ST over Fibre Channel
Content for T11.1/Project 1245-D
Annex A (Fibre Channel as Lower Layer)

Draft 2.3
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A.1 Fibre Channel as LLP

Fibre Channel Physical Interface, X3.230-1994 and X3.230/AM1: 1996 describes the FC-PH link and protocol. Within the Fibre Channel Physical Interface document, Annex S describes the model for using the FC-PH service interface, which is used as the basis for FC-LE. FC-LE specification in turn is the basis for mapping ST as the ULP.

Fibre Channel Link Encapsulation (FC-LE), X3.287-1996 specifies generic protocol encapsulation for Fibre Channel networks. Class 1 or class 3 service may be used for ST encapsulation using FC-LE services on one or more FC-PH links.

Note that the term port may be ambiguous when discussing both upper layer protocol and lower layer protocol. To distinguish, the term N_port is used when referring to an LLP fibre channel port. One or more fibre channel N_ports may be employed when encapsulating ST to provide independent virtual connections for ST control channels and data channels. Figure 1 shows two fibre channel nodes, each with two LLP N_Ports.

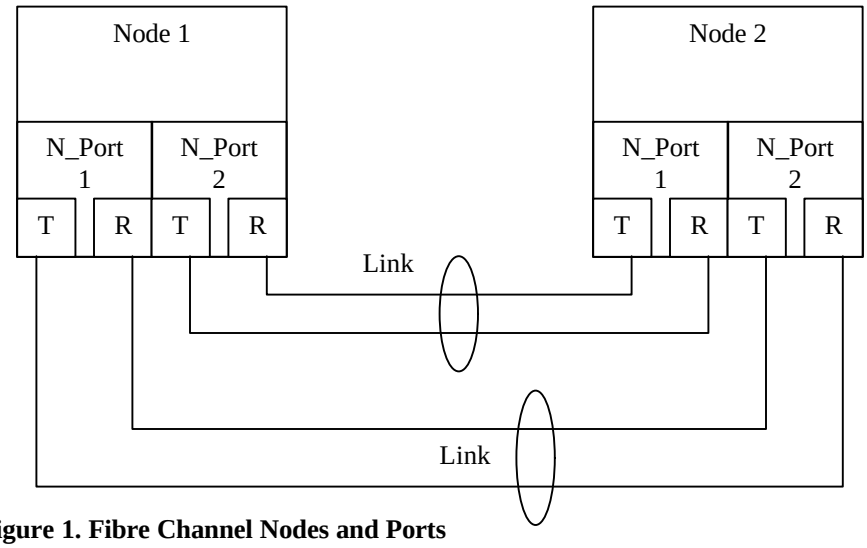

Figure 1. Fibre Channel Nodes and Ports

Although FC-LE encapsulation of ST permits bridging and routing, no attempt is made to describe bridging or routing beyond a fabric region as described for FC-LE. A fabric region is equivalent to a LAN segment.

Mapping ST on FC-LE is similar to ST on HIPPI-FP. The LLP header has two parts, the FC-PH Frame header and the optional Network header, which includes the MAC header, as defined for FC-PH, and the SNAP header, as defined for FC-LE. The optional Network header is required for the first frame, but is not included with subsequent frames in an FC-PH Sequence. The ST header appears once for each STU.

Figure 2 depicts the ST header following the FC-PH Frame and Network headers.

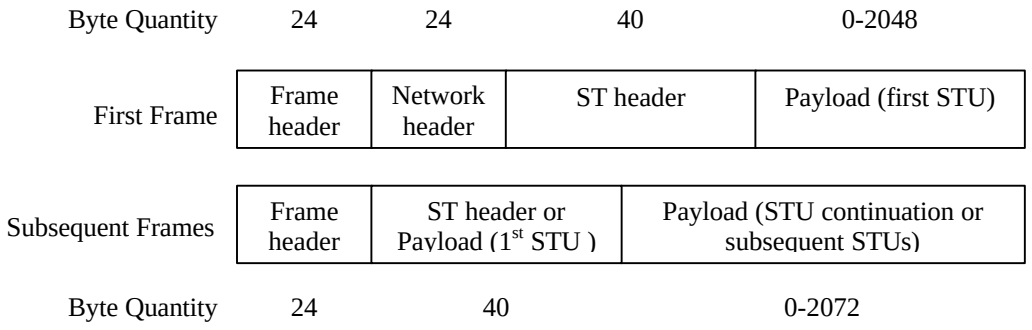

Figure 2. Frame Content

Because FC-PH physical addresses are used for the network routing within the FC region (LAN segment), address resolution services are also provided with the FC-PH and FC-LE standards. The implementation of these services is outside the scope of this description. However, the Network header format is depicted in Figure 3.

