

FCoE Technology Update

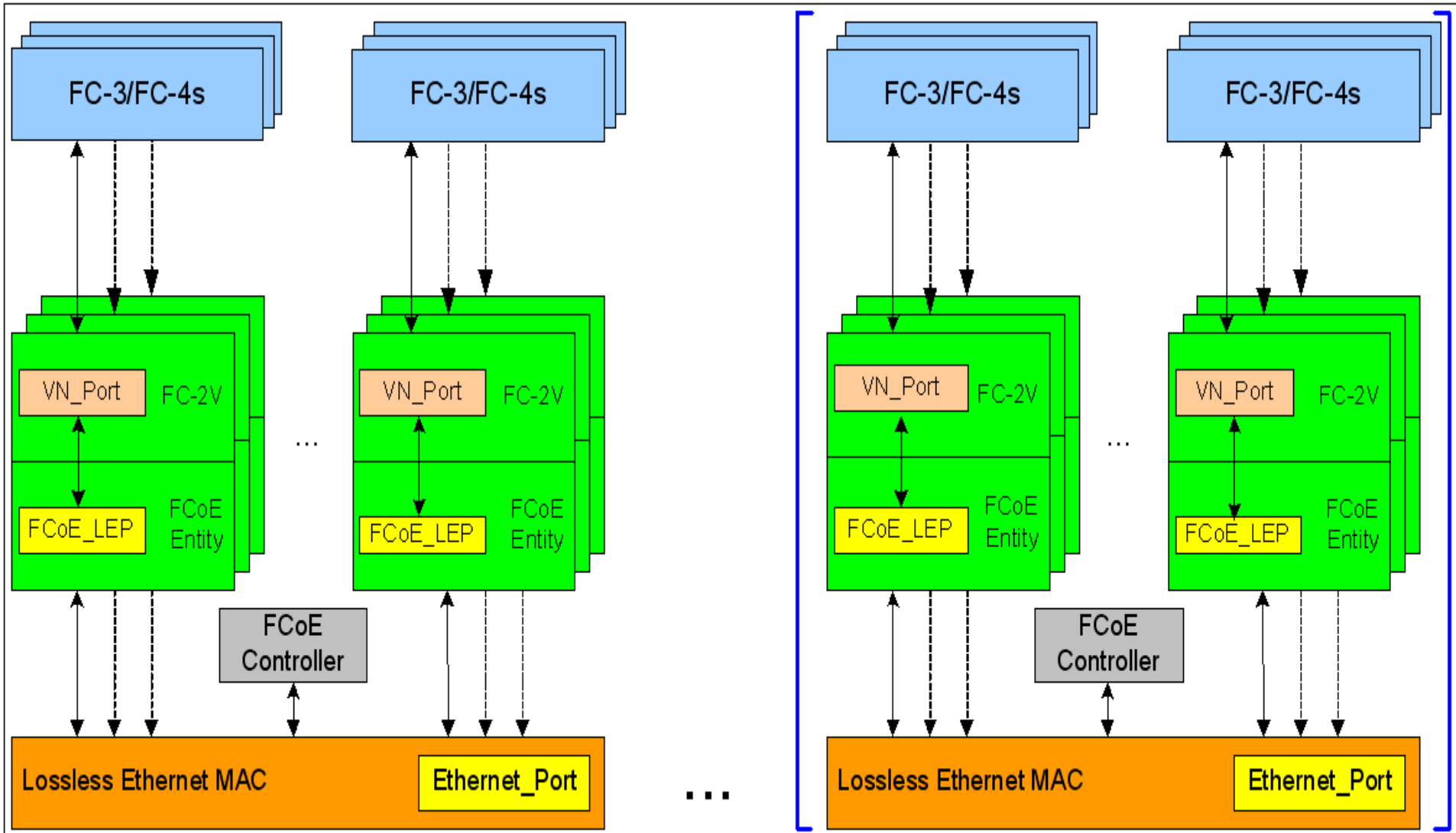
- Many new FCoE architectural features have been defined in the FC-BB-5 standard in recent months. Dave Peterson, the editor of the FC-BB-5 standard will provide a technical overview of the FCoE technology with focus on the new architectural features of FCoE. Such topics include port models, VLAN discovery, FIP discovery, virtual link instantiation, virtual link maintenance, and new ELS functionality.

- ❑ T11 draft standard that specifies the FC-BB_E model (i.e., FCoE) was completed and approved for forwarding to INCITS for Public Review in June 2009
 - ❑ Public Review period is 45 days
 - ❑ Currently working on FC-BB-6 draft standard

