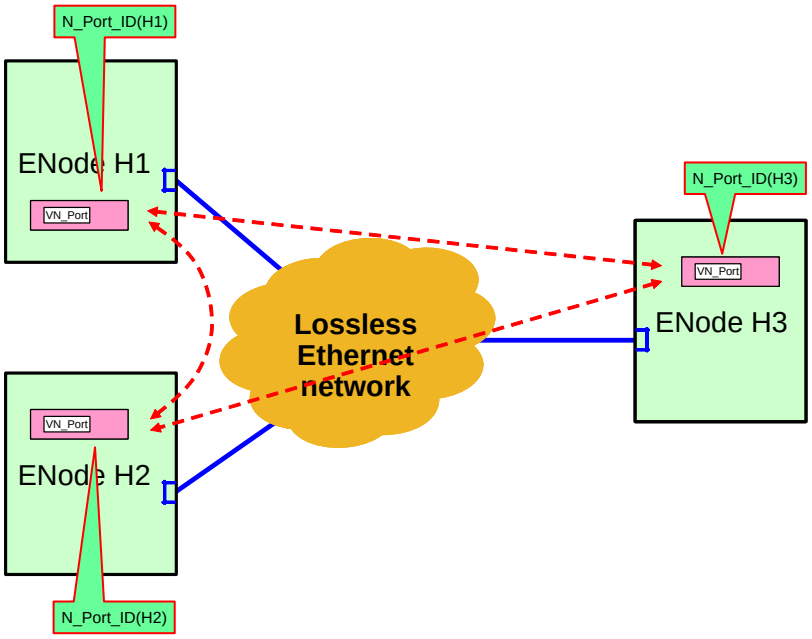

Figure 1 – VN_Port to VN_Port Reference Model

As shown in figure 1, VN2VN ENode MACs shall assign by themselves the N_Port_IDs to the VN2VN_Ports, because in the VN_Port to VN_Port reference model there is no FCF that performs N_Port_ID assignment.

N_Port_IDs used for VN_Port to VN_Port Virtual Links shall be unique over the Lossless Ethernet network to which VN2VN ENode MACs are connected and are suitable to be used only for communications over that Lossless Ethernet network. These N_Port_ID are called Locally Unique N_Port_ID.

The protocol defined in this document enables VN2VN ENode MACs to select Locally Unique N_Port_IDs (see 1.4.1), to discover the VN2VN_Ports reachable over the Lossless Ethernet to which they are connected, including their FC-4 support (see 1.4.1), and to establish VN_Port to VN_Port Virtual Links with the discovered VN2VN_Ports (see 1.5).

The FPMA used as VN_Port MAC address for a VN2VN_Port is determined by concatenating its Locally Unique N_Port_ID to the constant VN2VN-FC-MAP. The constant VN2VN-FC-MAP has the value 0EFD00h. This allows to identify easily all MAC addresses used by FCoE for VN_Port to VN_Port communications, because they all share the same VN2VN-FC-MAP prefix. The value VN2VN-FC-MAP shall not be used as a Fabric FC-MAP.

Figure 2 shows an example of a configuration in which two VN2VN ENode MACs instantiate a VN_Port to VN_Port Virtual Link in presence of an FCF.

