SAE INTERNATIONAL

AEROSPACE STANDARD

AS5653 REV. B

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Superseding AS5653A

High Speed Network for MIL-STD-1760

RATIONALE

The AS5653A standard defined a High Speed Fibre Channel Network to improve the capability of MIL-STD-1760 to transfer information. That activity was initiated at the request of the US Navy in 2001. This standard – AS5653B - is a followup to AS5653A initiated to correct some technical issues discovered in AS5653A as well as to include some additional useful features. This revision completely replaces the previous AS5653A version.

FOREWORD

AS5653 makes extensive reference to Fibre Channel standards. In the context of the MIL-STD-1760 interfaces, AS5653 is referred to as a "bus". In the context of Fibre Channel, AS5653 is referred to as a "network". To aid comprehension of AS5653 explanatory text is included, as illustrated below. This explanatory text is for guidance only.

Text in this font is explanatory, for the reader's guidance and does not form a part of the standard.

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TABLE OF CONTENTS

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1. SCOPE

AS5653 may be applied to Air Vehicles and Stores implementing MIL-STD-1760 Interface Standard for Aircraft/Store Electrical Interconnection System.

1.1 Purpose

This standard defines the characteristics and requirements for a high speed data bus incorporated within a MIL-STD-1760 interface to provide improved transfer capabilities and an alternative command and control path. The high speed data bus is based on Fibre Channel standards. This document (AS5653) is a profile of Fibre Channel standards. This standard identifies the network topology in examples. Supported topologies include Fabric Switched and Point-to-point. The Fibre Channel Arbitrated Loop topology is prohibited.

This standard contains the minimum interoperability requirements necessary to define a standardized transport mechanism for video, audio, data files, and command and control transfers. This standard assumes knowledge of Fibre Channel communication concepts - reference should be made to the Fibre Channel standards where appropriate.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 Government Publications

Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6396, http://quicksearch.dla.mil/.

MIL-STD-1553B, Notice 4	Digital time Division Command/Response Multiplex Data Bus (Note: Revision B Notice 4 is specifically required)
MIL-STD-1760E	Aircraft/Store Electrical Interconnection System

Despite MIL-STD-1760 being the parent document, reference is made to it for connector details.

2.1.2 ANSI Publications

For electronic or paper copies of ANSI standards listed here contact: Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112-5704 or on the web at http://webstore.ansi.org/ or http://global.ihs.com/.

FC-AE-1553	INCITS TR-42-2007 INCITS Technical Report for Information Technology - Fibre Channel - Avionics Environment - Upper Level Protocol (FC-AE-1553)
FC-AV	ANSI INCITS 356-2002 Fibre Channel - Audio Video (FC-AV)
FC-PI	ANSI INCITS 352-2002 Information Technology - Fibre Channel - Physical Interfaces (FC-PI)
FC-SW-4	ANSI INCITS 418-2006 American National Standard for Information Technology - Fibre Channel - Switched Fabric - 4 (FC-SW-4)
FC-FS-2	ANSI INCITS 424-2007 Information Technology - Fibre Channel - Framing and Signalling (FC-FS-2)
FC-LS-2	ANSI INCITS 477-2011 Information Technology - Fibre Channel Link Services (FC-LS-2)

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2.1.3 Usage of References

This standard profiles existing Fibre Channel standards. Table 1 describes the purpose of each referenced document.

TABLE 1 - PURPOSE OF REFERENCED DOCUMENTS

Referenced Document	Purpose
MIL-STD-1760	This is the parent document defining the aircraft store interface. Referenced by this document for signal assignments, connector details and contact details.
FC-SW-4	FC-SW-4 defines the switched fabric topology used, the means of assigning addresses, network initialization and Fast Fabric Initialization. AS5653 selects the Fast Fabric Initialization protocol defined in FC-SW-4 Annex D.
FC-PI	FC-PI defines the physical layer.
FC-AV	Profiled to provide specific means to transfer Audio and Video information.
FC-AE-1553	Profiled to provide a file transfer, command and control mechanism.
FC-FS-2	Defines the Fibre Channel Framing and Signalling.
FC-LS-2	Defines Fibre Channel Extended Link Services.
MIL-STD-1553	Defines the Mil-Standard Bus.

2.2 Definitions

The following definitions are used in Fibre Channel profiling documentation and are adopted for consistency.

REQUIRED: If a feature or parameter value is Required, it means that it shall be used between compliant implementations. Compliant implementations are required to implement the feature. Interoperability is not guaranteed if Required features are not implemented.

INVOCABLE: If a feature or parameter value is Invocable, it means that compliant implementations are required to implement the feature. Invocable is different than Required in that an implementation may invoke (i.e., use) the feature if needed, but it is not required to invoke it.

ALLOWED: If a feature or parameter value is Allowed, it means that it may be used between compliant implementations. Compliant implementations are not required to implement the feature. Typically, the potential user of an Allowed feature may determine if an implementation supports it via an Invocable discovery process.

PROHIBITED: If a feature is Prohibited, it means that it shall not be used between compliant implementations.

Table 2 summarizes the above definitions.

TABLE 2 - SUMMARY OF IMPLEMENTATION AND USE OF FEATURES

Term	Implementation	Use
Required	Shall	Shall
Invocable	Shall	May
Allowed	May	May
Prohibited	May	Shall Not

These definitions are re-used from Fibre Channel to give a consistent approach.

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2.3 Abbreviations

AE	Avionics Expansion
AE_Port	Avionics Expansion Fibre Channel Port
ASI	Aircraft Store Interface
BB_Credit	Buffer-to-Buffer Credit
CSI	Carriage Store Interface
CSSI	Carriage Store Station Interface
DFC	Down Fibre Channel
E_D_TOV	Error_Detect_Timeout value
ELP	Exchange Link Parameters
ELS	Extended Link Services
FC	Fibre Channel
FFI	Fast Fabric Initialization
FLOGI	Fabric Login
F_Port	Fibre Channel Fabric Port
Gbaud	Giga Baud
ISL	Inter-Switch Link
MSI	Mission Store Interface
NC	Network Controller
N_Port	Fibre Channel Node Port
NT	Network Terminal
PLOGI	N_Port Login
R_A_TOV	Resource_Allocation_Timeout value
R_T_TOV	Receiver_Transmitter_Timeout value
RDMA	Remote Direct Memory Access
UFC	Up Fibre Channel
C-S/D_TX_TOV	End of command or status sequence transmission to start of data sequence transmission timeout value

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C-S/D_RX_TOV	End of command or status sequence reception to start of data sequence reception timeout value
NC_C-D/S_BURST _TOV	Network Controller command or data transmission to status reception indicating burst size timeout value
NC_C/S _TOV	Network Controller command or data transmission to status reception timeout value
NT_C-D/S_BURST _TOV	Network Terminal command or data reception to status transmission indicating burst size timeout value
NT_C/S_TOV	Network Terminal command or command plus data reception to status transmission timeout value
R_RDY	Receiver Ready flow control Primitive Signal
UI	Unit Interval
VC_RDY	Virtual Circuit Ready flow control Primitive Signal.

3. GENERAL REQUIREMENTS

3.1 Port Designation

The ports shall provide 1.0625 Gbaud Fibre Channel Port functionality as defined in FC-FS-2 and FC-SW-4 and allocated in Table 3. Examples are given in Figures 1 and 2.

TABLE 3 - MIL-STD-1760 INTERFACE TO FIBRE CHANNEL PORT FUNCTIONALITY MAPPING

MIL-STD-1760 Connector	Fibre Channel Port Functionality
ASI	AE_Port or F_Port or N_Port
MSI	N_Port
CSI	AE_Port or N_Port
CSSI	AE_Port or F_Port or N_Port

A Fibre Channel Port may be capable of multiple functionalities. The functionality used depends upon the initialization sequence followed, and is determined by responses to link initialization commands. After initialization, a Fibre Channel port has a single functionality. In this profile, an ASI connected to an MSI is an F-port or N_Port, and an ASI connected to a CSI is an AE_Port or N_Port. The same logic applies for a CSSI.