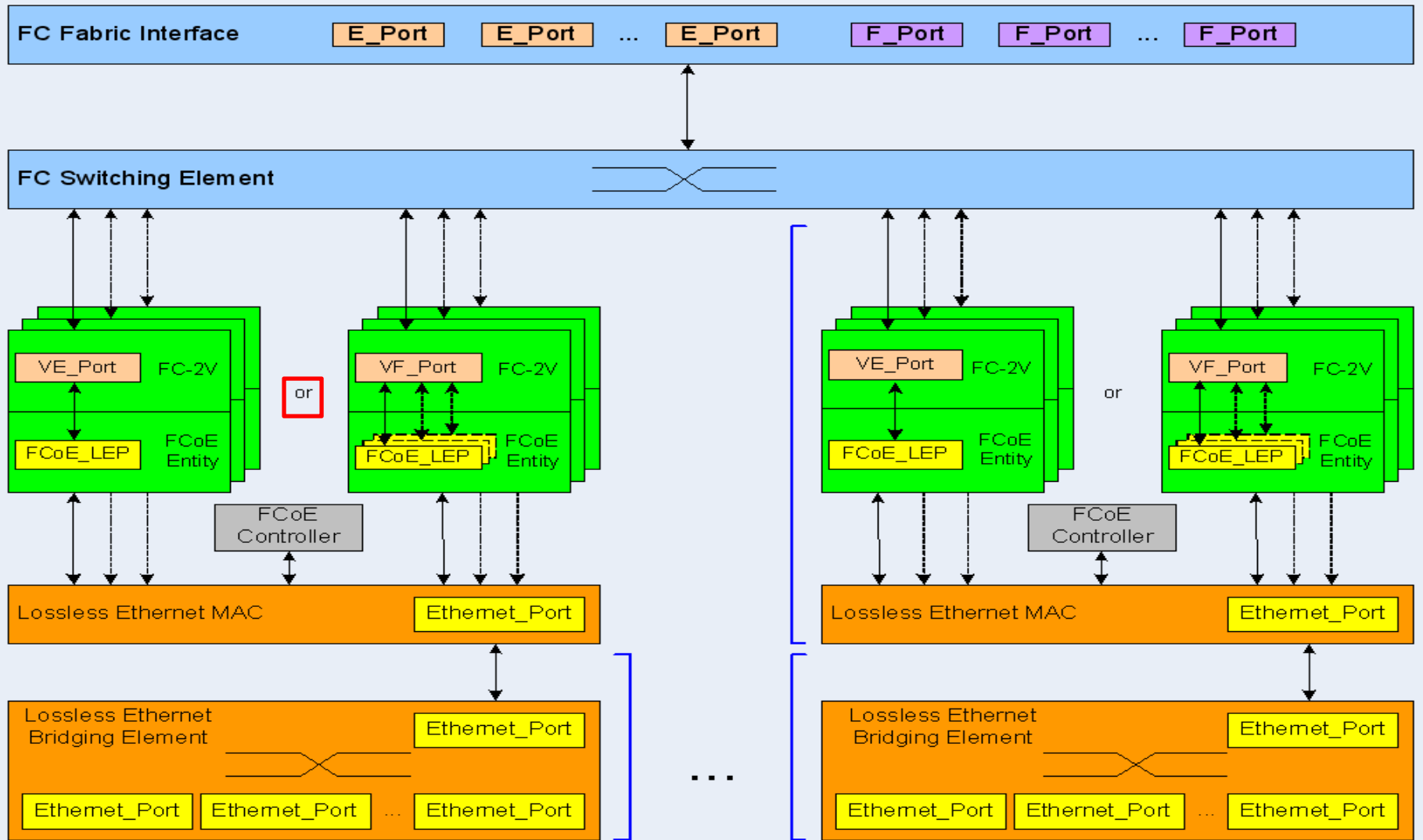
- ❑ ENode (FCoE Node)
 - ❑ A Fibre Channel node that is able to transmit (and receive) FCoE frames using one or more ENode MACs
- ❑ VN_Port (Virtual N_Port)
 - ❑ An instance of the FC-2V sublevel of Fibre Channel that operates as an N_Port and is dynamically instantiated on successful completion of a FIP FLOGI or FIP NPIV FDISC Exchange

- ❑ VF_Port (Virtual F_Port)
 - ❑ An instance of the FC-2V sublevel of Fibre Channel that communicates with one or more VN_Ports and that is dynamically instantiated on successful completion of a FIP FLOGI Exchange
- ❑ VE_Port (Virtual E_Port)
 - ❑ An instance of the FC-2V sublevel of Fibre Channel that communicates with another VE_Port and that is dynamically instantiated on successful completion of a FIP ELP Exchange

FCoE Port Models - ENode



FCoE Port Models - FCF



- ❑ ENode FCoE Controller optionally initiates VLAN discovery to discover FCoE VLANs
- ❑ VF_Port FCoE Controller optionally performs VLAN discovery initiated by ENode
- ❑ VE_Port FCoE Controller optionally performs the VLAN discovery to discover FCoE VLANs

VLAN Discovery (2)

- ❑ Recommendation to use the FIP VLAN discovery on default VLAN (i.e., one)
- ❑ At init time, ENode MAC or FCF-MAC may invoke FIP VLAN discovery to discover VLANs in the Lossless Ethernet network that provide FC-BB_E services
- ❑ FIP VLAN discovery not needed if FC-BB_E VLANs already known or VLANs not used

- ❑ ENode MAC may send FIP VLAN Request to All-FCF-MACs MAC address over available VLAN (e.g., the port VLAN)
- ❑ VF_Port FCF-MACs that receive a FIP VLAN Request responds with a unicast FIP VLAN Notification over same VLAN
 - ❑ FIP VLAN Notification frame should provide the list of VLAN IDs over which the originating FCF offers FC-BB_E services

- ❑ ENode MAC that received FIP VLAN Notification may enable one or more of these VLANs for subsequent operations
- ❑ VF_Port FCF-MACs may limit the number of VLAN IDs listed in a FIP VLAN Notification on a per-requester basis

- ❑ VF_Port FCF-MAC discards multicast FIP VLAN Request with source address equal to its FCF-MAC address
 - ❑ FIP VLAN Request should be reported in a vendor specific way as indication of MAC address duplication

- If configuration of VLANs on which a VF_Port FCF-MAC supports FC-BB_E services changes, that FCF-MAC sends unicast FIP VLAN Notification to each ENode MAC address with which that FCF-MAC has established VN_Port to VF_Port Virtual Links
 - Unicast FIP VLAN Notification specifies the revised list of VLAN IDs over which the originating VF_Port FCF-MAC offers FC-BB_E services

VLAN Discovery (7) – VE_Port

- ❑ VE_Port FCF-MAC may send a FIP VLAN Request to the MAC address All- FCF-MACs over available VLAN (e.g., the default VLAN)
- ❑ VE_Port FCF-MACs that receive a FIP VLAN Request respond with a unicast FIP VLAN Notification over the same VLAN