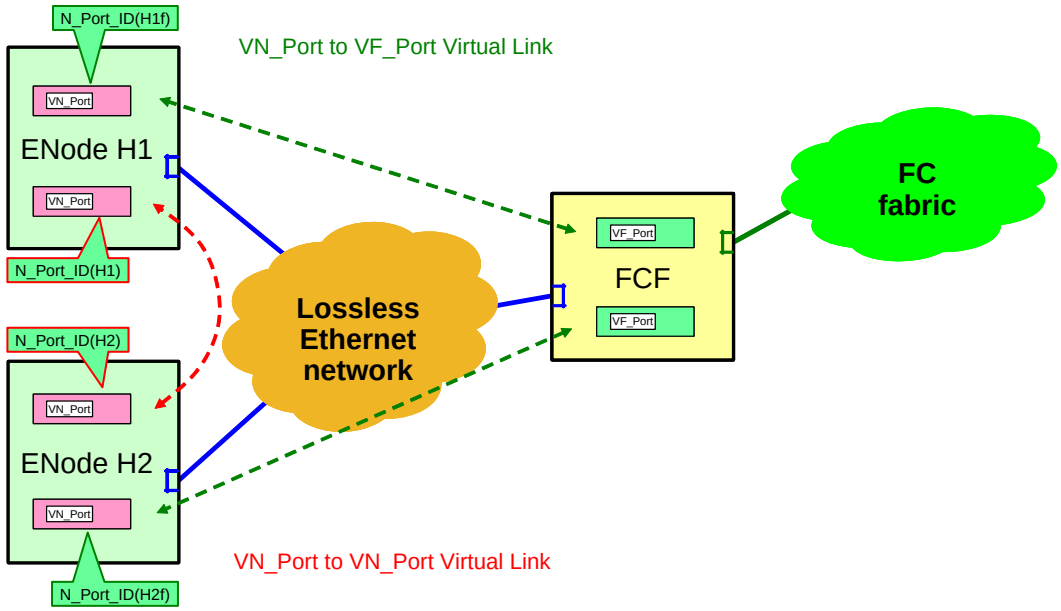

Figure 2 – Example of Mixed Configuration

Each VN2VN ENode MAC may instantiate a VN_Port to VF_Port Virtual Link with the FCF using the protocols defined in FC-BB-5. However, it has to be possible to instantiate VN_Port to VN_Port Virtual Links when the FCF is not connected to the Lossless Ethernet network and the VN_Port to VN_Port Virtual Links shall remain operational when the FCF is disconnected from the Lossless Ethernet network. Therefore the VN_Ports involved in VN_Port to VN_Port Virtual Links shall be independent from the VN_Ports involved in VN_Port to VF_Port Virtual Links, because otherwise the VN_Port to VN_Port Virtual Links do not exist without the FCF.

Figure 2 shows that Locally Unique N_Port_IDs shall not conflict with and shall be independent from the N_Port_IDs assigned by a Fibre Channel Fabric. This ensures each VN_Port has a unique N_Port_ID.

A Fibre Channel Fabric does not assign N_Port_IDs with Domain_ID in the range F0h .. FEh (see FC-SW-5). However an N_Port_ID with a Domain_ID in that range is valid per FC-FS-3 and therefore suitable to be used for VN_Port to VN_Port configurations. Locally Unique N_Port_IDs shall have the format ‘F0.xx.yy’h (i.e., N_Port_IDs having the value F0h as Domain_ID). This assures that they do not conflict with N_Port_IDs assigned by a Fibre Channel Fabric.

1.2 VN2VN ENode Functional Model

Figure 3 shows the functional model of a VN2VN ENode.

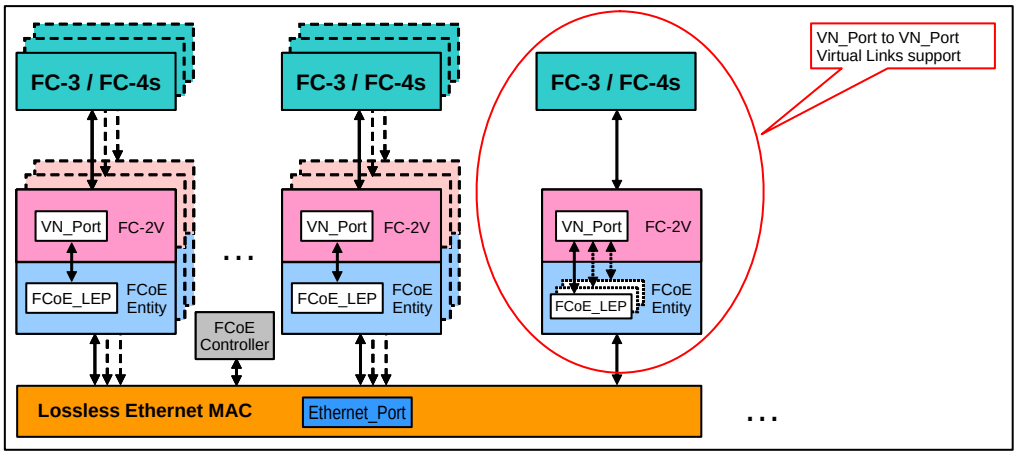

Figure 3 – VN2VN ENode Functional Model

A VN2VN ENode MAC has a VN_Port dedicated to the instantiation of VN_Port to VN_Port Virtual Links, called VN2VN_Port. The FCoE Controller of a VN2VN ENode MAC may perform FIP FLOGIs with multiple remote VN2VN ENode MACs to instantiate multiple VN_Port to VN_Port Virtual Links. This results in multiple FCoE_LEPs associated with a VN2VN_Port.

The FCoE_LEP is the functional entity performing the encapsulation of FC frames into FCoE frames in transmission and the decapsulation of FCoE frames into FC frames in reception. An FCoE_LEP operates according to the MAC address of the local link end-point and the MAC address of the remote link end-point. When encapsulating FC frames into FCoE frames, the MAC address of the local link end-point shall be used as source address and the MAC address of the remote link end-point shall be used as destination address of the generated FCoE frame. When decapsulating FC frames from FCoE frames, the FCoE_LEP shall verify that the destination address of the received FCoE frame is equal to the MAC address of the local link end-point and shall verify that the source address of the received FCoE frame is equal to the MAC address of the remote link end-point. If either check fails the FCoE frame shall be discarded.