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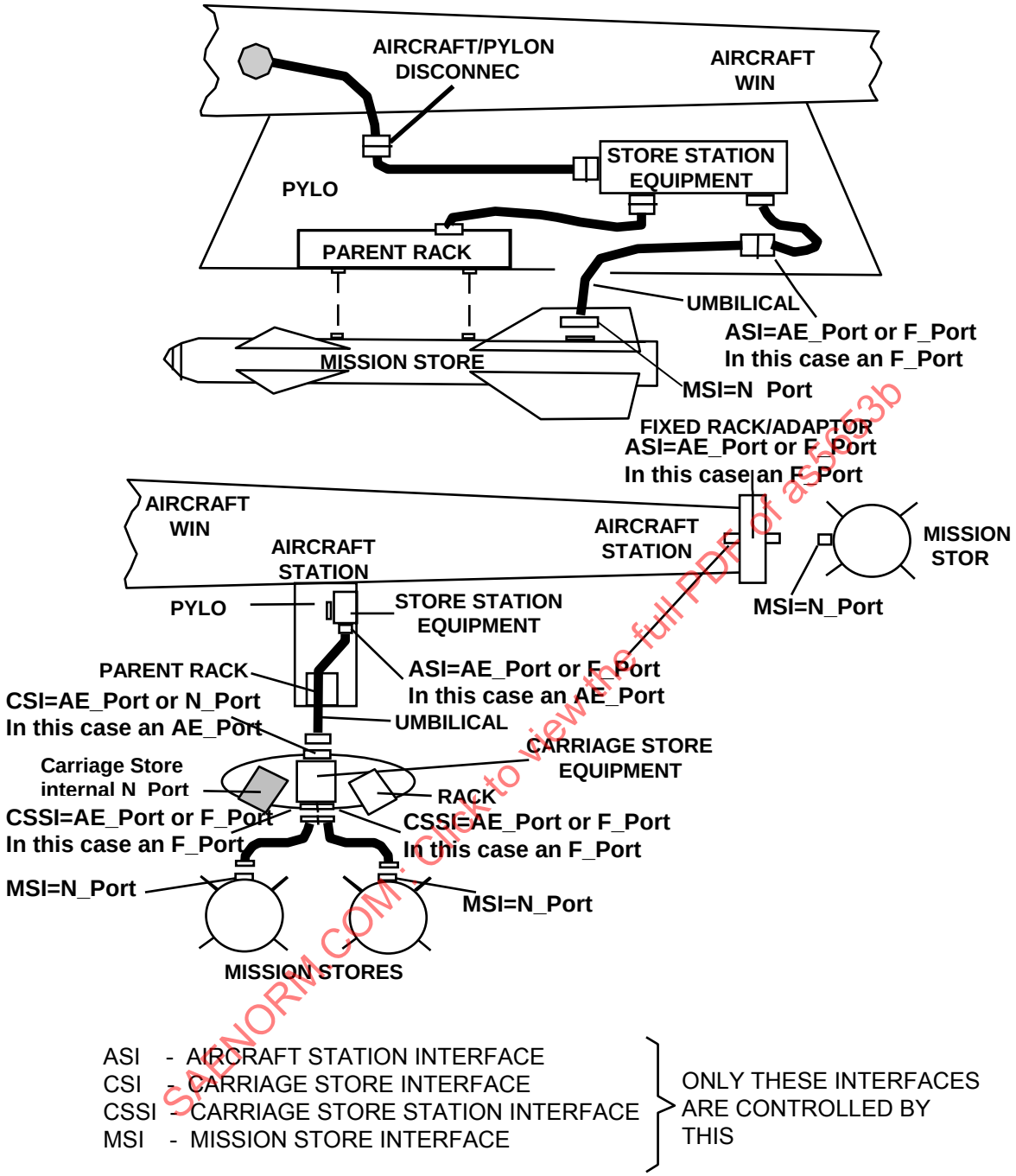

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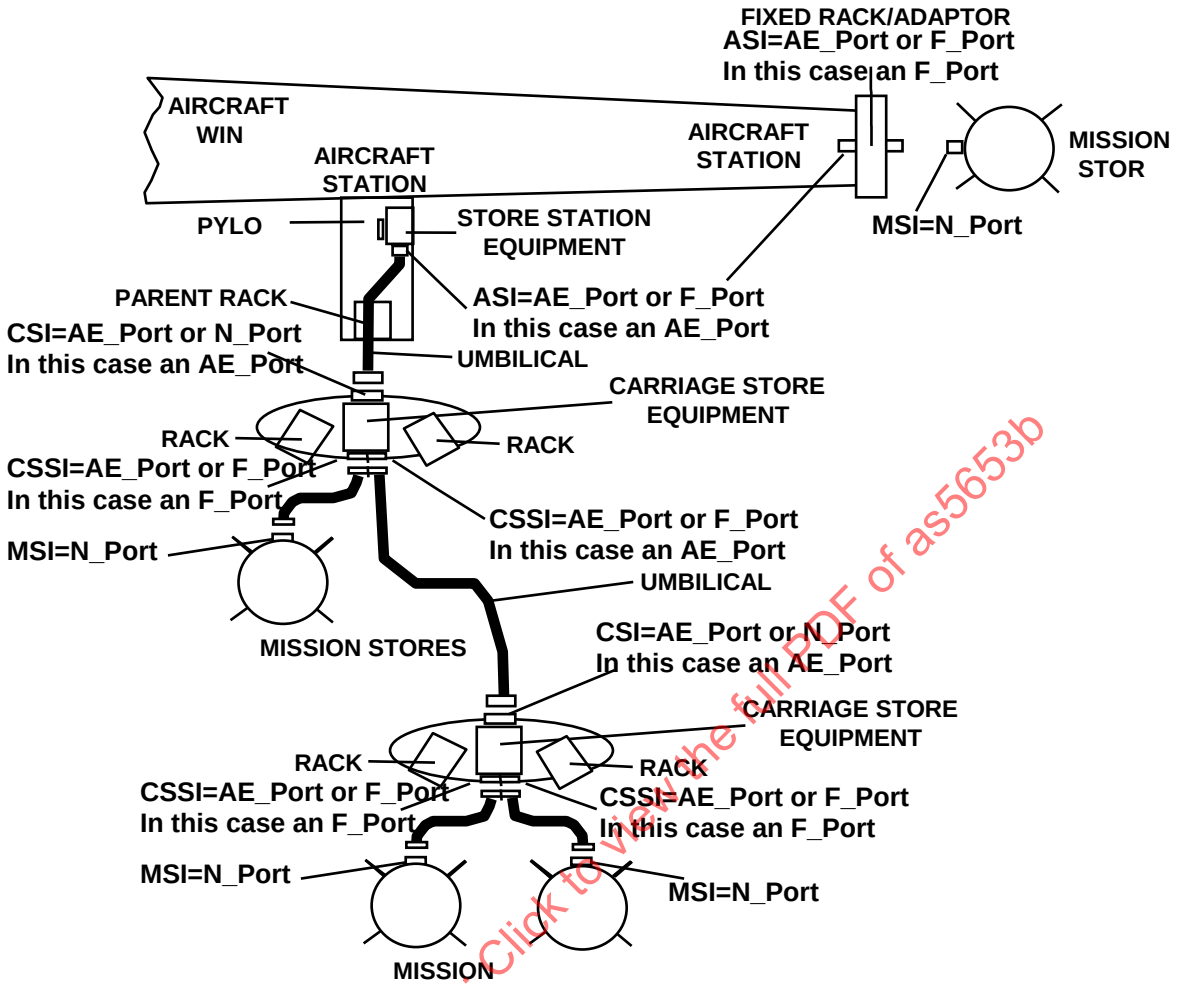
FIGURE 1 - AIRCRAFT STORE CONFIGURATION EXAMPLE 1 WITH FIBRE CHANNEL PORT NOTATION



ASI - AIRCRAFT STATION INTERFACE
CSI - CARRIAGE STORE INTERFACE
CSSI - CARRIAGE STORE STATION INTERFACE
MSI - MISSION STORE INTERFACE

} ONLY THESE INTERFACES ARE CONTROLLED BY THIS

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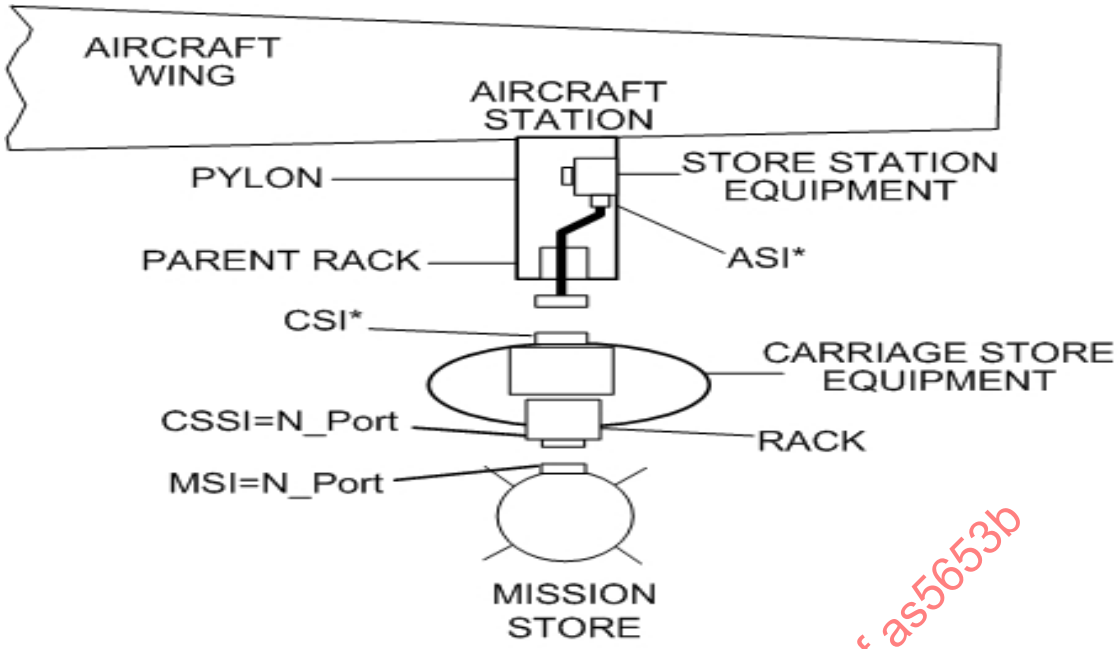
FIGURE 2 - AIRCRAFT STORE CONFIGURATION EXAMPLE 2 WITH FIBRE CHANNEL PORT NOTATION



*Don't Care. Can be either switched fabric or point-to-point topology.

