

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.

AS5653B has been reaffirmed to comply with the SAE Five-Year Review policy.

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.

TABLE OF CONTENTS

1.	SCOPE.....	3
1.1	Purpose.....	3
2.	REFERENCES.....	3
2.1	Applicable Documents	3
2.1.1	Government Publications	3
2.1.2	ANSI Publications	3
2.1.3	Usage of References	4
2.2	Definitions	4
2.3	Abbreviations	5
3.	GENERAL REQUIREMENTS.....	6
3.1	Port Designation.....	6
3.2	Topology	10
3.3	Upper Level Protocols.....	10
4.	DETAILED REQUIREMENTS	10
4.1	Fibre Channel Level 4	10
4.1.1	Video Transfer.....	10
4.1.2	Audio Transfer.....	11
4.1.3	File Transfer	11
4.1.4	Command and Control.....	11
4.1.5	FC-AE-1553 Profiling	11

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Documents

Standard, visit Sharing Hub

4.2	Fibre Channel Level 3 Common Services	16
4.3	Fibre Channel Level 2 Framing Protocol and Flow Control	16
4.3.1	Switch Fabric Type	16
4.3.2	Order of Delivery	16
4.3.3	Switch Fabric Initialization	17
4.3.4	Domain Identity Storage	17
4.3.5	Address Assignment	17
4.3.6	N_Port and Store Initialization	17
4.3.7	Fibre Channel Login	17
4.3.8	Flow Control	19
4.3.9	Domain Topology Maps	20
4.3.10	Fibre Channel Class of Service	21
4.3.11	Priority	22
4.4	Requirement Deleted	22
4.5	Fibre Channel Level 0 Physical Interface and Media	22
4.5.1	UFC Signal Characteristics	23
4.5.2	DFC Signal Characteristics	24
5.	NOTES	25
APPENDIX A	FC-AE-1553 PROFILE	26
APPENDIX B	FC-LS-2 ERRATA	35
FIGURE 1	AIRCRAFT STORE CONFIGURATION EXAMPLE 1 WITH FIBRE CHANNEL PORT NOTATION	7
FIGURE 2	AIRCRAFT STORE CONFIGURATION EXAMPLE 2 WITH FIBRE CHANNEL PORT NOTATION	8
FIGURE 3	AIRCRAFT STORE CONFIGURATION WITH A POINT_TO_POINT FIBRE CHANNEL TOPOLOGY ILLUSTRATED	9
FIGURE 4	LOCATION OF INTERFACES	23
FIGURE 5	UFC SIGNAL CHARACTERISTICS	24
FIGURE 6	DFC EYE MASK.	25
TABLE 1	PURPOSE OF REFERENCED DOCUMENTS	4
TABLE 2	SUMMARY OF IMPLEMENTATION AND USE OF FEATURES	4
TABLE 3	MIL-STD-1760 INTERFACE TO FIBRE CHANNEL PORT FUNCTIONALITY MAPPING	6
TABLE 4	USE OF FC-AE-1553 ALLOWED FEATURES	12
TABLE 5	FC-AE-1553 PRLI SERVICE PARAMETERS FOR AS5653	12
TABLE 6	ASI, MSI, CSI, CSSI AND CARRIAGE STORE ACTION AT LOGIN	18
TABLE 7	FIBRE CHANNEL LOGIN PARAMETERS.	19
TABLE 8	UP FIBRE CHANNEL LINK SIGNAL	23
TABLE 9	DFC SIGNAL CHARACTERISTICS	24

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)

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.

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

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.