For a FCoE_LEP associated with a VN2VN_Port, the MAC address of the local link end-point is the FPMA associated with that VN2VN_Port and the remote link end-point address is the FPMA associated with the remote VN2VN_Port. Therefore the source MAC address of FCoE frames used for VN_Port to VN_Port Virtual Links is ‘VN2VN-FC-MAP || S_ID’ and the destination MAC address is ‘VN2VN-FC-MAP || D_ID’. On receiving an FCoE frame, the FCoE_LEP associated with a VN2VN_Port shall verify that the least significant 24 bits of the source MAC address are equal to the S_ID of the encapsulated FC frame and that the least significant 24 bits of the destination MAC address are equal to the D_ID of the encapsulated FC frame. The FCoE_LEP associated with a VN2VN_Port shall verify also that the most significant 24 bits of the source and destination MAC address are equal to VN2VN-FC-MAP. If any check fails the FCoE frame shall be discarded.

1.3 VN_Port to VN_Port Virtual Links

Figure 4 shows how the functional model defined in 1.2 models VN_Port to VN_Port Virtual Links.

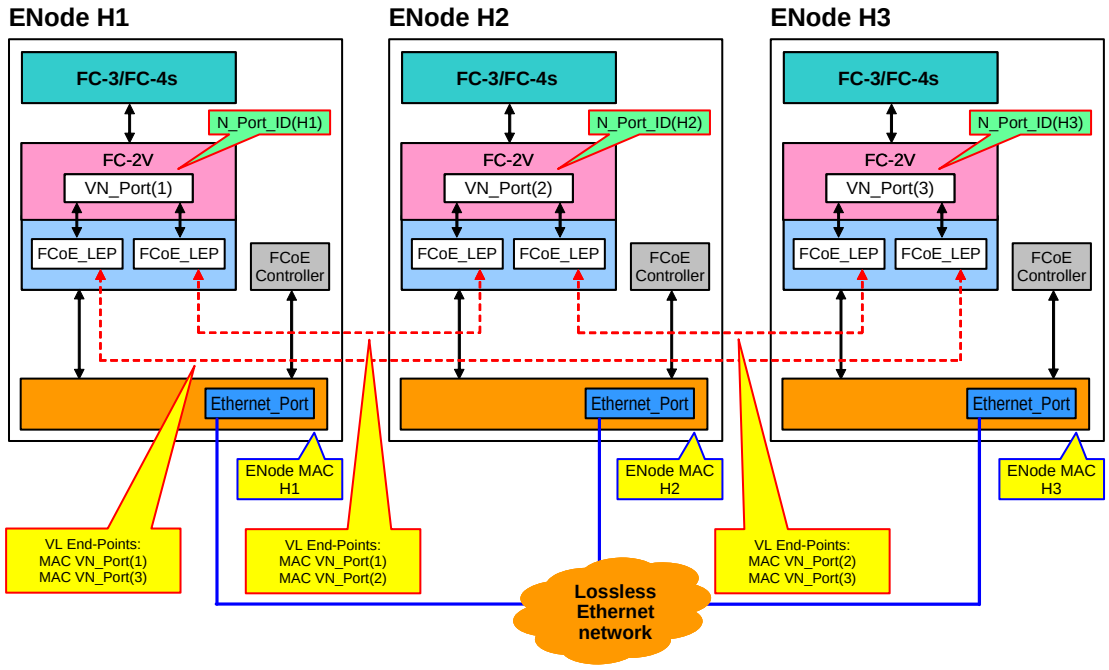

Figure 4 – VN_Port to VN_Port Virtual Links Example

VN_Port to VN_Port Virtual Links are instantiated on successful completion of point-to-point FIP FLOGI Exchanges (see 1.5). VN_Port to VN_Port Virtual Links are identified by the two VN_Port MAC addresses (FPMA) associated with the involved VN2VN_Ports.

1.4 Locally Unique N_Port_IDs

1.4.1 Selection Algorithm

The algorithm to select Locally Unique N_Port_IDs relies on VN2VN ENode MACs listening to the multicast MAC address All-VN2VN-ENode-MACs.