FIGURE 3 - AIRCRAFT STORE CONFIGURATION WITH A POINT_TO_POINT FIBRE CHANNEL TOPOLOGY ILLUSTRATED

Below lists the potential communication paths that system designers need to consider for the application of the UFC interface details.

Transmitter	Receiver
Mission Store (MSI)	Carriage Store (CSSI)
Carriage Store (CSI)	Carriage Store (CSSI)
Carriage Store (CSI)	Platform (ASI)
Mission Store (MSI)	Platform (ASI)

Below lists the potential communication paths that system designers need to consider for the application of the DFC interface details.

Transmitter	Receiver
Platform (ASI)	Carriage Store (CSI)
Carriage Store (CSSI)	Carriage Store (CSI)
Carriage Store (CSSI)	Mission Store (MSI)
Platform (ASI)	Mission Store (MSI)

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3.2 Topology

This specification is intended to promote interoperability in a switch fabric or point-to-point topology as defined in FC-FS-2. The use of Arbitrated Loop Topology is prohibited.

Although Fibre Channel standards allow multiple topologies, created from a series of point-to-point links, this profile excludes the use of loop topologies and associated initialization protocol as they are not suited to applications where nodes (stores) leave (release or jettison, power down) the network.

3.3 Upper Level Protocols

For an NC only the following protocols shall be used:

- FC-AE-1553 - for file transfer and command and control.
- Frame Header Control Protocol (FHCP) - for video and audio defined in FC-AV.

For an NT, FC-AE-1553 shall be used. Optionally, an NT may implement FHCP for video and audio defined in FC-AV

Fibre Channel provides many Upper Layer Protocols. This paragraph limits the Upper Layer Protocols to those required to satisfy the needs of an aircraft stores system. An indication of the use is given in Table 1. Not all of the Upper Layer Protocol is necessarily adopted.

FC-AV is an ANSI INCITS developed standard describing the mapping of digital audio and video formats to Fibre Channel. The FC-AV standard targeted applications within the broadcast and post production environments as well as avionics sensor and display networks found in aerospace environments. FC-AV needs to be profiled to focus only on the aerospace environment and for this document on the weapons bus environment.

FHCP is the upper level application protocol described within FC-AV that is called out in this document as the video transfer protocol. Fibre Channel as a transport protocol does not have a native upper level protocol. Consequently, to utilize Fibre Channel as a data transport either an existing upper level protocol must be mapped to Fibre Channel or one must be invented for the purpose. FC-AE-1553 is an example of mapping an existing upper level protocol to Fibre Channel and FHCP is an example of inventing an upper level protocol for a specific set of applications; in this case video transfers.

Simple Parametric Digital Video profile, (SPDV), defines how the mapping of user payloads within Fibre Channel Frames can use the Container system described in clause 5 of FC-AV for real-time distribution of digital video.

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4. DETAILED REQUIREMENTS

4.1 Fibre Channel Level 4

4.1.1 Video Transfer

Video data shall be transferred using the methods defined in the SPDV profile in FC-AV Annex A.

A single protocol with multiple formats is used for the transfer of video information.

4.1.2 Audio Transfer

Audio data shall be transferred using the methods defined in FC-AV.

A single protocol is used for the transfer of audio information. The Fibre Channel specifications lack detail for audio transport. The purpose of this paragraph is to provide an alternate means to transfer audio other than the MIL-STD 1760 Low Bandwidth signal line. If audio over Fibre Channel is required then further standardization activity may be required.

4.1.3 File Transfer

File based information is transferred as defined in 4.1.5.

This defines the protocol for file transfer as an alternative to (or replacement of) MIL-STD-1760 Mass Data Transfer, one of the limiting features of MIL-STD-1760. File transfer can be achieved by using either long messages in FC-AE-1553 or the mass data transfer protocol running over FC-AE-1553. The latter option is inefficient and using long messages in FC-AE-1553 is the better alternative.

4.1.4 Command and Control

Command and control information is transferred as defined in 4.1.5.

This defines FC-AE-1553 as the command and control protocol. This provides an alternate command and control path to MIL-STD-1760 MUX A and MUX B.

4.1.5 FC-AE-1553 Profiling

Required, Invocable and Prohibited FC-FS-2 features shall be implemented as per FC-AE-1553. The FC-AE-1553 Allowed features shall be used as per Table 4 and Table 5. The Process login is implicit using the parameters defined in Table 5.

There can be only one Network Controller in the network. The Network Controller shall be connected to physical port zero of the Principal Switch. The FFI_DTM ELS shall only be accepted by the Principal Switch on port zero.

"Port Zero" of the Principal Switch is meant to refer to the first physical port on the switch. It could conceivably be called "Port 1" if the switch ports start numbering at "1" instead of "0".

This ensures the host platform has one Fibre Channel node functioning as a Network Controller (NC). Mission stores must be capable of functioning as Network Terminals (NT). Table 5 provides time out values for FC-AE-1553. These numeric values and allowed options profile FC-AE-1553 to give a standard set of parameters for use in AS5653.

NC Commands and NT Status responses with less than or equal to 2048 bytes (512 words) of payload data following the NC Command Header extension or the NT Status Header extension shall be transmitted as single-frame sequences.

This will minimize the time to process short command and control type exchanges.

For file transfers using either the NC-to-NT or NT-to-NT exchange formats, the command word bit "NT Burst Size Request" shall have a value of logic "1", while the command word bit "Delayed NT Burst Size Request" shall have a value of logic "0".

Using this option, no data bytes will be transmitted to the receiving NT prior to the receiving NT indicating the maximum number of data bytes that it can receive in the first Data Sequence. All transfers larger than a single Fibre Channel Frame must use NT Burst Size Request allowing the receiving NT to pace the flow of data to it.

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TABLE 4 - USE OF FC-AE-1553 ALLOWED FEATURES.

Feature	Requirement
NT–to-NT Transfers	Invocable
NC to monitor NT-to-NT transfers	Prohibited
Broadcast	Invocable
Multicast	Prohibited
NT status response to broadcast exchanges	Prohibited

FC-AE-1553 Subaddresses ’00 00 00 01’ through ’00 00 00 1E’ are reserved for legacy MIL-STD-1553 non-mode code command and control Exchanges, with byte counts limited to ≤ 64 bytes. Exchanges to the same subaddress shall be limited to one concurrent Exchange at a time. Multiple concurrent Exchanges to the same NT or NC shall be to different subaddresses on that NC or NT.

TABLE 5 - FC-AE-1553 PRLI SERVICE PARAMETERS FOR AS5653

FC-AE-1553 PRLI Service Parameter	Word	Bit(s)	Value for NC	Value for NT	Notes
FC-AE-1553 TYPE CODE (48h)	0	31–24	48H	48H	
RESERVED FOR TYPE CODE EXTENSION	0	23–16	00H	00H	
ORIGINATOR PROCESS_ASSOCIATOR VALID	0	15	0B	0B	
RESPONDER PROCESS_ASSOCIATOR VALID	0	14	0B	0B	
ORIGINATOR: ESTABLISH IMAGE PAIR RESPONDER: IMAGE PAIR ESTABLISHED	0	13	1B	1B	For AS5653, NC is PRLI originator, NT is PRLI responder.
RESERVED	0	12	0B	0B	
ORIGINATOR: RESERVED RESPONDER: ACCEPT RESPONSE CODE	0	11-8	0000B	0001B	For AS5653, NC is PRLI originator, NT is PRLI responder.
RESERVED	0	7-0	00H	00H	
ORIGINATOR PROCESS_ASSOCIATOR	1	31–0	00 00 00 00H	00 00 00 00H	
RESPONDER PROCESS_ASSOCIATOR	2	31–0	00 00 00 00H	00 00 00 00H	
NC FUNCTION	3	31	1B	X	NC may optionally have NT capability.
NT FUNCTION	3	30	X	1B	NT may optionally have NC capability.
NC: NC-TO-NT TRANSFER (USING NT BURST SIZE REQUEST)	3	29	1B	X	
NC: NC-TO-NT TRANSFER (USING DELAYED NT BURST SIZE REQUEST)	3	28	0B	0B	Prohibited transfer format for AS5653
NC: NT-TO-NT TRANSFER (USING NT BURST SIZE REQUEST)	3	27	1B	X	
NC: NT-TO-NT TRANSFER, WHERE THE NC IS THE RECEIVING NT (USING NT BURST SIZE REQUEST)	3	26	1B	X	
NC: NT-TO-NT TRANSFER (USING DELAYED NT BURST SIZE REQUEST)	3	25	0B	0B	Prohibited transfer format for AS5653