VLAN Discovery (8) – VE_Port

- ❑ FIP VLAN Notification carries the list of VLAN IDs over which the originating FCF offers FC-BB_E services
- ❑ VE_Port FCF-MAC that received FIP VLAN Notification may enable one or more of these VLANs for subsequent operations

- ❑ VE_Port FCF-MAC discards a multicast VLAN Request frame that has a source address equal to its FCF-MAC address
 - ❑ VLAN Request frame should be reported in a vendor specific way as indication of MAC address duplication
- ❑ FCF-MACs 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

- If configuration of VLANs on which a VE_Port FCF-MAC supports FC-BB_E services changes, that FCF-MAC should send a unicast FIP VLAN Notification frame to each FCF-MAC address with which that FCF-MAC has established VE_Port to VE_Port Virtual Links
 - Unicast FIP VLAN Notification frame specifies the revised list of VLAN IDs over which the originating VE_Port FCF-MAC offers FC-BB_E services

- On network with multiple VLANs, FIP discovery is performed in the VLANs where FC-BB_E services are offered when these VLANs are known (e.g., via FIP VLAN discovery)

FIP Discovery (2) – ENode/FCF

- ❑ VF_Port FCoE Controller periodically transmits (every FKA_ADV_PERIOD) multicast DAs to All-ENode-MACs group address
- ❑ FKA_ADV_PERIOD period randomized by adding a random delay (between 0 and 100 ms)
 - ❑ avoids synchronized bursts of multicast traffic within the Ethernet network
- ❑ VF_Port FCoE Controller begins transmitting unsolicited multicast DAs on completion of Fabric configuration

FIP Discovery (3) – ENode/FCF

- ❑ On receiving DAs, ENode FCoE Controller verifies VN_Port addressing capabilities of advertising FCF-MAC (i.e., the values of the FP and SP flags) against its VN_Port addressing capabilities
- ❑ ENode FCoE Controller discards incompatible DAs and creates entry for each compatible FCF-MAC in internal FCF list

- Each entry in FCF list has flags:
 - ‘Max FCoE Size Verified’ - set to zero for entries created from unsolicited multicast DAs, set to one when solicited unicast DA is received
 - ‘Available for Login’ - reflects value of A bit provided by most recently received DA from that VF_Port FCF-MAC

- Enode FCoE Controller selects for login a subset of the FCF-MACs in FCF list having ‘Available for Login’ flag set to one (i.e., the FCF Login Set)
 - based on local policy that should default to selecting the one(s) with higher priority (i.e., lower priority value), unless configured otherwise

FIP Discovery (6) – ENode/FCF

- ❑ FIP FLOGI may be performed with FCF-MAC in FCF Login Set only if its ‘Max FCoE Size Verified’ flag is set to one
- ❑ To perform FIP FLOGI with FCF-MAC in FCF Login Set with ‘Max FCoE Size Verified’ flag set to zero, ENode FCoE Controller transmits unicast DS to that FCF-MAC address and receives solicited unicast DA in response

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

FIP Discovery (8) – ENode/FCF

- ❑ When ENode FCoE Controller becomes operational it discovers VF_Port FCF-MACs that it may perform FIP FLOGI with by transmitting a multicast DS to the All-FCF-MACs group address
- ❑ In response to DS from an ENode MAC, a VF_Port FCF-MAC transmits a solicited unicast DA to the soliciting ENode MAC if its VN_Port addressing modes are compatible with the modes of the ENode MAC and if it is configured to allow a FIP FLOGI from that ENode

- Solicited unicast DA is transmitted to the MAC address specified in the MAC address descriptor in the received DS
 - Solicited unicast DA is transmitted within ADV_TOV upon reception of the DS

- ❑ DAs transmitted in response to a multicast DS should be delayed by a random time uniformly distributed between 0 and 100 ms to avoid synchronized bursts of multicast traffic within the Ethernet network.
 - ❑ Delay should not be applied to solicited unicast DAs sent in response to unicast DSs
 - ❑ Solicited unicast DAs should not be transmitted until Fabric configuration is completed

- ❑ DS carries in the Max FCoE Size descriptor the maximum FCoE PDU size the ENode MAC intends to use for FCoE traffic
- ❑ FIP PDU in a solicited unicast DA is extended to a length that matches the Max_FCoE_Size field value in the Max FCoE Size descriptor in the DS that the DA is responding to
- ❑ ENode MAC may generate multiple DSs

- Reception of solicited unicast DA from an FCF-MAC sets the ‘Max FCoE Size Verified’ flag to one in the entry for that FCF-MAC in the FCF Login Set of an ENode MAC

- ❑ FCF may receive multicast DS from the same ENode MAC on multiple FCF-MACs
 - ❑ Separate solicited unicast DA is transmitted by each of the FCF-MACs that received the multicast DS

- ENode MAC that transmitted the multicast DS is able to determine that it received multiple solicited unicast DAs from the same FCF since the value of the Name_Identifier field in the Name_Identifier descriptor is the same in each of the solicited unicast DAs
 - ENode MAC should select the FCF-MAC for Fabric login with that FCF based on the value of the Priority descriptor in the DAs

- ❑ ENode MAC may receive multiple unsolicited multicast DAs from multiple FCF-MACs of the same FCF
 - ❑ ENode MAC able to determine that those unsolicited multicast DAs are from the same FCF as value of Name_Identifier field in Name_Identifier descriptor is the same in each of the unsolicited multicast DAs
 - ❑ ENode MAC should select the FCF-MAC for Fabric login with that FCF based on the value of the Priority descriptor in the DAs