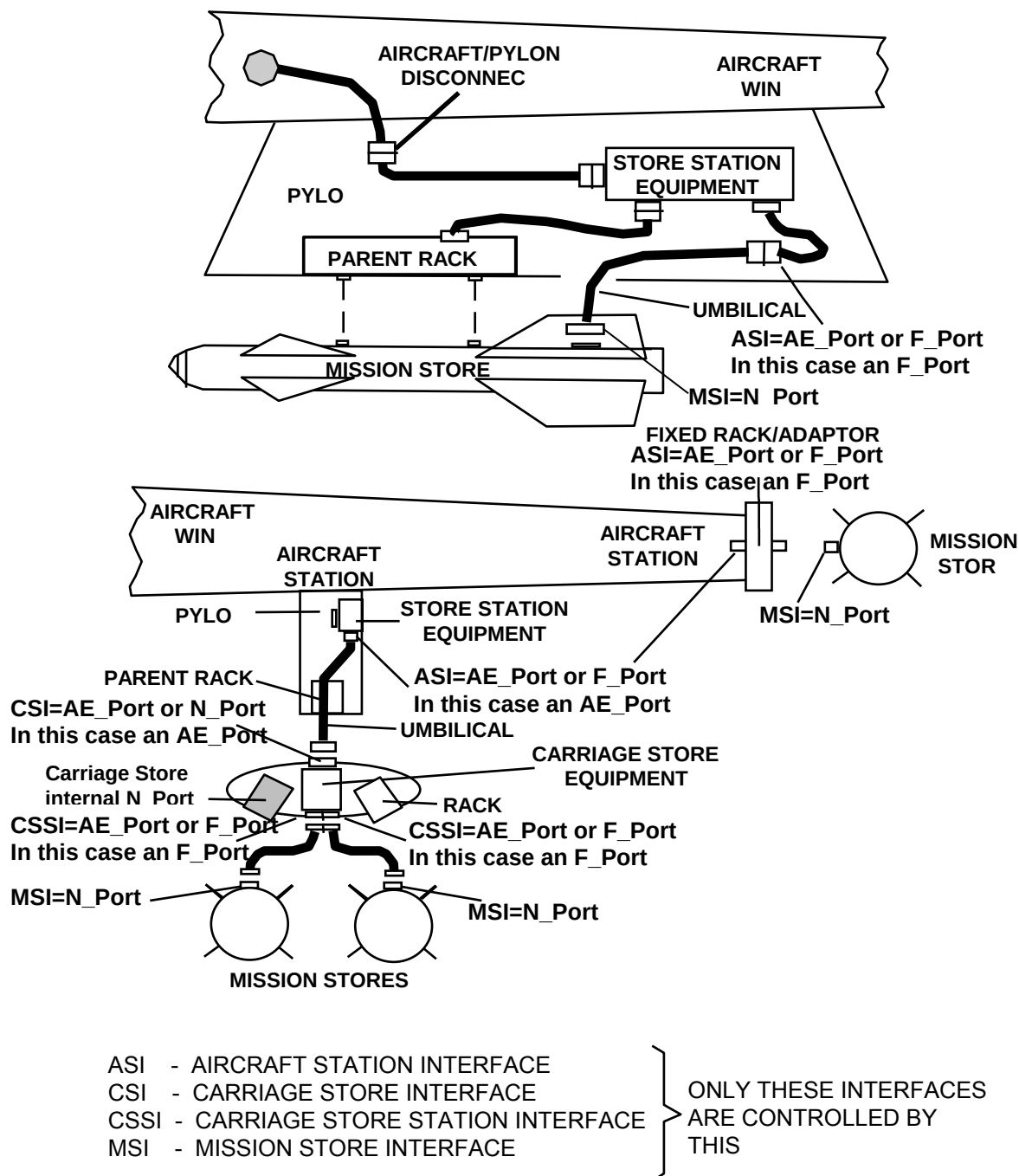


FIGURE 1 - AIRCRAFT STORE CONFIGURATION EXAMPLE 1 WITH FIBRE CHANNEL PORT NOTATION

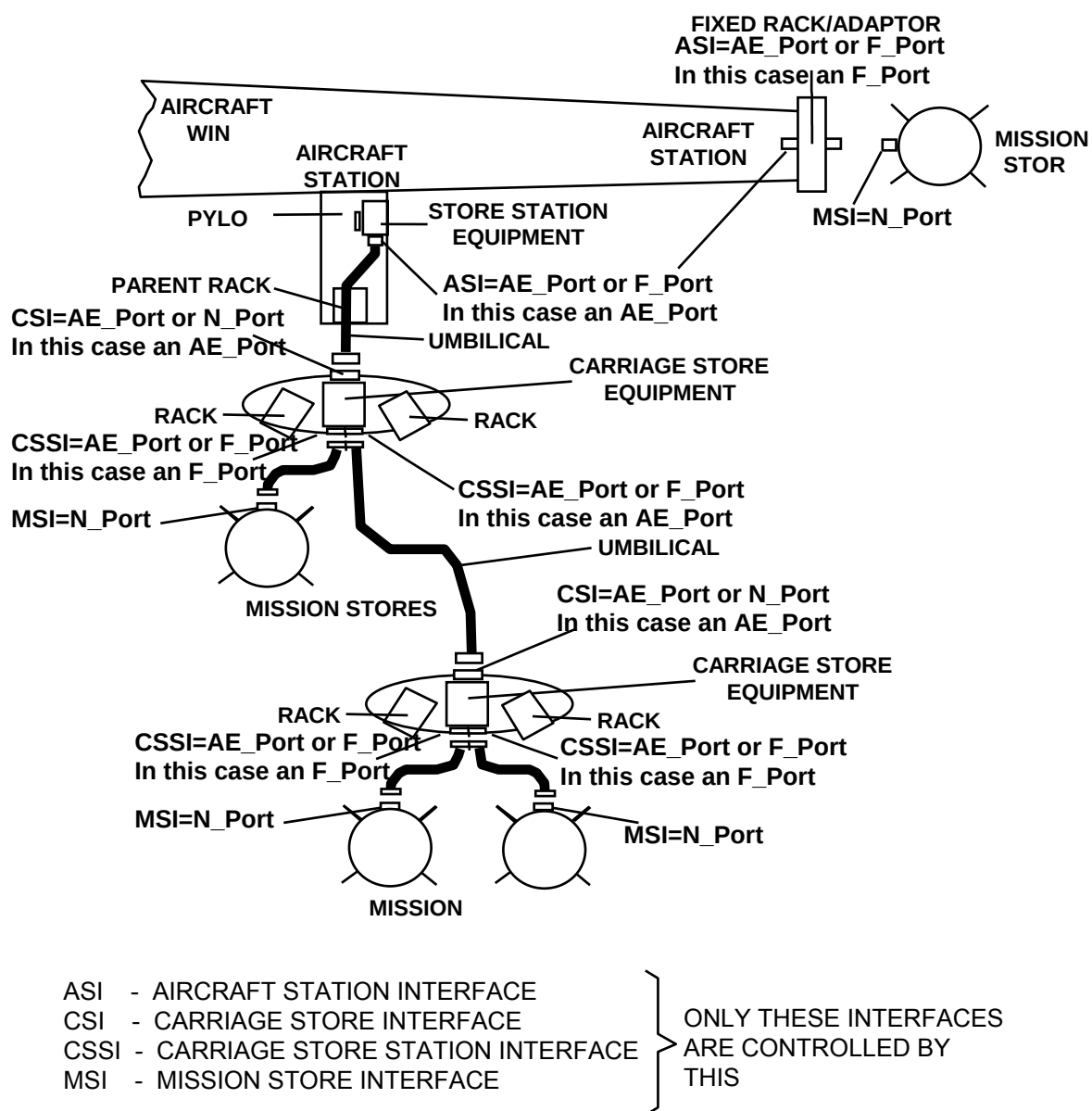
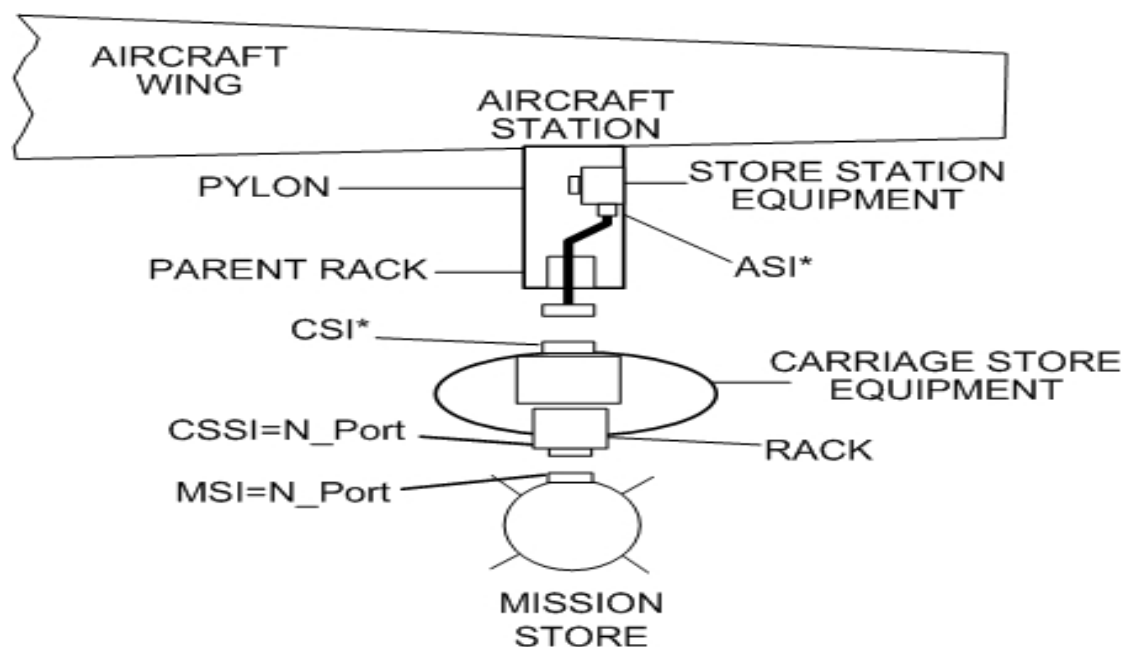


FIGURE 2 - AIRCRAFT STORE CONFIGURATION EXAMPLE 2 WITH FIBRE CHANNEL PORT NOTATION



*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)

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.

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.