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FC-AE-1553 PRLI Service Parameter	Word	Bit(s)	Value for NC	Value for NT	Notes
NC: NT-TO-NT TRANSFER, WHERE THE NC IS THE RECEIVING NT (USING DELAYED NT BURST SIZE REQUEST)	3	24	0B	0B	Prohibited transfer format for AS5653
NC: NC-TO-NT RDMA	3	23	0B	0B	Prohibited feature for AS5653
NC: NT-TO-NC RDMA	3	22	0B	0B	Prohibited feature for AS5653
NC: NT-TO-NT RDMA	3	21	0B	0B	Prohibited feature for AS5653
NC: DYNAMIC NETWORK CONTROL MODE COMMAND – NON-BROADCAST	3	20	0B	0B	Prohibited mode command for AS5653
NC: TRANSMIT RT ADDRESS MODE COMMAND – NON-BROADCAST	3	19	1B	X	
NC: TRANSMIT NT_CS_BURST_TOV MODE COMMAND – NON-BROADCAST	3	18	1B	X	
NC: USE OF ABTS BASIC LINK SERVICE AND RRQ EXTENDED LINK SERVICE TO ABORT ERRONEOUS EXCHANGES.	3	17	0B	0B	Prohibited feature for AS5653
NC: NC MONITOR FOR NT-TO-NT TRANSFER	3	16	0B	0B	Prohibited feature for AS5653
NC: MULTICAST	3	15	0B	0B	Prohibited transfer format for AS5653
NC: TRANSMITTER SHUTDOWN – NON-BROADCAST	3	14	0B	0B	Prohibited mode code for AS5653
NC: TRANSMITTER SHUTDOWN – BROADCAST	3	13	0B	0B	Prohibited mode code for AS5653
NC: OVERRIDE TRANSMITTER SHUTDOWN – NON-BROADCAST	3	12	0B	0B	Prohibited mode code for AS5653
NC: OVERRIDE TRANSMITTER SHUTDOWN – BROADCAST	3	11	0B	0B	Prohibited mode code for AS5653
NC: SELECTED TRANSMITTER SHUTDOWN – NON-BROADCAST	3	10	0B	0B	Prohibited mode code for AS5653
NC: SELECTED TRANSMITTER SHUTDOWN – BROADCAST	3	9	0B	0B	Prohibited mode code for AS5653
NC: OVERRIDE SELECTED TRANSMITTER SHUTDOWN – NON-BROADCAST	3	8	0B	0B	Prohibited mode code for AS5653
NC: OVERRIDE SELECTED TRANSMITTER SHUTDOWN – BROADCAST	3	7	0B	0B	Prohibited mode code for AS5653
RESERVED	3	6-0	000 0000B	000 0000B	
NT: NC-TO-NT TRANSFER (USING NT BURST SIZE REQUEST)	4	31	X	1B	
NT: NC-TO-NT TRANSFER (USING DELAYED NT BURST SIZE REQUEST)	4	30	0B	0B	Prohibited transfer format for AS5653
NT: NT-TO-NT TRANSFER (USING NT BURST SIZE REQUEST)	4	29	X	1B	
NT: NT-TO-NT TRANSFER, WHERE THE NC IS THE RECEIVING NT (USING NT BURST SIZE REQUEST)	4	28	X	1B	

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FC-AE-1553 PRLI Service Parameter	Word	Bit(s)	Value for NC	Value for NT	Notes
NT: NT-TO-NT TRANSFER (USING DELAYED NT BURST SIZE REQUEST)	4	27	0B	0B	Prohibited transfer format for AS5653
NT: NT-TO-NT TRANSFER, WHERE THE NC IS THE RECEIVING NT (USING DELAYED NT BURST SIZE REQUEST)	4	26	0B	0B	Prohibited feature for AS5653
NT: NT-TO-MULTIPLE NTs	4	25	X	1B	Broadcast is invocable, multicast is prohibited
NT: RECEIVE MODE CODE, WITH DATA TO MULTIPLE NTs	4	24	X	1B	Broadcast is invocable, multicast is prohibited
NT: NC-TO-NT RDMA	4	23	0B	0B	Prohibited feature for AS5653
NT: NT-TO-NC RDMA	4	22	0B	0B	Prohibited feature for AS5653
NT: NT-TO-NT RDMA	4	21	0B	0B	Prohibited feature for AS5653
NT: NO RESPONSE BY MIL-STD-1553 RT = “1b”	4	20	0B	0B	No provision in AS5653 to bridge to 1 Mb/s 1553/1760 RTs
NT: MIL-STD-1553 FORMAT ERROR = “1b”	4	19	0B	0B	No provision in AS5653 to bridge to 1 Mb/s 1553/1760 RTs
NT: BURST SIZE ACKNOWLEDGE = “1b”	4	18	X	1B	Invocable NT Status Sequence bit
NT: PORT LOGIN REQUIRED = “1b”	4	17	X	1B	Invocable NT Status Sequence bit
NT: SERVICE REQUEST = “1b”	4	16	X	1B	Invocable NT Status Sequence bit
NT: BUSY = “1b”	4	15	X	1B	Invocable NT Status Sequence bit
NT: SUBSYSTEM FLAG = “1b”	4	14	X	1B	Invocable NT Status Sequence bit
NT: TERMINAL FLAG = “1b”	4	13	X	1B	Invocable NT Status Sequence bit
NT: NC MONITOR FOR NT-TO-NT TRANSFER	4	12	0B	0B	Prohibited transfer format for AS5653
NT: MULTICAST	4	11	0B	0B	Prohibited transfer format for AS5653
NT: TRANSMITTER SHUTDOWN – NON-BROADCAST	4	10	0B	0B	Prohibited mode code for AS5653
NT: TRANSMITTER SHUTDOWN – BROADCAST	4	9	0B	0B	Prohibited mode code for AS5653
NT: OVERRIDE TRANSMITTER SHUTDOWN – NON-BROADCAST	4	8	0B	0B	Prohibited mode code for AS5653
NT: OVERRIDE TRANSMITTER SHUTDOWN – BROADCAST	4	7	0B	0B	Prohibited mode code for AS5653
RESERVED	4	6-0	000 0000B	000 0000B	
NT: DYNAMIC NETWORK CONTROL MODE COMMAND – NON-BROADCAST	5	31	0B	0B	Prohibited mode code for AS5653
NT: SYNCHRONIZE (WITHOUT DATA WORD) MODE COMMAND – NON-BROADCAST	5	30	X	1B	Invocable mode command for AS5653

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FC-AE-1553 PRLI Service Parameter	Word	Bit(s)	Value for NC	Value for NT	Notes
NT: SYNCHRONIZE (WITHOUT DATA WORD) MODE COMMAND – BROADCAST	5	29	X	1B	Invocable mode command for AS5653
NT: INITIATE SELF-TEST MODE COMMAND – NON-BROADCAST	5	28	X	1B	Invocable mode command for AS5653
NT: INITIATE SELF-TEST MODE COMMAND – BROADCAST	5	27	X	1B	Invocable mode command for AS5653
NT: INHIBIT TERMINAL FLAG MODE COMMAND – NON-BROADCAST	5	26	X	1B	Invocable mode command for AS5653
NT: INHIBIT TERMINAL FLAG MODE COMMAND – BROADCAST	5	25	X	1B	Invocable mode command for AS5653
NT: OVERRIDE INHIBIT TERMINAL FLAG MODE COMMAND – NON-BROADCAST	5	24	X	1B	Invocable mode command for AS5653
NT: OVERRIDE INHIBIT TERMINAL FLAG MODE COMMAND – BROADCAST	5	23	X	1B	Invocable mode command for AS5653
NT: TRANSMIT VECTOR WORD MODE COMMAND – NON-BROADCAST	5	22	X	1B	Invocable mode command for AS5653
NT: SYNCHRONIZE (WITH DATA WORD) MODE COMMAND – NON-BROADCAST	5	21	X	1B	Invocable mode command for AS5653
NT: SYNCHRONIZE (WITH DATA WORD) MODE COMMAND – BROADCAST	5	20	X	1B	Invocable mode command for AS5653
NT: TRANSMIT LAST COMMAND SEQUENCE MODE COMMAND – NON-BROADCAST	5	19	X	1B	Invocable mode command for AS5653
NT: TRANSMIT BIT WORD MODE COMMAND – NON-BROADCAST	5	18	X	1B	Invocable mode command for AS5653
NT: SELECTED TRANSMITTER SHUTDOWN MODE COMMAND – NON-BROADCSAT	5	17	0B	0B	Prohibited mode command for AS5653
NT: SELECTED TRANSMITTER SHUTDOWN MODE COMMAND – BROADCAST	5	16	0B	0B	Prohibited mode command for AS5653
NT: OVERRIDE SELECTED TRANSMITTER SHUTDOWN MODE COMMAND-NON-BROADCAST	5	15	0B	0B	Prohibited mode command for AS5653
NT: OVERRIDE SELECTED TRANSMITTER SHUTDOWN MODE COMMAND – BROADCAST	5	14	0B	0B	Prohibited mode command for AS5653
NT: TRANSMIT RT ADDRESS MODE COMMAND – NON-BROADCAST	5	13	X	1B	Invocable mode command for AS5653
NT: TRANSMIT NT_CS_BURST_TOV MODE COMMAND – NON-BROADCAST	5	12	X	1B	Invocable mode command for AS5653