- ❑ ENode MAC discard any received DS
- ❑ VF_Port FCF-MAC discards any DS originated by a VE_Port FCF-MAC (i.e., F bit set to one)
- ❑ ENode MAC discards unsolicited multicast DA with source address equal to its ENode MAC address
 - ❑ DA should be reported in a vendor specific way as indication of MAC address duplication

- ❑ VF_Port FCF-MAC discards multicast DS that has a source address equal to its FCF-MAC address
 - ❑ DS should be reported in a vendor specific way as indication of MAC address duplication
- ❑ Reception of DAs for more than one Fabric on the same VLAN should be reported by an ENode MAC in a vendor specific manner and no subsequent VN_Port to VF_Port Virtual Links should be instantiated

- ❑ VE_Port FCoE Controller periodically transmits multicast DAs to the All-FCF-MACs group address every FKA_ADV_PERIOD
 - ❑ FKA_ADV_PERIOD is randomized by adding a random delay uniformly distributed between 0 and 100 ms to avoid synchronized bursts of multicast traffic within the Ethernet network.
- ❑ On receiving DAs, the VE_Port FCoE Controller creates an entry per FCF-MAC in an internal FCF list

- Each entry in the FCF list has flags:
 - ‘Max FCoE Size Verified’ - set to zero for entries created from unsolicited multicast DAs, set to one when a solicited unicast DA is received
 - ‘Available for ELP’ - reflects the value of the A bit provided by most recently received DA from that VE_Port FCF-MAC.

- ❑ 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
 - ❑ To perform FIP ELP with FCF-MAC in the FCF list with ‘Max FCoE Size Verified’ flag set to zero, VE_Port FCoE Controller transmits unicast DS to that FCF-MAC address and receives solicited unicast DA in response

- ❑ Periodic reception of unsolicited multicast DAs allow the VE_Port FCoE Controller to continuously verify the FCF-MACs connectivity
 - ❑ ‘Available for Login’ (A) bit in received DAs 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 DAs
- ❑ (A) bit is informational - no effect on existing VE_Port to VE_Port Virtual Links

- ❑ When VE_Port FCoE Controller becomes operational it discovers other VE_Port FCF-MACs by transmitting a multicast DS to the All-FCF-MACs group address
- ❑ In response to a DS from an FCF-MAC, a VE_Port FCF-MAC transmits a solicited unicast DA to the soliciting FCF-MAC if the FC-MAP value in the DS is compatible with the FC-MAP configured on the FCF and if it is configured to allow a Virtual Link with that FCF

- ❑ Solicited unicast DA is transmitted to the MAC address specified in the MAC address descriptor in the received DS
- ❑ Solicited unicast DA is transmitted within ADV_TOV upon reception of the DS
- ❑ DAs transmitted in response to a multicast DS should be delayed by a random time (between 0 and 100 ms) to avoid synchronized bursts of multicast traffic within the Ethernet network
- ❑ Delay should not be applied to solicited unicast DAs sent in response to unicast DSs

FIP Discovery (25) – FCF/FCF

- ❑ DS specifies in the Max FCoE Size descriptor the maximum FCoE PDU size the VE_Port FCF-MAC intends to use for FCoE traffic
- ❑ FIP PDU in a solicited unicast DA is extended to have a length that matches the Max_FCoE_Size field value in the Max FCoE Size descriptor in the DS that the DA is responding to
- ❑ VE_Port FCF-MAC may transmit multiple DSs

FIP Discovery (26) – FCF/FCF

- Reception of solicited unicast DA from an FCF-MAC sets the ‘Max FCoE Size Verified’ flag to one in the entry for that FCF-MAC in the FCF list of the receiving VE_Port FCF-MAC

- ❑ FCF may receive multicast DSs from the same VE_Port FCF-MAC on multiple FCF-MACs
 - ❑ Separate solicited unicast DA is transmitted by each of the FCF-MACs that received the DS
- ❑ VE_Port FCF-MAC that transmitted the multicast DS is able to determine that it received multiple solicited unicast DAs from the same FCF since the value of the Name_Identifier field in the Name_Identifier descriptor is the same in each of the solicited unicast DAs

FIP Discovery (28) – FCF/FCF

- ❑ VE_Port FCF-MAC may receive multiple unsolicited multicast DAs from multiple FCF-MACs of the same FCF
- ❑ VE_Port FCF-MAC is able to determine that those unsolicited multicast DAs are from the same FCF since the value of the Name_Identifier field in the Name_Identifier descriptor is the same in each of the unsolicited multicast DAs

- ❑ After receiving DS originated by FCF (i.e., F bit set to one), FCF-MAC performs verification checks
 - ❑ Name_Identifier field value in the DS is different than Switch_Name of the recipient FCF; and
 - ❑ either:
 - ❑ FP bit is set to one and FC-MAP value in the FC-MAP descriptor in the DS is the same as the FC-MAP value of the recipient FCF; or
 - ❑ FP bit is set to zero, SP bit is set to one, and FC-MAP value in the FC-MAP descriptor in the DS is zero
- ❑ If any verification check is false, DS is discarded

- ❑ After receiving DA, FCF-MAC performs verification checks
 - ❑ Name_Identifier field value in the DA is different than the Switch_Name of the recipient FCF; and
 - ❑ either:
 - ❑ FP bit is set to one and the FC-MAP value in the Fabric descriptor in the DA is the same as the FC-MAP value of the recipient FCF; or
 - ❑ FP bit is set to zero, SP bit is set to one, and the FC-MAP value in the Fabric descriptor in the DA is zero
- ❑ If any verification check is false, DA is discarded