When becoming operational, a VN2VN ENode MAC shall enable reception of frames sent to All-VN2VN-ENode-MACs and select a tentative Locally Unique N_Port_ID. A tentative Locally Unique N_Port_ID should be a recorded Locally Unique N_Port_ID if available (see below in this subclause), otherwise it is selected through a pseudo-random number generator with a uniform distribution in the range F00001h .. F0FFFEh. The pseudo-random number generator should be seeded with the N_Port_Name of the VN2VN_Port for which a Locally Unique N_Port_ID is being selected. In this way different ENode MACs generate different numbers and a VN2VN_Port is usually associated with the same N_Port_ID each time it is enabled. The pseudo-random number generation algorithm shall be chosen so that different VN2VN ENode MACs do not generate the same sequence of numbers.

NOTE 1 – Seeding the pseudo-random number generator using the real-time clock or any other information which is (or may be) identical in every VN2VN ENode MAC is not suitable for this purpose, because a group of VN2VN ENode MACs that are all powered on at the same time might then all generate the same sequence, resulting in a never-ending series of conflicts as the VN2VN ENode MACs move in lock-step through exactly the same pseudo-random sequence, conflicting on every address they probe.

After selecting a tentative Locally Unique N_Port_ID, a VN2VN ENode MAC shall probe the Lossless Ethernet network to which it is connected to verify if the Locally Unique N_Port_ID is already in use. The VN2VN ENode MAC shall wait for a random time interval selected uniformly in the range zero to PROBE_WAIT milliseconds, and shall then transmit two multicast N_Port_ID Probe Requests to All-VN2VN-ENode-MACs, spaced PROBE_WAIT milliseconds apart.

If during the period from the beginning of the probing process until ANNOUNCE_WAIT milliseconds after the last N_Port_ID Probe Request is sent, the VN2VN ENode MAC receives any N_Port_ID Probe Reply, then the VN2VN ENode MAC shall treat this N_Port_ID as being already in use and shall select a new random tentative Locally Unique N_Port_ID and repeat the process (i.e., wait for a random time interval and then transmit two N_Port_ID Probe Requests).

If during the same period the VN2VN ENode MAC receives any N_Port_ID Probe Request probing the same tentative Locally Unique N_Port_ID, then the VN2VN ENode MAC shall check the N_Port_Name carried in the Vx_Port_Identification descriptor of the received N_Port_ID Probe Request. If the received N_Port_Name is greater than the N_Port_Name of its VN2VN_Port then the VN2VN ENode MAC shall select a new random tentative Locally Unique N_Port_ID and repeat the process (i.e., wait for a random time interval and then transmit two N_Port_ID Probe Requests) without replying to the received N_Port_ID Probe Request, otherwise it shall keep its selection and reply to the received N_Port_ID Probe Request with a N_Port_ID Probe Reply.

A VN2VN ENode MAC should maintain a counter of the number of Locally Unique N_Port_ID conflicts it has experienced while trying to acquire a Locally Unique N_Port_ID. If the number of conflicts exceeds ten, then the VN2VN ENode MAC should report the situation in a vendor specific way as an indication of potential network failure and shall limit the rate at which it probes for new Locally Unique N_Port_IDs to no more than one new N_Port_ID per RATE_LIMIT_INTERVAL. This is to prevent multicast storms in pathological failure cases, such as a rogue VN2VN ENode MAC that answers all N_Port_ID Probe Requests, causing legitimate VN2VN ENode MACs to go into an infinite loop while attempting to select a usable Locally Unique N_Port_ID.

If by ANNOUNCE_WAIT milliseconds after the transmission of the last N_Port_ID Probe Request no conflicting N_Port_ID Probe Reply or N_Port_ID Probe Request has been received, then the VN2VN ENode MAC has successfully claimed the selected Locally Unique N_Port_ID. Having claimed a Locally Unique N_Port_ID to use, the VN2VN ENode MAC shall then announce its claimed address by transmitting a multicast N_Port_ID Claim Notification to All-VN2VN-ENode-MACs. A N_Port_ID Claim Notification notifies the other VN2VN ENode MACs on the Lossless Ethernet network of the selected Locally Unique N_Port_ID and causes all other VN2VN ENode MACs on the network to reply with a unicast N_Port_ID Claim Response. The N_Port_ID Claim Notification provides the maximum FCoE size the VN2VN ENode MAC intends to use for VN_Port to VN_Port Virtual Links, and N_Port_ID Claim Responses FIP PDU shall have a length that matches this FCoE size. Upon transmitting the N_Port_ID Claim Notification, the VN2VN ENode MAC shall wait for ANNOUNCE_WAIT milliseconds to collect N_Port_ID Claim Responses. A VN2VN ENode MAC maintains the received N_Port_ID Claim Responses in a VN2VN Neighbor Set, from which it determines the VN2VN ENode MACs with which to establish VN_Port to VN_Port Virtual Links (the VN2VN Login Set), also on the basis of their FC-4 support. Upon receiving a N_Port_ID Claim Notification a VN2VN ENode MAC adds the notifying VN2VN_Port to its VN2VN Neighbor Set.