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FC-AE-1553 PRLI Service Parameter	Word	Bit(s)	Value for NC	Value for NT	Notes
NT: USE OF ABTS BASIC LINK SERVICE AND RRQ EXTENDED LINK SERVICE TO ABORT ERRONEOUS EXCHANGES	5	11	0B	0B	Prohibited feature for AS5653
RESERVED	5	10-0	000 0000 0000B	000 0000 0000B	
MAXIMUM NUMBER OF BYTES TO RECEIVE FOR FIRST DATA SEQUENCE WITH DELAYED NT BURST SIZE REQUEST = 1	6	31-0	00 00 00 00H	00 00 00 00H	Prohibited feature for AS5653
NT_C/S_TOV	7	31-16	X	0200H	NT timer; value = 32 µs
NT_C-D/S_BURST_TOV	7	15-0	X	7FF3H	NT timer; default value = 8.38 s (max) [3].
NC_C/S_TOV	8	31-16	0640H	X	NC timer; value = ((2N+1) * 32) where N is the number of hops in the longest path.
NC_C-D/S_BURST_TOV	8	15-0	7FF3H	X	NC timer; default value = 8.38 s (max) [3].
C-S/D_TX _TOV	9	31-16	0190H	0190H	NC and NT timer; value = 25 µs
C-S/D_RX_TOV	9	15-0	0320H	0320H	NC and NT timer; value = 50 µs

For AS5653, the PRLI originator is an NC, while an NT will be a PRLI responder.

"X" = don't care. However, for an NT with NC capability, the value of "X" for a given PRLI parameter in the "NT" column matches the corresponding value indicated in the "NC" column. Similarly, for an NC with NT capability, the value of "X" for a given PRLI parameter in the "NC" column matches the corresponding value indicated in the "NT" column.

[3] The 8.38 s value of an NT's NT_C-D/S_BURST_TOV timer is the maximum value set as a default. The NC can interrogate an NT, by means of a Transmit NT_C-D/S_BURST_TOV mode command, to establish the actual value being used by the NT. The NC may adjust the value of its NC_C-D/S_BURST_TOV to correspond.

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4.2 Fibre Channel Level 3 Common Services

No profiling needs to be done at Fibre Channel Level 3.

4.3 Fibre Channel Level 2 Framing Protocol and Flow Control

4.3.1 Switch Fabric Type

The switches within the fabric shall be non-blocking.

```
A non-blocking switch fabric is specified to ensure minimal transport delays.
```

4.3.2 Order of Delivery

The switch shall ensure in-order delivery of frames. The NC, switch, and NT shall support at least two priority levels.

4.3.3 Switch Fabric Initialization

Switches shall use the Fast Fabric Initialization (FFI) process defined in FC-SW-4 Annex D. The AE_Principal switch function shall be provided by the switch directly connected to the NC. The switch port type shall be determined explicitly via the Exchange Link Parameters (ELP) command.

```
This states that Fibre Channel Fast Fabric Initialization is to be used to start the
network and track the available nodes.

The switch port type (AE_Port or F_Port) at the ASI and CSSI must be determined explicitly
because it cannot be known ahead of time if the port is connected to an N_Port or another
AE_Port. The CSI will always be an AE_Port.
```

4.3.4 Domain Identity Storage

Fabric switches that are part of carriage store or carriage system shall

a. discard their Domain_ID when power is removed.

b. not have implicit knowledge of its Domain_ID.

```
Some Fibre Channel Switches can remember their address. This explicitly prohibits storage
of Domain Identity in a carriage store, or carriage system.
```

4.3.5 Address Assignment

The fabric shall provide address identifiers to attached N_Ports during Fabric Login.

4.3.6 N_Port and Store Initialization

Within 120 ms of power application an MSI or Carriage Store internal N_port shall be capable of accepting Port Login Extended Link Service (PLOGI) Request and transmitting either a PLOGI Accept or PLOGI Reject.

```
This requirement aims to mimic the initialization provided by MIL-STD-1760.
```

4.3.7 Fibre Channel Login

N_Ports shall initiate and respond to login sequences as detailed in Table 6.

Fields in Table 6 indicating unsupported features shall be initialized with the value indicating that the feature is not supported. (Typically zero.)

4.3.7.1 Switch Fabric Login

ASI (when acting as an F_Port), MSI, CSSI, and Carriage Store Internal N_ports shall only use explicit Fabric Login (FLOGI) as defined in FC-FS-2. FLOGI is initiated by the attached N_Port. When initiating FLOGI, the attached N_Ports shall use an address identifier (Source_ID) of “000000h”.

```
Fabric Login is how the N_Port learns (a) that a Fabric is present, and (b) its address
identifier.
```

4.3.7.2 N_Port Login

When in a point-to-point topology the N_port acting as an NC shall initiate the PLOGI Exchange with the N_Port acting as an NT. The NC will assign the NT_Port’s address during the PLOGI Exchange. If the N_Port acting as an NC does not know its topology then it shall initiate an FLOGI first. If the FLOGI succeeds then it is in a Fabric topology, if the FLOGI fails then it is in a point-to-point topology and the NC shall respond to a PLOGI Request from the attached NT N_Port..

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N_Ports above the ASI, MSI and Carriage Store internal N_Ports shall only use explicit N_Port Login (PLOGI) described in FC-FS-2. PLOGI shall be initiated by an N_Port acting as the NC.

There are slight differences associated with the two supported Fibre Channel topologies. For instance, in a switched topology the NC of a MIL-STD-1760E system is located above the ASI. In such a system N_Port Login must be initiated by the NC N_Port above the ASI because the N_Ports below the ASI do not know the address identifiers of N_Ports above the ASI until login occurs. On the other hand, in a point-to-point topology the NC may be below the ASI but it is not ever going to be the weapon or the MSI.

TABLE 6 - ASI, MSI, CSI, CSSI AND CARRIAGE STORE ACTION AT LOGIN

Acting as a Fibre Channel port type	FLOGI	PLOGI
ASI AE_port	Not applicable	Passes data between corresponding N_Ports
ASI F_port	Responds to FLOGI request	Passes data between corresponding N_Ports
CSI AE_port	Not applicable	Passes data between corresponding N_Ports
CSI N_port	Initiates FLOGI	Responds to PLOGI request
MSI N_port	Initiates FLOGI	Responds to PLOGI request
Carriage Store Internal N_port	Initiates FLOGI	Responds to PLOGI request
CSSI AE_port	Not applicable	Passes data between corresponding N_Ports
CSSI F_port	Responds to FLOGI request	Passes data between corresponding N_Ports
CSSI N_Port	Initiates FLOGI	Responds to PLOGI Request
NC	Initiates FLOGI	Initiates PLOGI

Table 6 describes the role each of the different port types has to undertake during the login process. FLOGI is initiated by MSI or Carriage Store internal N-ports. The response is provided by the attached ASI or CSSI. The platform (N-ports above the ASI) has to initiate PLOGI. MSI and Carriage Store internal N-ports have to respond to them. The CSI and CSSI relay PLOGI sequences and do not interact with them.

Note the Stores Management Computer will perform PLOGI with all the other N-ports on the network. However, for NT-to-NT transfers additional PLOGI will be required between the two NTs.

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4.3.7.3 Login Parameters

The Fibre Channel login parameters in Table 7 shall be used.

TABLE 7 - FIBRE CHANNEL LOGIN PARAMETERS.

Feature	Requirement
E_D_TOV	500 µs
R_A_TOV	1 ms
R_T_TOV	100 µs
Buffer-to-Buffer Received Data Field Size	>=2072 bytes
BB_Credit per priority-channel	>=2

Some of the options provided by Fibre Channel have to be standardized to give an interoperable network. These parameters have to be chosen on a network wide basis. The options presented in Table 7 are all set in the switches and are passed to the N_Ports (NC & NT) via the PLOGI Exchange. E_D_TOV (Error Detect Timeout Value) is a Fibre Channel Sequence timer. It specifies the maximum amount of time between Frames of the same Seqeunce. R_A_TOV (Resource Allocation Timeout Value) specifies the maximum amount of time a Frame is valid for delivery to its destination. R_T_TOV (Receiver Transmitter Timeout Value)is a timer used in Link Initialization.