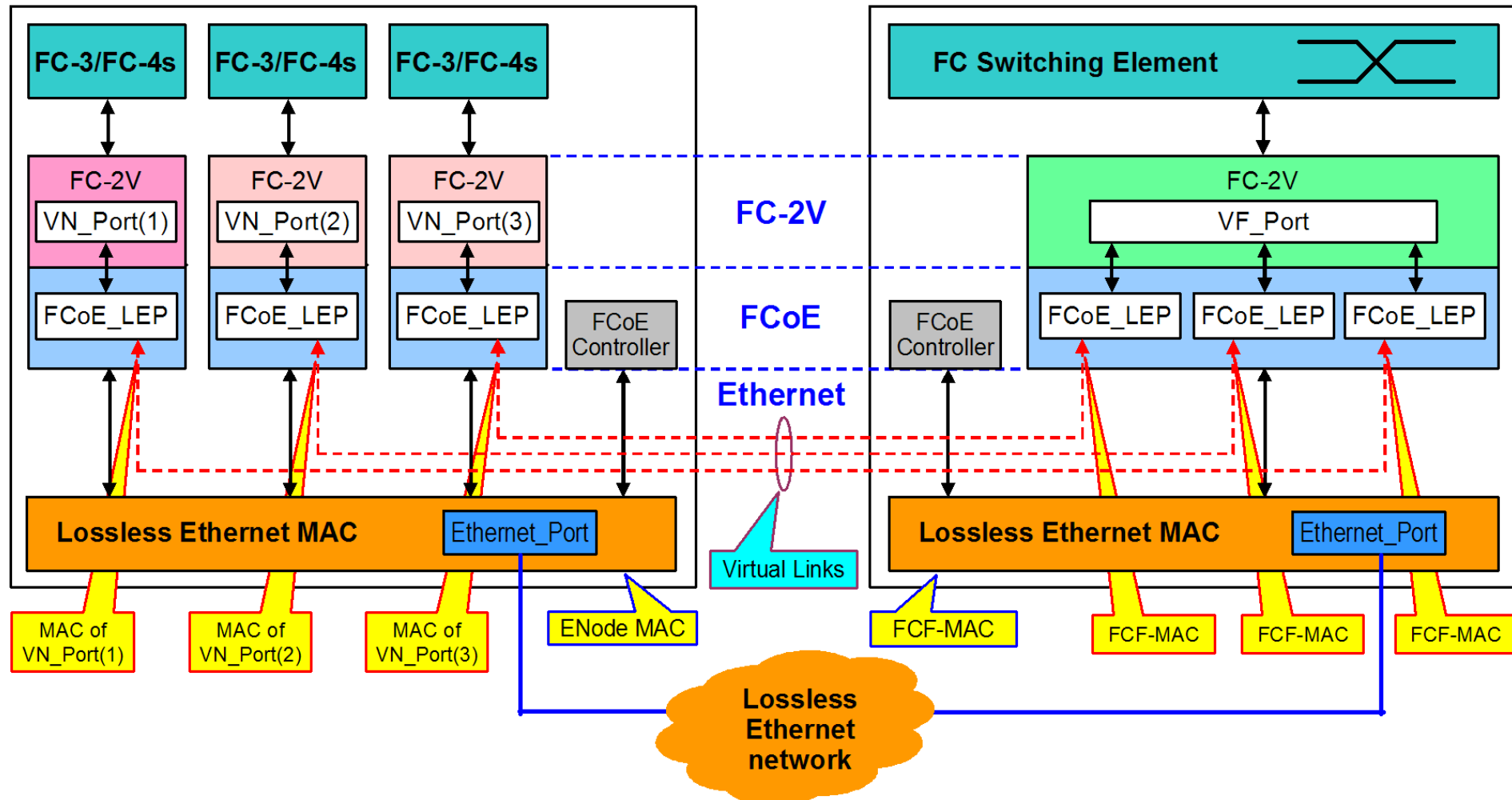
FIP Discovery (3 I) – FCF/FCF

- ❑ VE_Port FCF-MAC discards any DS originated by an ENode (i.e., F bit set to zero).
- ❑ VE_Port FCF-MAC discards a multicast DS that has a source address equal to its FCF-MAC address
 - ❑ DS should be reported in a vendor specific way as indication of MAC address duplication
- ❑ Reception of DAs for more than one Fabric on the same VLAN should be reported by VE_Port FCF-MAC in a vendor specific manner and no subsequent VE_Port to VE_Port Virtual Links should be instantiated