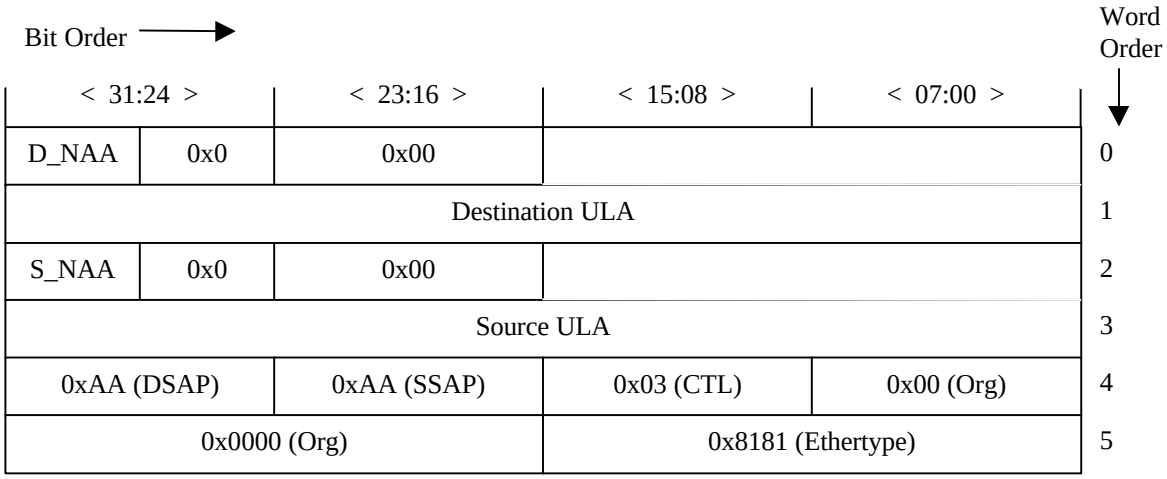

Figure 3. Network Header

The LLC/SNAP header is an 8 byte header as defined by 802.3 LLC-SNAP with the following field assignments:

LLC DSAP byte shall contain (1010 1010) or 0xAA
LLC SSAP byte shall contain (1010 1010) or 0xAA
LLC CTL byte shall contain (0000 0011) or 0x03 for Unnumbered Info
SNAP Organization Code (24 bits) shall be zero
SNAP Type or Ethertype field (16 bits) shall be set as defined in Assigned Numbers
(ST = 0x8181)

Each ST transfer uses one or more FC-PH Exchanges. An FC-PH Exchange consists of one or more related non-concurrent FC-PH Sequences, hence an ST transfer will use more than one FC-PH Exchange to permit concurrency for Block transfers. Each ST Block will use one FC-PH Sequence. Each STU will use up to 65,536 FC-PH data frames within an FC-PH Sequence, the frame quantity within an FC-PH Sequence is limited by the 16-bit SEQ CNT field. Consequently, the maximum STU size is limited to 138,411,968 bytes (2,048 in the 1st frame plus 2,112*65,535= 138,409,920 in subsequent frames).

FC-LE services may be used to establish address resolution within the FC-LE region. These services provide N_Port addressing for the FC-PH routing. The ST port request process shall establish virtual connections in the ULP.

The FC-LE layer shall use the destination address and the source address to discover, and include in the FC-PH frame, the destination and source ids, respectively. Additionally, the network destination and source addresses shall be included in the network destination and source address fields of the Network header when required. The FC-LE layer shall also use the ethertype field from the CCI information to include in the SNAP header.

Neither FC-PH Class 1 nor Class 3 service provides virtual circuits or virtual channels, therefore both Control and Data Operations are queued and processed in fifo order when one fibre channel is employed. Although operations are transmitted in order, for Class 3, the fabric may not deliver them in the same order. ST requires in-order transmission and delivery of STUs, but it is expected that many implementations will handle out-of-order Blocks. So, if the FC-LE service cannot preserve ordering, then the Blocksize should be set to 2,048 bytes and STUs should be limited to 2,048 to occupy one FC-PH frame.

When Class 1 is used for both large and small transmissions, either latency or bandwidth must be sacrificed to provide optimal performance for one or the other. When Class 3 is employed, the Blocksize limit required for ordering restricts bandwidth. To overcome each of these restrictions, the Intermix feature may be employed and large transfers may use Class 1 while small transfers use Class 3. In this case, Control Operations and Data Operations may be interleaved: there is no requirement for all the STUs of a multi-STU block to be transmitted contiguously on the medium.

Fabric Loop Attachment has been profiled in T11/Project 1235-DT/Rev 2.6. When the Fabric Loop Attachment profile is used as a part of the topology employed for ST protocol, Class 1 is prohibited.

When more than one fibre channel is employed, striping should follow principles provided in Annex B.