The number of buffers must be >= to 2 for each priority path (or priority-channel). Meaning there are at least four buffers, two for the low-priority path and two for the high-priority path. Whatever the value set in the login parameters, it must be >= 2, it will be interpreted as that number of buffers per priority path.

4.3.8 Flow Control

There shall be separate flow control tokens utilized for each priority path. The low-priority path shall use the R_RDY Primitive Signal to manage buffer-to-buffer flow control and the VC_RDY Primitive Signal shall be used to manage the high-priority path. The use of the flow control Primitive Signals is as described in FC-FS-2 and FC-SW-4 and this paragraph.

The VC_RDY Virtual Channel Number used for the high-priority path shall be 00h with a VC_ID Value of D0.0. The Primitive Signal shall be:

K28.5	D21.7	D0.0	D0.0

The initiating N_port shall set Bit 17 of the F_CTL field of every Frame sent and set the proper value in the CS_CTL field per 4.3.11 and only offer Frames when the appropriate credit is available for the selected channel, either the low-priority path/channel or the high-priority path/channel. A receiving AE_Port shall forward received Frames along the path indicated by the value in the CS_CTL field. If bit 17 of the F_CTL field is not set and no value is placed in the CS_CTL field the receiving ports shall not indicate an error but will treat the Frame as if Bit 17 were set and that the value in the CS_CTL field indicates the low-priority path.

The initiating N_Port shall be able to send a high-priority Sequence during an interframe gap of a low priority Sequence. Conversely, a receiving N_Port shall be able to receive at least two active Sequences concurrently as a high-priority Sequence is received in the middle of a low-priority Sequence. Neither the sending nor receiving N_Port shall allow a head of Sequence blocking problem occur for high-priority Sequences waiting for low-priority Sequences.

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4.3.9 Domain Topology Maps

A Domain Topology Map (DTM) describes the Domain IDs and all of the inter-switch links in a switched fabric. The DTM is used by switches in a fabric to ensure correct routing of messages. All Domain IDs and inter-switch links remain unchanged for the duration of a mission.

4.3.9.1 State Change Registration and Registered State Change Notification (SCR and RSCN)

SCR and RSCN shall be invocable services as defined in FC-LS-2.

Distributed switches within the Fabric shall update the Principal switch with state changes. The Principal switch shall be the server that sends out RSCN notices.

In practice it is envisioned that the NC would be the only N_Port requesting link state updates.

Switches inherently know which links are active, which are inactive and when the state of a link changes. Fibre Channel provides two Extended Link Services (ELS), SCR and RSCN, that allow N_Ports to request to be notified of link state changes.

4.3.9.2 Define FFI Domain Topology Map (FFI_DTM)

FFI_DTM shall be invocable as defined in FC-LS-2.

If invoked, the NC shall be the Requester that sends the FFI Domain Topology Map to the AE Principal Switch.

The FFI_DTM ELS Request transfers a complete initial or replacement Domain Topology Map to the Domain Controller of the AE Principal Switch. This ELS provides a standardized method of loading the FFI Domain Topology Map into the AE Principal Switch.

4.3.9.3 Request FFI Domain Topology Map (FFI_RTM)

FFI_RTM shall be invocable as defined in FC-LS-2.

If invoked, the NC shall send the ELS FFI_RTM to the AE Principal Switch requesting the latest copy of the FFI Domain Topology Map.

The FFI_RTM Request causes the AE Principal Switch to transfer the latest FFI Domain Topology Map to the requester. This provides a standardized way for an NC to access the latest Map.

4.3.9.4 FFI Map Update Registration (FFI_MUR)

FFI_MUR shall be invocable as defined in FC-LS-2.

If invoked, the NC shall send this request to the Domain Controller of the AE Principal Switch.

The FFI_MUR ELS Request causes the AE Principal Switch to add or remove the sending N_Port to/from the list of N_Ports registered to receive the latest FFI Domain Topology Map via FFI_RMUN ELS Requests. It is envisioned that the NC is the only N_Port that will be allowed to issue this registration request. The FFI_MUR together with the FFI_RMUN ELS act to dynamically update the NC with the latest changed FFI Domain Topology Map.

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4.3.9.5 FFI Registered Map Update Notification (FFI_RMUN)

FFI_RMUN shall be invocable as defined in FC-LS-2.

If invoked, the AE Principal Switch will send updated FFI Domain Topology Maps to the registered NC.

The FFI_RMUN ELS Request is a unidirectional transfer of the FFI Domain Topology Map to any N_Ports registered to receive these dynamic updates via the FFI_MUR ELS. In practice the only N_Port that should be registered for these updates is the NC. This would allow the NC to seamlessly get timely notifications of changes to the FFI Domain Topology Map. Similar to SCR and RSCN the difference is that SCR and RSCN reflect changes to the links attached to AE Ports. For instance the link status to a MSI would change if the weapon were powered up or down. SCR and RSCN would allow the NC to be notified of these events. FFI Domain Topology Maps do not contain link status information at that level. The FFI Domain Topology Map would notify the NC of event related to the AE Ports including error conditions.

4.3.9.6 FFI Suspend Map Updates (FFI_SMU)

FFI_SMU shall be invocable as defined in FC-LS-2.

If invoked, the FFI_SMU ELS Request shall be issued from the NC to the Domain Controller of the AE Principal Switch.

The FFI_SMU ELS Request causes the Domain Controller of the AE Principal Switch to suspend FFI Domain Topology Map updates to the NC.

4.3.9.7 FFI Resume Map Updates (FFI_RMU)

FFI_RMU shall be invocable as defined in FC-LS-2.

If invoked, the FFI_RMU ELS Request shall be issued from the NC to the Domain Controller of the AE Principal Switch.

The FFI_RMU ELS Request causes the Domain Controller of the AE Principal Switch to resume sending FFI Domain Topology Map updates to the NC.

4.3.10 Fibre Channel Class of Service

Fibre Channel Class 3 shall be used for file transfer, audio, video, command and control. Fibre Channel Class F shall be used for fabric initialization and inter-switch communication. Other classes (1, 2, 4, and 6) are prohibited.

Fibre Channel provides a number of different classes of service. For AS5653 applications only Class 3 is required. Class 3 provides adequate performance for all types of data without the burden of multiple Classes of service.

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4.3.11 Priority

The Fabric shall support two priority levels using bit 17 of the Fibre Channel F_CTL field and the CS_CTL field. Priority 1 shall be used for command and control messages; priority 0 shall be used for all other messages. If any priorities are used above the two required priorities of '0' and '1' then they will be user defined.

In order to ensure that low-priority messages, which could be associated with high-bandwidth applications, do not block high-priority messages the system must guarantee buffers and a path throughout the system from the source to the destination. This in turn results in a requirement for two different buffer-to-buffer flow control mechanisms; one for the low-priority traffic and one for the high-priority traffic. See 4.3.8. The Fibre Channel standards defined one flow control token, namely the R_RDY Primitive Signal, for Class 2 and Class 3 traffic and the standards defined different flow control tokens, the VC_RDY, for the guaranteed Class 4 traffic. The INCITS Fibre Channel Committee has since removed Class 4 from the most current versions of their standards but they retained the use of VC_RDY for ISL links between switches and the use of a vendor specific or vendor proprietary flow control from end devices to the entry and exit switches. We capitalize on that work by using VC_RDY for flow control on ISL links between the switches as well as between the entry and exit switches and the end devices for the high-priority traffic and R_RDY for flow control of the low-priority traffic. Any switch designed to be compliant to this standard will have both flow control mechanisms. However if a legacy switch is used that does not support the two-level flow control then only the lower level flow control, the R_RDY, would be supported and all traffic competes for the same buffer pool as the traffic flows from source to destination. In other words, it works but there are no guarantees that low-priority traffic will not block the progress of high-priority traffic.

Setting Bit 17 of the F_CTL field indicates that the Frame is being sent with a priority setting. The priority used is set in the CS_CTL field. The CS_CTL field is the most significant byte (bits 31 thru 24) of the second word of the Fibre Channel Frame Header. The least significant bit (bit 24) of the CS_CTL field is reserved for Class 1 circuit preemption control. The priority field is described in bits 25 thru 31 of the CS_CTL field. Setting the 8-bit CS_CTL field to 00h allocates the Frame to the low priority path, setting the 8-bit CS_CTL field to 02h allocates the Frame to the high-priority path.

4.4 Requirement Deleted

4.5 Fibre Channel Level 0 Physical Interface and Media

The physical layer of AS5653 shall comply with Fibre Channel Physical Interface [FC-PI 100-SE-EL-S] as amended in this paragraph. The interfaces defined in MIL-STD-1760 and Fibre Channel [FC-PI] are merged as illustrated in Figure 4.