After collecting the N_Port_ID Claim Responses a VN2VN ENode MAC shall transmit a multicast VN2VN Advertisement to All-VN2VN-ENode-MACs and shall continue to transmit multicast VN2VN Advertisements periodically every ADV_VN_PERIOD milliseconds.

NOTE 2 – An ENode MAC connecting to a network with 1 300 ENodes has a 98% chance of selecting an unused Locally Unique N_Port_ID on the first try and a 99.96% chance of selecting an unused Locally Unique N_Port_ID within two tries. The probability that it will have to try more than ten times is about 10^{-17}.

VN2VN ENode MACs that are equipped with persistent storage may record the Locally Unique N_Port_ID they have selected for themselves. On booting, VN2VN ENode MACs with a recorded Locally Unique N_Port_ID should use that Locally Unique N_Port_ID as their first candidate when probing. This increases the stability of N_Port_IDs. For example, if a group of VN2VN ENode MACs are powered off, then when they are powered on they all resume using the previous Locally Unique N_Port_IDs, instead of picking different N_Port_IDs and potentially having to resolve conflicts.

Depending on local configuration, a VN2VN ENode MAC may stop the processing of the Locally Unique N_Port_ID selection protocol and report the situation in a vendor specific way if it detects that its recorded Locally Unique N_Port_ID is already in use on the network. The recorded Locally Unique N_Port_ID may be also administratively configured.

1.4.2 Handling N_Port_ID Conflicts

N_Port_ID conflict detection is not limited to the N_Port_ID selection phase, when a VN2VN ENode MAC is sending N_Port_ID Probe Requests. If, after having selected a Locally Unique N_Port_ID, a VN2VN ENode MAC receives a N_Port_ID Claim Notification claiming the same Locally Unique N_Port_ID, or a VN2VN Advertisement where the N_Port_ID field is equal to its VN2VN_Port's N_Port_ID, then this is an indication of an N_Port_ID conflict.

NOTE 3 – N_Port_ID conflicts are not expected in stable network configurations. When joining two previously separated networks there is a chance of conflict, resulting in one or more VN2VN_Ports needing to change their Locally Unique N_Port_IDs.

A VN2VN ENode MAC shall not ignore N_Port_ID conflicts. Between the two conflicting VN2VN_Ports, the one with the greater N_Port_Name shall keep its N_Port_ID and the one with the lesser N_Port_Name shall implicitly log out from all the VN2VN_Ports it is logged with and select a new Locally Unique N_Port_ID (see 1.4.1). The FCoE Controller of the VN2VN ENode MAC with the VN2VN_Port with the greater N_Port_Name shall transmit a N_Port_ID Claim Notification to All-VN2VN-ENode-MACs, to notify all other VN2VN ENode MACs on the network that it has that N_Port_ID, and collect the N_Port_ID Claim Responses. Upon receiving such a N_Port_ID Claim Notification, a VN2VN ENode MAC with a VN2VN_Port that had a Virtual Link with the VN2VN_Port that is changing its N_Port_ID shall implicitly deinstantate that Virtual Link.

Reception of a VN2VN Advertisement from a VN2VN ENode MAC not listed in the VN2VN Neighbor Set is an indication of a network join. The receiving VN2VN ENode MAC shall react by transmitting a N_Port_ID Claim Notification to All-VN2VN-ENode-MACs and by collecting the N_Port_ID Claim Responses. If an N_Port_ID conflict is detected on receiving the N_Port_ID Claim Responses, the VN2VN ENode MAC shall resolve the conflict as described above in this subclause.

1.4.3 Protocol Timers

Table 1 shows the timers of the Locally Unique N_Port_IDs selection algorithm.

Table 1 – Locally Unique N_Port_IDs Selection Timers

Parameter	Value
PROBE_WAIT	100 ms
ANNOUNCE_WAIT	400 ms
RATE_LIMIT_INTERVAL	10 000 ms
ADV_VN_PERIOD	8 000 ms

1.5 VN_Port to VN_Port Virtual Link Instantiation Protocol

The FCoE Controller of a VN2VN ENode MAC instantiates VN_Port to VN_Port Virtual Links on successful completion of a point-to-point FIP FLOGI. Both FIP FLOGI Request and LS_ACC shall have the Locally Unique N_Port_ID selected for the originating VN2VN_Port (see 1.4.1) as S_ID for the point-to-point FLOGI protocol, and the associated originating VN_Port FPMA in the MAC Address descriptor. As specified in FC-LS-2, the VN2VN_Port with the greater N_Port_Name proceeds to N_Port Login, with the PLOGI ELSs encapsulated in FCoE. The FCoE PLOGI Request shall have the Locally Unique N_Port_ID of the originating VN2VN_Port as S_ID and the Locally Unique N_Port_ID of the destination VN2VN_Port as D_ID. Upon completion of FCoE PLOGI the involved VN_Ports operate in point-to-point mode (see FC-LS-2).