Virtual Links – VN_Port to VF_Port

ENode

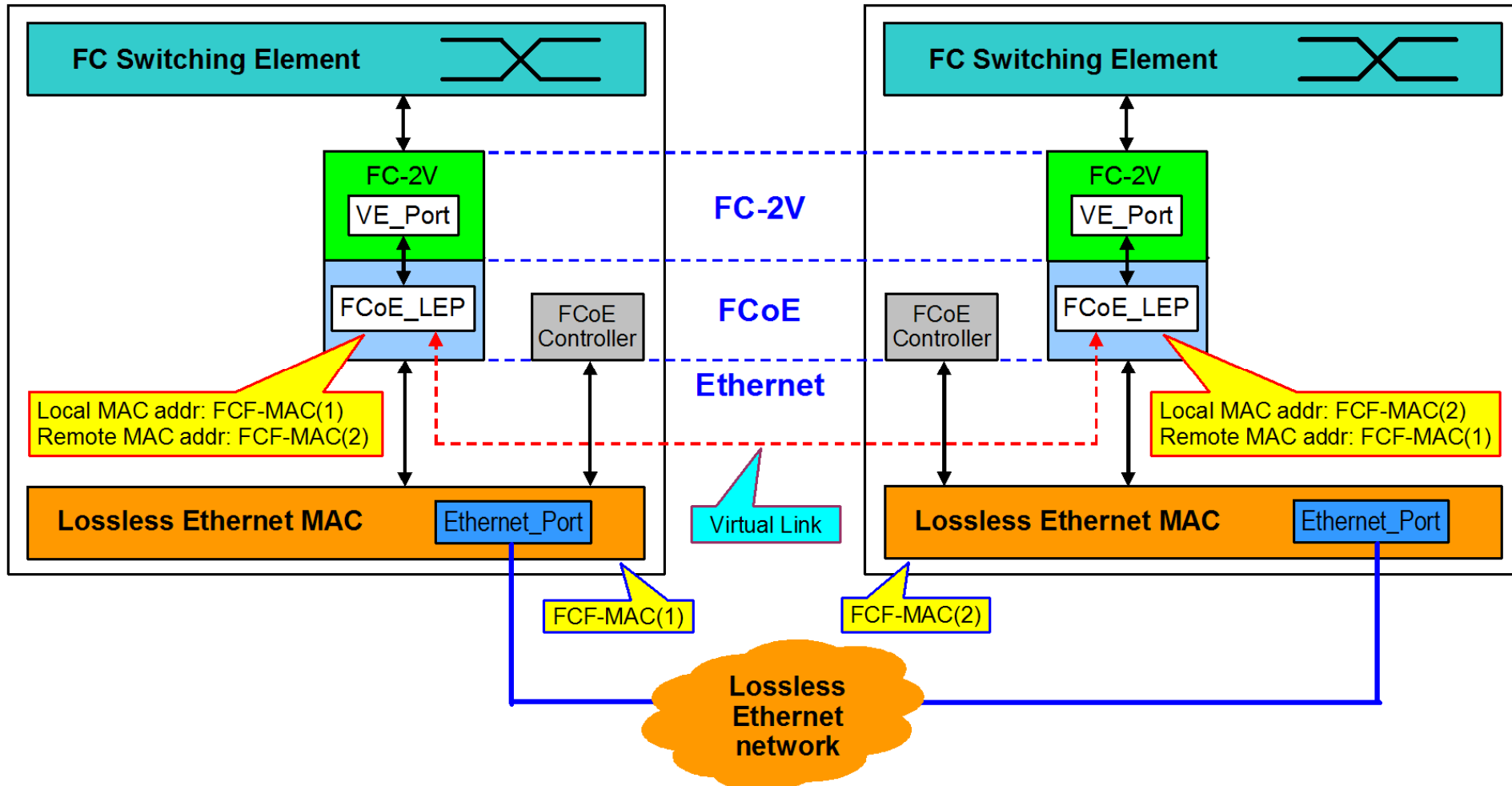
FCF



Virtual Links – VE_Port to VE_Port

FCF 1

FCF 2



- ❑ ENode FCoE Controller instantiates VN_Port to VF_Port Virtual Links on successful completion of FIP Fabric login request. Fabric login (i.e., FLOGI, NPIV FDISC) is performed using FIP frames and the associated FIP descriptor type
- ❑ Fabric login (i.e., FLOGI, NPIV FDISC) not performed using FCoE frames
- ❑ FIP Fabric login also provides method to assign a MAC address for the VN_Port

- ❑ When ENode FCoE Controller transmits FIP FLOGI Request or FIP NPIV FDISC Request it indicates the addressing mode it intends to use (i.e., FPMA, SPMA, both)
- ❑ MAC address returned by the FCF in a FIP FLOGI LS_ACC or FIP NPIV FDISC LS_ACC is used as the VN_Port MAC address

- If SP bit is set to one in FIP FLOGI Request or FIP NPIV FDISC Request and the FCF selects to use SPMA, the FCF returns the MAC address specified in the FIP FLOGI Request or FIP NPIV FDISC Request in the FIP FLOGI LS_ACC or FIP NPIV FDISC LS_ACC, if that MAC address is valid

- ❑ If FP bit is set to one in a FIP FLOGI Request or FIP NPIV FDISC Request and the FCF selects to use FPMA, the FCF returns a properly formed FPMA MAC address in the FIP FLOGI LS_ACC or FIP NPIV FDISC LS_ACC
- ❑ If both FCF and ENode support both SPMA and FPMA, the FCF selects a type and returns a MAC address for the selected type

- ❑ Explicit VN_Port to VF_Port Virtual Link de-instantiation is performed by an ENode MAC by performing Fabric logout
- ❑ Fabric logout (i.e., Fabric LOGO) is performed by an ENode using FIP frames and the associated FIP descriptor type
- ❑ Fabric logout not performed using FCoE frames
- ❑ FIP Fabric logout also provides a method to de-assign a MAC address for the VN_Port

- ❑ VE_Port FCoE Controller instantiates VE_Port to VE_Port Virtual Links on successful completion of a FIP ELP request
- ❑ ELP performed using FIP frames and the associated FIP descriptor type
- ❑ ELP not performed using FCoE frames
- ❑ FIP ELP also provides a method to communicate the MAC address for the VE_Port

- ❑ VN_Port to VF_Port Virtual Links and VE_Port to VE_Port Virtual Links overlay a Lossless Ethernet network
- ❑ Virtual Link maintenance protocol specifies how to process faults that may occur in the Lossless Ethernet network

- Upon local physical layer faults, an ENode MAC de-instantiates all its VN_Ports to VF_Port Virtual Links upon detecting physical layer is not operational
- Condition is handled as implicit Fabric logout for involved VN_Ports
- VF_Port FCF-MAC de-instantiates all its VF_Ports upon detecting physical layer is not operational