FC-PI 100-SE-EL-S provides a 1.0625 Gbaud channel on 75Ω coaxial media. This media type is defined in Fibre Channel Physical Implementation along with others. AS5653 has selected this one as most suited to the aircraft store application. An increased transmit power gives an enhanced signal loss budget compared to that provided in Fibre Channel (FC-PI). The values in Table 8 and Table 9 were derived based on a Γ_{Tx} of 2Vpk-pk to 3Vpk-pk, with normal Γ_{Rx} characteristics. The signal budget has been allocated in two parts: the first part is the parent system (platform or carriage store), umbilical and or buffer, and the second part of the signal budget to the stores. The allocation has taken the different distances likely to be encountered into account. The basis for the budget was 95% of the length in the platform and 5% in the store. Note for carriage stores that the signal is re-generated.

AS5653 does not control the signal levels at Γ_{Tx} and Γ_{Rx} The signal levels at these points are part of the detailed implementation design.

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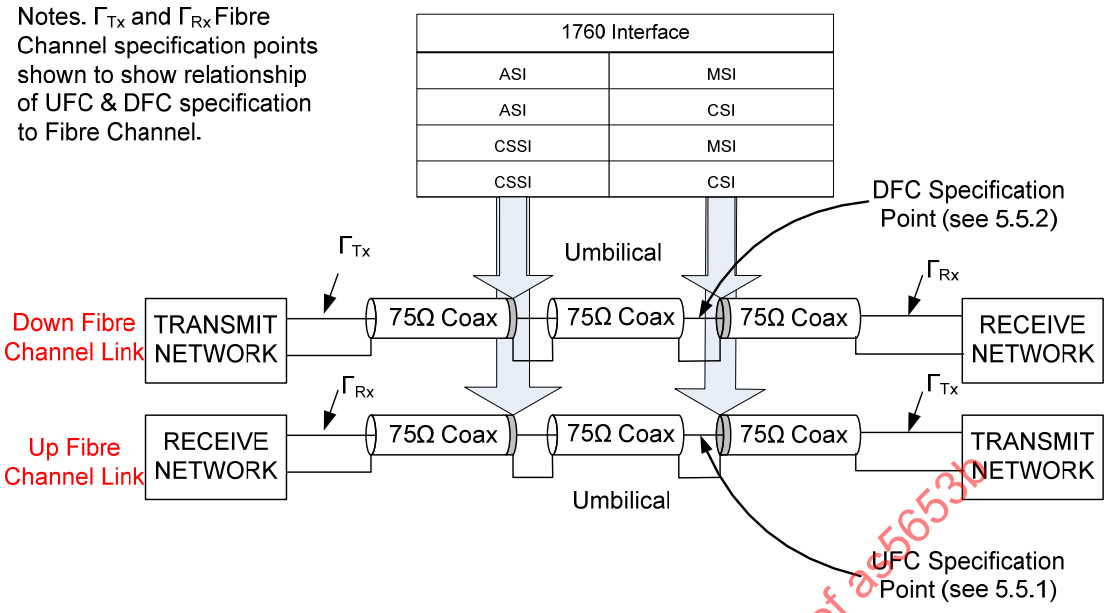

FIGURE 4 - LOCATION OF INTERFACES

4.5.1 UFC Signal Characteristics

The UFC signal characteristics are defined at the interface illustrated in Figure 4. The UFC transmitter shall generate a signal with the characteristics detailed in Table 8 and Figure 5. The UFC receiver shall accept and decode a signal with the characteristics detailed in Table 8 and Figure 5 with a bit error rate of less than 10^{-12}.

Potential links where this applies are described in the note in 3.1

TABLE 8 - UP FIBRE CHANNEL LINK SIGNAL

		Units	UFC
Jitter Output	Deterministic	UI (p-p)	0.14
	Total	UI (p-p)	0.28
Eye Mask [1]	B [2]	mV	1420
	A [3]	mV	923
	X1	ps	134
	X2	ps	312
Maximum Transmitter off voltage (Tx off) [4]		mV (p-p)	70
Eye Mask normalised amplitudes	Y1	none	0.2
	Y2	none	0.1
Rise Fall Time 20%-80% [5]	Max	ps	385
	Min	ps	100

[1] Drivers must meet both the absolute and normalized amplitude requirements. The transmitted eye mask from FC-PI shall be used.
[2] The B amplitude specification identifies the maximum signal peak (including overshoots) that can be delivered into a resistive load matching those shown in [FC-PI] Figure 41, “Test loads”.
[3]The minimum allowed p-p eye amplitude opening that shall be delivered into a resistive load matching those shown in [FC-PI] Figure 41, “Test loads”, is twice the “A” amplitude shown above.
[4] The “transmitter off voltage” is the maximum voltage measured at point T (across a resistive load matching those shown in [FC-PI] Figure 41, “Test loads”) when the transmitter is logically turned off or is unpowered. Measurement conditions are specified in [FC-PI] annex E.5.
[5] Rise/fall time measurements to be made using an oscilloscope with a bandwidth including probes of at least 1.8 times the baud rate. See [FC-PI] A.1.2.2.

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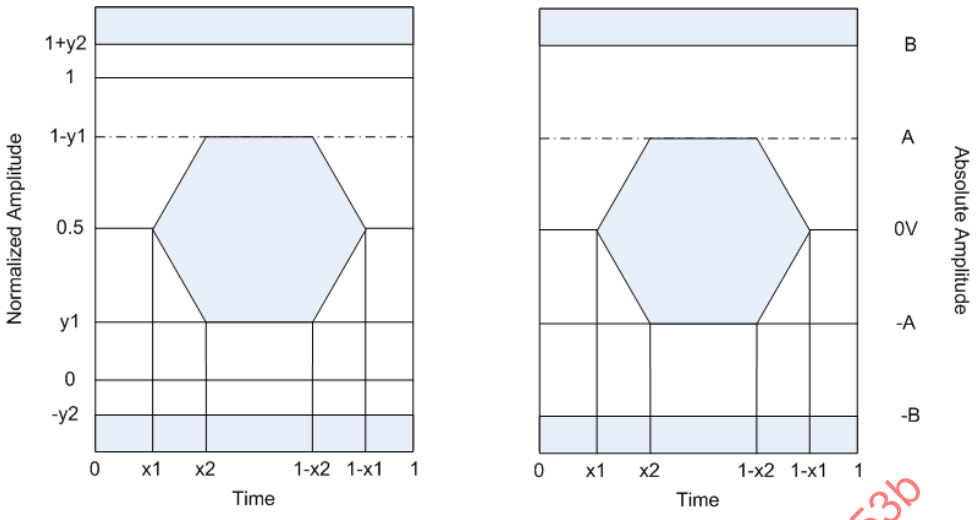

FIGURE 5 - UFC SIGNAL CHARACTERISTICS

4.5.2 DFC Signal Characteristics

The DFC signal characteristics are defined at the interface illustrated in Figure 4. The DFC transmitter shall generate a signal with the characteristics detailed in Table 9 and Figure 6. The DFC receiver shall accept and decode a signal with the characteristics detailed in Table 9 and Figure 6 with a bit error rate of less than 10^{-12}.

TABLE 9 - DFC SIGNAL CHARACTERISTICS

		Units	DFC
Jitter Output	Deterministic	UI(p-p)	0.34
	Total	UI(p-p)	0.53
Eye Mask	Y1	mV	217
	Y2	mV	1000
	X1	ps	248
	X2	ps	471

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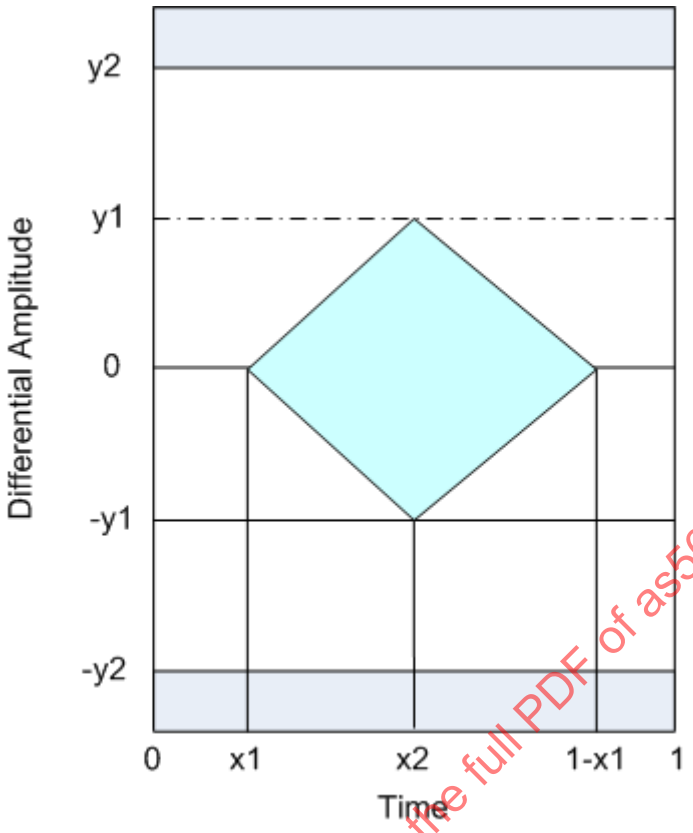

FIGURE 6 - DFCEYE MASK.