A VN_Port to VN_Port Virtual Link is explicitly deinstantiated by performing a FCoE LOGO, to perform a N_Port logout, followed by a FIP LOGO, to deinstantiate the FCoE_LEPs. In both cases the S_ID and D_ID on the encapsulated LOGO ELS shall be set to the involved VN2VN_Ports Locally Unique N_Port_IDs.

1.6 VN_Port to VN_Port Virtual Link Maintenance Protocol

To deal with local physical layer faults, a VN2VN ENode MAC shall de-instantiate all its VN_Ports to VN_Port Virtual Links upon detecting that its physical layer is not operational.

To deal with non-local faults, the FCoE Controller of a VN2VN ENode MAC shall continuously verify the state of the VN_Port to VN_Port Virtual Links by verifying received VN2VN Advertisements per each VN2VN_Port in the VN2VN Login Set (see 1.4.1). VN2VN Advertisements are expected to be received every ADV_VN_PERIOD. If VN2VN Advertisements from a VN2VN_Port are not received within 2.5 * ADV_VN_PERIOD, the VN_Port to VN_Port Virtual Link with that remote VN2VN_Port shall be implicitly de-instantiated.

1.7 VN2VN FIP Frames

The VN2VN FIP Protocol Code and FIP Subcode field values and operations are specified in table 2.

Table 2 – VN2VN FIP Protocol Code and FIP Subcode Field Values

FIP Protocol Code	FIP Subcode	FIP Protocol Messages	Reference
0005h	01h	N_Port_ID Probe Request	1.9.2
	02h	N_Port_ID Probe Reply	1.9.3
	03h	N_Port_ID Claim Notification	1.9.4
	04h	N_Port_ID Claim Response	1.9.5
	05h	VN2VN Advertisement	1.9.6

1.8 VN2VN FIP Descriptors

1.8.1 Overview

VN2VN operations require the additional descriptors shown in table 3.

Table 3 – FIP Descriptor Types

Range	Type	FIP Descriptor	Reference
Critical	15	FC-4 Attributes	1.8.2

1.8.2 FIP FC-4 Attributes Descriptor

The FIP FC-4 Attributes descriptor is used in FIP operations as shown in table 5.

The FIP FC-4 Attributes descriptor format shall be as specified in table 4.

Table 4 – FIP FC-4 Attributes 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 = 0Fh								Length = 29h								Reserved															
1 .. 8	MSB FC-4 Types LSB																															
9 .. 40	MSB FC-4 Features LSB																															

FC-4 Types: the FC-4 Types object, as defined in FC-GS-6.

FC-4 Features: the FC-4 Features object, as defined in FC-GS-6.

1.9 VN2VN FIP Operations

1.9.1 Overview

Table 5 shows the FIP operations used by VN2VN ENodes.

Table 5 – FIP Operation Descriptors and Order

FIP Operation	FIP Protocol Code/Subcode	Originator	Expected Descriptors and Order
N_Port_ID Probe Request	0005h / 01h	VN2VN ENode	1) MAC address 2) Name_Identifier 3) Vx_Port Identification

Table 5 – FIP Operation Descriptors and Order (Continued)

FIP Operation	FIP Protocol Code/Subcode	Originator	Expected Descriptors and Order
N_Port_ID Probe Reply	0005h / 02h	VN2VN ENode	1) MAC address 2) Name_Identifier 3) Vx_Port Identification
N_Port_ID Claim Notification	0005h / 03h	VN2VN ENode	1) MAC address 2) Name_Identifier 3) Vx_Port Identification 4) FC-4 Attributes 5) Max FCoE Size
N_Port_ID Claim Response	0005h / 04h	VN2VN ENode	1) MAC address 2) Name_Identifier 3) Vx_Port Identification 4) FC-4 Attributes
VN2VN Advertisement	0005h / 05h	VN2VN ENode	1) MAC address 2) Name_Identifier 3) Vx_Port Identification

1.9.2 N_Port_ID Probe Request

As shown in table 5, an N_Port_ID Probe Request operation contains a MAC address descriptor, a Name_Identifier descriptor and a Vx_Port Identification descriptor.