- ❑ For non-local faults, ENode and FCF FCoE Controllers continuously verify state of VN_Port to VF_Port Virtual Link by transmitting appropriate FIP frames and verifying received FIP frames
- ❑ Behavior may be disabled by VF_Port FCF-MACs under administrative control by setting D bit to one in DA FKA_ADV_Period descriptor(s)
- ❑ (D) bit in the FKA_ADV_Period descriptor may only be set to one in a direct-attach topology (i.e., ENode directly connected to FCF with no intermediate Ethernet bridges)

Virtual Link Maintenance

Bit Word	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0	
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0	Type=0Ch						Length=02h						Reserved										D									
1	FKA_ADV_PERIOD																															

- ❑ Value of D bit is administratively configurable on FCFs
- ❑ D bit is set to zero unless administratively set to one
- ❑ VE_Port FCF-MACs ignore value of D bit provided in received DAs
- ❑ ENode MACs process the value of D bit provided in received DAs

- ❑ D bit set to zero, receiving ENode MAC verifies periodic reception of DAdS and transmits periodic ENode FIP Keep Alive and VN_Port FIP Keep Alive
- ❑ VF_Port FCF-MAC verifies periodic reception of ENode FIP Keep Alive and VN_Port FIP Keep Alive

- ❑ D bit set to one, receiving ENode MAC may verify periodic reception of DAs and should not transmit periodic ENode FIP Keep Alive and VN_Port FIP Keep Alive
- ❑ VF_Port FCF-MAC does not verify periodic reception of ENode FIP Keep Alive and VN_Port FIP Keep Alive
- ❑ Discard any received ENode FIP Keep Alive and VN_Port FIP Keep Alive

- ❑ ENode FCoE Controller transmits unicast FIP Keep Alive 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 to each VF_Port FCF-MAC that is has VN_Ports logged in with
- ❑ ENode FIP Keep Alive is transmitted every FKA_ADV_PERIOD

- ❑ FKA_ADV_PERIOD is obtained from DAs received from VF_Port FCF-MACs that the ENode MAC has VN_Ports logged in with
- ❑ EnNode FCoE Controller also transmits unicast FIP Keep Alive 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) to the VF_Port FCF-MAC that the VN_Port is logged in with

- VN_Port FIP Keep Alive frame is transmitted every FKA_VN_PERIOD

- ❑ ENode FCoE Controller monitors the status of a VF_Port that it has VN_Ports logged in with by verifying reception of unsolicited multicast DAs from that VF_Port FCF-MAC
- ❑ Unsolicited multicast DAs are supposed to be received every FKA_ADV_PERIOD
- ❑ If unsolicited multicast DAs not received within $2.5 * \text{FKA_ADV_PERIOD}$, all VN_Port to VF_Port Virtual Links with that VF_Port are implicitly de-instantiated

- ❑ Condition is counted as a Virtual Link failure and handled as an implicit Fabric logout for the involved VN_Ports
- ❑ FCF-MAC is removed from FCF Login Set
- ❑ Subsequent FIP Fabric Login may be performed with an FCF-MAC in the current FCF Login Set

- ❑ VF_Port FCoE Controller transmits an unsolicited multicast DA to the All-ENode-MACs group address every FKA_ADV_PERIOD
- ❑ VF_Port FCoE Controller monitors the status of an ENode MAC that it has active VN_Port to VF_Port Virtual Links with by verifying the reception of FIP Keep Alive from that ENode MAC and its VN_Ports

- VN_Port FIP Keep Alives (i.e., those containing a Vx_Port Identification descriptor) are supposed to be received every FKA_VN_PERIOD and ENode FIP Keep Alives (i.e., those not containing a Vx_Port Identification descriptor) are supposed to be received every FKA_ADV_PERIOD

- ❑ If VN_Port FIP Keep Alives not received within $2.5 * FKA_VN_PERIOD$, the associated VN_Port to VF_Port Virtual Link is explicitly de-instantiated (i.e., FIP Clear Virtual Links listing the unreachable VN_Port is transmitted)
- ❑ Condition is handled as implicit Fabric logout for the involved VN_Port

- ❑ If ENode FIP Keep Alives not received within $2.5 * FKA_ADV_PERIOD$, all associated VN_Port to VF_Port Virtual Links are explicitly de-instantiated (i.e., FIP Clear Virtual Links listing all the unreachable VN_Ports is transmitted)
- ❑ Condition is handled as implicit Fabric logout for the involved VN_Ports

- ❑ Explicit VN_Port to VF_Port Virtual Link de-instantiation invoked by VF_Port FCF-MAC by transmitting FIP Clear Virtual Links
- ❑ FIP Clear Virtual Links transmitted to an ENode MAC with logged in VN_Ports provides the list of VN_Ports to be removed
- ❑ ENode MAC de-instantiates VN_Ports listed in a FIP Clear Virtual Link upon reception of the FIP frame
- ❑ Condition is handled as implicit Fabric logout for involved VN_Ports

- ❑ Size of FIP Clear Virtual Links (frame) does not exceed standard Ethernet MAC Client Data size
 - ❑ 1,500 bytes for basic frames
 - ❑ 1,504 bytes for Q-tagged frames
- ❑ If list of VN_Ports to be removed does not fit in single FIP frame, multiple FIP frames are transmitted to provide the entire list
- ❑ On reception of VN_Port FIP Keep Alive frame from VN_Port not logged, VF_Port FCoE Controller transmits FIP Clear Virtual Links frame specifying that VN_Port

- ❑ On reception of ENode FIP Keep Alive from ENode MAC not logged in, VF_Port FCoE Controller transmits FIP Clear Virtual Links specifying no VN_Ports
- ❑ FIP Clear Virtual Links specifying no VN_Ports is handled by ENode MAC by de-instantiating all VN_Port to VF_Port Virtual Links with that VF_Port FCF-MAC
- ❑ Condition is handled as implicit Fabric logout for involved VN_Ports
- ❑ FIP Clear Virtual Links may be transmitted by FCFs whenever appropriate to speed-up fault recovery