Deleted This requirement was incorporated into MIL-STD-1760E.

5. NOTES

5.1 A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY SAE COMMITTEE AS-1A, NETWORK AND REQUIREMENTS TASK GROUP

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APPENDIX A - FC-AE-1553 PROFILE

This appendix holds the errata collected on the INCITS Technical Report for Information Technology Fibre Channel - Avionics Environment - Upper Layer Protocol (FC-AE-1553); INCITS TR-42-2007.

APPENDIX A FC-AE-1553 ERRATA

This appendix consists of errata collected on the INCITS Technical Report for Information Technology Fibre Channel – Avionics Environment – Upper Layer Protocol (FC-AE-1553); INCITS TR-42-2007.

A.1.0 Mapping MIL-STD-1553 Data Words into Fibre Channel Payloads

MIL-STD-1760E has repurposed the High Bandwidth 2 and High Bandwidth 4 signals defined in earlier versions of the specification for use as a high-speed Fibre Channel digital interface. MIL-STD-1760E cites SAE AS5653 as the source of detailed requirements for this Fibre Channel interface and AS5653 in turn provides a tailoring of ISO/IEC FC-AE-1553 for use in avionics systems. Individual avionics and weapon systems typically trace their Fibre Channel-related requirements indirectly to FC-AE-1553 through MIL-STD-1760E and AS5653.

FC-AE-1553 specifies how MIL-STD-1553 messages are transmitted within Fibre Channel frame payloads. FC-AE-1553 completely defines how MIL-STD-1553 Command and Status Words are mapped into a Fibre Channel Frame payload, but it does not define a similar mapping for MIL-STD-1553 Data Words. In fact, nowhere in the requirements documentation chain of MIL-STD-1760E, AS5653, and FC-AE-1553 is this mapping of Data Words addressed. Because FC-AE-1553 is based on MIL-STD-1553B it can reasonably be inferred that within a data word, bits should be transmitted most significant bit first as specified in MIL-STD-1553B Section 4.3.2. However, MIL-STD-1553B says nothing about the transmission order of words within a message and neither it nor any other document states explicitly how 16-bit MIL-STD-1553 data words are mapped into the 32-bit words of a Fibre Channel frame payload. This oversight presents some risk to projects where big-endian and little-endian processors are used in the same system.

The mapping described below is both intuitive and consistent with the intent of MIL-STD-1553. It is also consistent with the mapping that some organizations have already adopted when implementing AS5653/FC-AE-1553.

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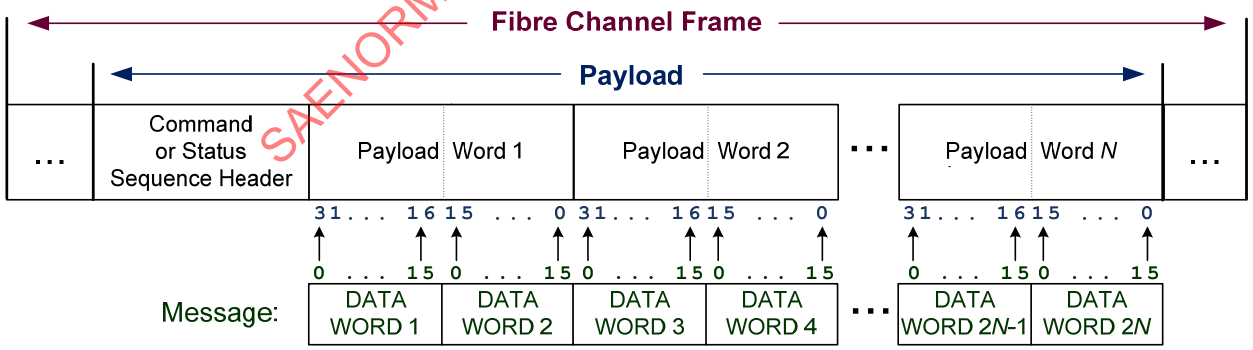

FIGURE A1 - MESSAGE DATA WORD MAPPING

Assumptions and Conventions

- In 16-bit MIL-STD-1553 data words, bit 0 is the most significant bit (MSB) and bit 15 is the least significant bit (LSB).
- In 32-bit Fibre Channel words, bit 31 is the MSB and bit 0 is the LSB.
- The 16-bit data words contained in MIL-STD-1553 messages are referred to as *1553 data words* in the remainder of this discussion to distinguish them from 32-bit Fibre Channel payload words.
- One byte contains 8 bits. A 1553 data word contains 2 bytes and a Fibre Channel payload word contains 4 bytes.

Bit Mapping Rules

- 1553 data words in each message will be transmitted in increasing order based on the word numbers assigned by MIL-STD-1553b.
- 1553 data words will be transmitted in the Fibre Channel frame payload immediately following the command or status sequence header with which they are associated.
- Two 1553 data words will be transmitted in each Fibre Channel payload word.
- Each 1553 data word will be transmitted in two consecutive bytes of a Fibre Channel payload word such that the 1553 data word's MSB occupies the MSB of the first of the two payload bytes with less significant bits following in descending order of value such that the LSB of the 1553 data word occupies the LSB of the second payload byte.
- If a message is comprised of an odd number of 1553 data words, the last 1553 data word in the message will occupy the two most significant bytes in a Fibre Channel payload word. The two least significant bytes in the partially used Fibre Channel payload word are fill-bytes.

The mapping is illustrated in Figure A1.

A.2.0 Correction to Operation of Transmit Last Command Mode Command

Change the first two paragraphs of FC-AE-1553 ¶4.4.4.2.13, Transmit Last Command Sequence, as follows:

FROM:

This mode code command shall cause the NT to transmit its Status Sequence comprised of the normal Status Sequence (see Table 9) concatenated with words 0 through 11 (see Table 7) of the most recently received Command Sequence other than a Transmit Status Sequence or Transmit Last Command Sequence mode command. This mode command shall not alter the state of the NT's Status Sequence.

In the case of a Transmit last Command Sequence mode code Exchange that is bridged through an FC-AE-1553 NT to a MIL-STD-1553 BC, the "last Command Sequence" transmitted back to the NC shall be for the last Exchange except for a Transmit status or Transmit last Command Sequence mode code Exchange that was relayed through the bridge to the addressed MIL-STD-1553 RT.

TO:

This mode code command shall cause the NT to transmit its Status Sequence comprised of the Status Sequence (see Table 9) concatenated with words 0 through 11 (see Table 7) of the most recently received Command Sequence other than a Transmit Last Command Sequence mode command. This mode command shall not alter the state of the NT's Status Sequence.

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In the case of a Transmit last Command Sequence mode code Exchange that is bridged through an FC-AE-1553 NT to a MIL-STD-1553 BC, the “last Command Sequence” transmitted back to the NC shall be for the last Exchange except for a Transmit last Command Sequence mode code Exchange that was relayed through the bridge to the addressed MIL-STD-1553 RT.

A.3.0 Editorial Correction for C-S/D_TX _TOV Timer

Change title of ¶4.4.4.4.6 from “C-S/D_RX _TOV” to “C-S/D_TX _TOV”.

A.4.0 Add Support for SCR and RSCN Extended Link Services

Page 79, add SCR and RSCN as “I” (Invocable) Extended Link Services to Table B.2.

A.5.0 Corrections to Table of Correct Values for FC_CTL Field Bits

The following corrections are to Table 10, “Correct Values for F_CTL Field Bits”.

A.5.1 Correction for NC Command Sequence Followed by a Data Sequence

Change the entry in the third row for the Sequence Initiative Transferred bit (for an NC Command Sequence Followed by a Data Sequence) as follows:

FROM:

1 (if Suppress Status = ‘0’b)
0 (if Suppress Status = ‘1’b)

TO:

0

A.5.2 Correction for an NC Command Sequence Followed by a Data Sequence

On page 59, under “Type(s) of Sequence”, change the entry in the fourth row as follows:

FROM:

- Last Frame of Data Sequence transmitted by originating NC for NC-to-NC or NC-to-multiple NTs transfer Exchanges.
- Last Frame of Data Sequence transmitted by transmitting NT for NT-to-NT or NT-to-NTs transfer Exchanges.

TO:

- Last Frame of last Data Sequence transmitted for NC-to-NT or NC-to-multiple NTs transfer Exchanges.
- Last Frame of last Data Sequence transmitted by transmitting NT for NT-to-NT or NT-to-NTs transfer Exchanges.

A.5.3 Addition for Last Frame of Data Sequence Other Than the Last Data Sequence

Add an additional row to Table 10, as follows:

Under “Type(s) of Sequence”:

- Last Frame of Data Sequence other than the last Data Sequence transmitted for NC-to-NT or NC-to-multiple NTs transfer Exchanges.
- Last Frame of Data Sequence other than the last Data Sequence transmitted by transmitting NT for NT-to-NT or NT-to-NTs transfer Exchanges.

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