The MAC address field in the MAC address descriptor shall be set to the ENode MAC address of the originating VN2VN ENode MAC. The Name_Identifier field in the Name_Identifier descriptor shall be set to the Node_Name of the originating VN2VN ENode MAC. In the Vx_Port Identification descriptor, the Port_Name field shall be set to the N_Port_Name of the VN2VN_Port whose tentative Locally Unique N_Port_ID is being probed, the Address Identifier field shall be set to the tentative Locally Unique N_Port_ID, and the MAC address field shall be set to the tentative VN_Port MAC address (FPMA).

An N_Port_ID Probe Request is multicast (i.e., addressed to the All-VN2VN-ENode-MACs multicast address).

1.9.3 N_Port_ID Probe Reply

As shown in table 5, an N_Port_ID Probe Reply operation contains a MAC address descriptor, a Name_Identifier descriptor and a Vx_Port Identification descriptor.

The MAC address field in the MAC address descriptor shall be set to the ENode MAC address of the originating VN2VN ENode MAC. The Name_Identifier field in the Name_Identifier descriptor shall be set to the Node_Name of the originating VN2VN ENode MAC. In the Vx_Port Identification descriptor, the Port_Name field shall be set to the N_Port_Name of the originating VN2VN_Port, the Address Identifier field shall be set to the Locally Unique N_Port_ID of the originating VN2VN_Port, and the MAC address field shall be set to the VN_Port MAC address (FPMA) of the originating VN2VN_Port.

An N_Port_ID Probe Reply is unicast (i.e., it replies to a multicast N_Port_ID Probe Request).

1.9.4 N_Port_ID Claim Notification

As shown in table 5, an N_Port_ID Claim Notification operation contains a MAC address descriptor, a Name_Identifier descriptor, a Vx_Port Identification descriptor, an FC-4 Attributes descriptor, and a Max FCoE Size descriptor.

The MAC address field in the MAC address descriptor shall be set to the ENode MAC address of the originating VN2VN ENode MAC. The Name_Identifier field in the Name_Identifier descriptor shall be set to the Node_Name of the originating VN2VN ENode MAC. In the Vx_Port Identification descriptor, the Port_Name field shall be set to the N_Port_Name of the originating VN2VN_Port, the Address Identifier field shall be set to the claimed Locally Unique N_Port_ID, and the MAC address field shall be set to the associated VN_Port MAC address (FPMA). The FC-4 Types and FC-4 Features fields of the FC-4 Attributes descriptor shall be set to the FC-4 Type and Features supported by the originating VN2VN_Port. The Max_FCoE_Size field in the Max FCoE Size descriptor shall be set to the maximum FCoE PDU size the ENode MAC intends to use for FCoE traffic.

An N_Port_ID Claim Notification is multicast (i.e., addressed to the All-VN2VN-ENode-MACs multicast address).

1.9.5 N_Port_ID Claim Response

As shown in table 5, an N_Port_ID Claim Response operation contains a MAC address descriptor, a Name_Identifier descriptor, a Vx_Port Identification descriptor, and an FC-4 Attributes descriptor.

The MAC address field in the MAC address descriptor shall be set to the ENode MAC address of the originating VN2VN ENode MAC. The Name_Identifier field in the Name_Identifier descriptor shall be set to the Node_Name of the originating VN2VN ENode MAC. In the Vx_Port Identification descriptor, the Port_Name field shall be set to the N_Port_Name of the originating VN2VN_Port, the Address Identifier field shall be set to the Locally Unique N_Port_ID of the originating VN2VN_Port, and the MAC address field shall be set to the VN_Port MAC address (FPMA) of the originating VN2VN_Port. The FC-4 Types and FC-4 Features fields of the FC-4 Attributes descriptor shall be set to the FC-4 Type and Features supported by the originating VN2VN_Port. The FIP_Pad field shall be used to extend the FIP PDU to have a length that matches the Max_FCoE_Size field value in the Max FCoE Size descriptor in the N_Port_ID Claim Notification to which the N_Port_ID Claim Response is responding.

An N_Port_ID Claim Response is unicast (i.e., it replies to a multicast N_Port_ID Claim Notification).

1.9.6 VN2VN Advertisement

As shown in table 5, a VN2VN Advertisement operation contains a MAC address descriptor, a Name_Identifier descriptor and a Vx_Port Identification descriptor.

The MAC address field in the MAC address descriptor shall be set to the ENode MAC address of the originating VN2VN ENode MAC. The Name_Identifier field in the Name_Identifier descriptor shall be set to the Node_Name of the originating VN2VN ENode MAC. In the Vx_Port Identification descriptor, the Port_Name field shall be set to the N_Port_Name of the originating VN2VN_Port, the Address Identifier field shall be set to the Locally Unique N_Port_ID of the originating VN2VN_Port, and the MAC address field shall be set to the VN_Port MAC address (FPMA) of the originating VN2VN_Port.