- ❑ FKA_ADV_PERIOD value can be changed on FCF via administrative control
 - ❑ Each VF_Port FCF-MAC of FCF advertises updated FKA_ADV_PERIOD in subsequent unsolicited multicast DAs
- ❑ FKA_ADV_PERIOD value decrease = FCF transmits unsolicited multicast DAs at interval specified by updated value, but does not use updated value for detection of missing ENode FIP Keep Alives until five times the old value has elapsed since the transmission of the first updated unsolicited multicast DA

- ❑ FKA_ADV_PERIOD value increase: FCF transmits unsolicited multicast DAs at the interval specified by the old value until five times the updated value has elapsed since the transmission of the first updated unsolicited multicast DA, but does not use the updated value for detection of missing ENode FIP Keep Alives
- ❑ On detecting updated value, ENode with VN_Port <->VF_Port Virtual Links instantiated with that FCF transmits ENode FIP Keep Alives at the interval specified by the updated FKA_ADV_PERIOD value and uses the updated value for detection of missing unsolicited multicast DAs

- ❑ For local physical layer faults, FCF de-instantiates all its VE_Port to VE_Port Virtual Links upon detecting physical layer not operational
- ❑ For non-local faults, VE_Port FCoE Controllers continuously verify state of VE_Port<->VE_Port Virtual Link by transmitting unsolicited multicast DAs and verifying received unsolicited multicast DAs
- ❑ VE_Port FCoE Controller transmits DA to All-FCF-MACs group address every FKA_ADV_PERIOD

- ❑ VE_Port FCoE Controller monitors the status of a VE_Port<->VE_Port Virtual Link by verifying reception of unsolicited multicast DAs
- ❑ Unsolicited multicast DAs supposed to be received every FKA_ADV_PERIOD
- ❑ Unsolicited multicast DAs not received within 2.5 * FKA_ADV_PERIOD, VE_Port<->VE_Port Virtual Link associated with that FCF-MAC is explicitly de-instantiated along with the associated VE_Port and FCF-MAC is removed from FCF List

- ❑ Explicit VE_Port <->VE_Port Virtual Link de-instantiation via transmitting FIP Clear Virtual Links from FCF
- ❑ FIP Clear Virtual Links transmitted to a VE_Port provides destination FCF-MAC address in the Vx_Port Identification descriptor
- ❑ VE_Port de-instantiates VE_Port listed in FIP Clear Virtual Link upon reception of FIP frame

- ❑ FKA_ADV_PERIOD value may be changed on FCF via administrative control
 - ❑ Each VE_Port FCF-MAC of FCF advertises updated FKA_ADV_PERIOD in subsequent unsolicited multicast DAs and transmits them at interval specified by updated value
- ❑ Upon detection of updated value in received unsolicited multicast DAs, VE_Port FCF-MACs use updated value for detection of missing unsolicited multicast DAs

New ELS Stuff

- ❑ Link Error Status Block definition
- ❑ Link Incidents definition

- ❑ Link Error Status Block (LESB) monitors link error statistics useful for problem determination in FC
- ❑ LESB obtained via VN_Port using Read Link Error Status Block (RLS) ELS
- ❑ VN_Port /VF_Port supporting LESB with FC-BB_E format provides its LESB format in response to an RLS ELS request

New ELS Stuff - LESB

Bit Word	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0	
	1	0	9	8	7	6	5	4	3	2	1	0	9	8	7	6	5	4	3	2	1	0										
0	Link Failure Count																															
1	Virtual Link Failure Count																															
2	Missing FIP Keep Alive or Discovery Advertisement Count																															
3	Symbol Error During Carrier Count																															
4	Errored Block Count																															
5	Frame Check Sequence Error Count																															

- ❑ Link Failure Count indicates number of link failures detected through detection of physical link transitions (i.e., the number of times that the `aMediaAvailable` attribute changes from the enumeration “available” to any other enumeration)
- ❑ Virtual Link Failure Count indicates number of virtual link failures detected by the Virtual Link maintenance protocol

- ❑ Missing FIP Keep Alive or Discovery Advertisement Count indicates number of missing Virtual Link maintenance protocol frames
- ❑ Missing Virtual Link maintenance protocol frame is detected after 1.5 times FKA_ADV_PERIOD since the reception of the last Virtual Link maintenance protocol frame
- ❑ For ENode, Missing FIP Keep Alive or Discovery Advertisement Count indicates the number of missing DAs

- ❑ For VF_Port, Missing FIP Keep Alive or Discovery Advertisement Count indicates number of missing FIP Keep Alives from an ENode
- ❑ Symbol Error During Carrier Count indicates number of reception errors at the PHY layer that occur during frame reception
- ❑ Errored Block Count indicates cumulative count of events counted by eight-bit errored blocks counter
- ❑ Frame Check Sequence Error Count indicates number of Ethernet frames received that are integral number of octets in length and do not pass FCS check

New ELS Stuff – Link Incidents

Value	Meaning
00h	Reserved
01h	Implicit incident
02h	Bit-error-rate threshold exceeded
03h	Link Failure - Loss-of-Signal
04h	Link Failure - Remote fault
05h	Link Failure - Virtual Link failure
06h-FFh	Reserved

- ❑ Bug fixes and enhancements
- ❑ FCoE End-to-End functionality
- ❑ FCoE direct connect functionality (i.e., point-to-point)
- ❑ Bit Error Rate improvement
 - ❑ 10^{-12} to 10^{-15}

Questions?

- Feel free to contact me anytime 😊
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**THANK YOU
MUCH !**