A VN2VN Advertisement is multicast (i.e., addressed to the All-VN2VN-ENode-MACs multicast address) and uses the VN_Port MAC address as source address.

Annex A: Increasing FC-BB_E Robustness Using Access Control Lists

A.1 Overview

When security threats exist in a Locally Unique N_Port_ID configuration, it is important to protect the FCoE traffic with appropriate FCoE ACLs, documented in this annex.

A.2 Prevention of FCoE Traffic

The ACL described in this subclause is appropriate for a Ethernet bridge port intended to block all FCoE traffic:

```
SApre = VN2VN-FC-MAP, deny;
Type = FCoE_TYPE, deny;
Type = FIP_TYPE, deny
```

A.3 FCoE Perimeter ACL

The set of ACLs described in this subclause is appropriate for a Ethernet bridge port intended to enable Locally Unique N_Port_IDs for a VN2VN ENode MACs connected to it. This set of ACLs protects also from accidental network joins, that otherwise may cause unwanted N_Port_ID changes.

The default perimeter ACL for Locally Unique N_Port_IDs is:

```
SApre = VN2VN-FC-MAP, deny;
Type = FCoE_TYPE, deny;
Type = FIP_TYPE, permit
```

The first entry blocks any frame that has a source address used for FCoE, including VN2VN Advertisements. The second entry provide additional protection blocking any traffic with the FCoE Ethertype. The third entry allows ENode to ENode FIP communication. This ACLs is sufficient to protect from accidental network joins.

The default perimeter ACL may be automatically updated to enable the Locally Unique N_Port_ID selection protocol to proceed. After receiving an N_Port_ID Claim Notification, the ACL becomes:

```
SA = src VN2VN_Port MAC, DA = All-VN2VN-ENode-MACs, Type = FIP_TYPE, permit;
SApre = VN2VN-FC-MAP, deny;
Type = FCoE_TYPE, deny;
Type = FIP_TYPE, permit
```

The first entry allows transmission of VN2VN Advertisements.

After successful completion of a point-to-point FIP FLOGI (i.e., upon detection of the FIP FLOGI LS_ACC), the ACL becomes:

```
SA = src VN2VN_Port MAC, DA = dst VN2VN_Port MAC, Type = FCoE_TYPE, permit;
SA = src VN2VN_Port MAC, DA = All-VN2VN-ENode-MACs, Type = FIP_TYPE, permit;
SApre = VN2VN-FC-MAP, deny;
Type = FCoE_TYPE, deny;
Type = FIP_TYPE, permit
```

The first entry allows point-to-point FCoE traffic.

A.4 Graceful Handling of Network Joins

Duplication of Locally Unique N_Port_IDs across independent networks may have adverse effects when a network administrator desires to join two networks. The set of ACLs described in this subclause is appropriate for a Ethernet bridge port intended to be used to join two independent networks.

The starting point is the ACL that protects each of the two networks from undesired joins:

```
SApre = VN2VN-FC-MAP, deny;
Type = FCoE_TYPE, deny
```

After a cable connects the two networks, this ACL should become:

```
SApre = VN2VN-FC-MAP, Type = FIP_TYPE, permit;
SApre = VN2VN-FC-MAP, deny;
Type = FCoE_TYPE, deny
```

The first entry allows the flow of periodic multicast VN2VN Advertisements, that enable the detection and resolution of N_Port_ID conflicts (see 1.4.2), while the last entry ensures that FCoE traffic still does not flow across the two networks. With this ACL in place N_Port_ID conflicts are resolved and Ethernet forwarding tables reconfigurations are possible, however it is not possible for the FCoE traffic to go from one network to the other one, therefore no FCoE traffic is delivered to an unintended VN2VN_Port. This ACL should stay in place for at least 2.5 * ADV_VN_PERIOD milliseconds, the timeout for VN_Port to VN_Port Virtual Links, therefore if VN2VN Advertisements are not received in this timeframe the Virtual Links are deinstantiated. During this time N_Port_ID conflicts are resolved.

After at least 2.5 * ADV_VN_PERIOD milliseconds the ACL should become:

```
SApre = VN2VN-FC-MAP, Type = FIP_TYPE, permit;
SApre = VN2VN-FC-MAP, Type = FCoE_TYPE, permit;
SApre = VN2VN-FC-MAP, deny
```

At this point the two networks are joined and FCoE traffic is able to flow.

NOTE 4 – The N_Port_ID conflicts resolution algorithm (see 1.4.2) affects only the VN2VN_Port with a duplicated N_Port_ID, any other VN2VN_Port is unaffected by the network join.