

TECHNICAL REPORT

**Information technology – Fibre channel –
Part 313: Avionics environment – Anonymous synchronous messaging
(FC-AE-ASM)**

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INFORMATION TECHNOLOGY– FIBRE CHANNEL –

Part 313: Avionics environment – Anonymous synchronous messaging (FC-AE-ASM)

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ISO/IEC TR 14165-313, which is a technical report, has been prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

A list of all currently available parts of the ISO/IEC 14165 series, under the general title *Information technology – Fibre channel*, can be found on the IEC web site.

This Technical Report has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the second title page.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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INTRODUCTION

This technical report defines a set of features necessary to implement a real-time fibre channel network (switched fabric or arbitrated loop) supporting the FC-AE-ASM Upper Level Protocol.

The FC-AE-2 task group determined that it was best to allow profiles defined in the FC-AE technical report to be updated independently. This report is the first update to the FC-AE-ASM protocol since FC-AE was released. It is recommended for new designs, but does not obsolete 4.1 in INCITS TR-31-2002.

The intended usage of this technical report is avionic command, control, instrumentation, simulation, signal processing, and sensor/video data distribution. These application areas are characterized by a variety of requirements, among them a need for high reliability, fault tolerance, and deterministic behaviour to support real-time control/response.

This technical report is divided into 4 clauses:

Clause 1 is the scope.

Clause 2 enumerates the normative references.

Clause 3 describes the terms, definitions, abbreviations and conventions.

Clause 4 defines the FC-AE-ASM Upper Level Protocol. It lists features defined in the *FC-FS-2*, *FC-AL-2* and *FC-LS* standards and indicates whether the features are required, prohibited, allowed, or invocable in FC-AE-ASM. FC-AE-ASM places certain restrictions on the referenced standards in order to improve support for low latency, real-time applications.

INFORMATION TECHNOLOGY – FIBRE CHANNEL –

Part 313: Avionics environment – Anonymous synchronous messaging (FC-AE-ASM)

1 Scope

Fibre Channel Avionics Environment (FC-AE)¹ is a group of protocols and profiles that specify Fibre Channel options for devices connected by fabric and/or loop topologies that are pertinent to their use in commercial and military aerospace industries. The primary areas of interest include avionic command, control, instrumentation, simulation, signal processing and sensor/video data distribution. These application areas are characterized by a variety of requirements, among them a need for high reliability, fault tolerance, and deterministic behavior to support real-time control/response.

This part of ISO/IEC 14165 is intended to support bi-directional communication between two N_Ports in a constrained and carefully defined environment, typical of avionics applications.

The primary objective of this part of ISO/IEC 14165 is to maximize the likelihood of interoperability between conforming implementations. This technical report Prohibits or Requires features that are optional and Prohibits the use of some non-optional features in the referenced standards.

A second objective of this technical report is to simplify implementations and their associated documentation, testing, and support requirements. It does not define internal characteristics of conformant implementations, and it incorporates features from the referenced standards.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 14165-122, *Information technology – Fibre channel – Part 122: Arbitrated loop-2 (FC-AL-2)*

ISO/IEC TR 14165-312, *Information technology – Fibre channel – Part 312: Avionics environment upper layer protocol (FC-AE 1553)*

ANSI/INCITS 424-2007, *Information Technology – Fibre Channel – Framing and Signaling-2 (FC-FS-2)*

ANSI/INCITS 433-2007, *Information Technology – Fibre Channel – Link Services (FC-LS)*

¹ See ISO/IEC TR 14165-312 (report number INCITS TR-31-2002).

3 Terms, definitions, abbreviations and editorial conventions

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1

anonymous subscriber messaging

ASM

deterministic, secure, low-latency communication protocol derived only from *FC-FS-2* constructs

Note 1 to entry: The Type code is hex '49'.

3.2 Abbreviations

Abbreviations and acronyms applicable to this technical report are listed below. Abbreviations and acronyms for commonly used terms are defined in the referenced standards and are not included here.

FC-AE-ASM mnemonic that defines this technical report

ASM Anonymous Subscriber Messaging

3.3 Editorial conventions

3.3.1 Overview

In this technical report, a number of conditions, mechanisms, sequences, parameters, events, states, or similar terms that do not have their normal English meaning are printed with the following conventions.

- The first letter of each word is presented in upper case and the rest in lower case (e.g., Exchange, Class, etc.).
- A term consisting of multiple words is presented, with the first letter of each word in upper case and the rest lower case, and each word separated from the other by an underscore (_) character. A word may consist of an acronym or abbreviation, which is printed in upper case (e.g., NL_Port, Transfer_Length, etc.).

All terms and words not conforming to the conventions noted above have the normal technical English meaning.

Numbered items in this technical report do not represent any priority. Any priority is explicitly indicated.

In all of the figures, tables, and text of this report, the most significant bit of a binary quantity is shown on the left side. Exceptions to this convention are indicated in the appropriate clauses.

The term “shall” is used to indicate a mandatory rule. If such a rule is not followed, the results are unpredictable unless indicated otherwise.

The term “should” is used to indicate flexibility of choice with a strongly preferred alternative; equivalent to the phrase “it is strongly recommended”.

The term “may” is used to indicate flexibility of choice with no implied preference; equivalent to “may” or “may not”.

The fields or control bits that are not applicable shall be set as required by the appropriate publication.

If a field or a control bit in a frame is specified as not meaningful, the entity that receives the frame shall not check that field or control bit.

In several tables within this report, there is a column on the right side of the table labeled “Notes”. These notes are **NORMATIVE** and shall be considered requirements of this technical report.

In the event of conflict between the text, tables, and figures in this report, the following precedence shall be used: tables (highest), text and figures (lowest).

3.3.2 Binary notation

Binary notation may be used to represent some fields. Single bit fields are represented using the binary values 0 and 1. For multiple bit fields, the binary value is enclosed in single quotation marks followed by the letter b. For example, a four-byte field containing a binary value may be represented as ‘00000000 11111111 10011000 11111010’b.

3.3.3 Hexadecimal notation

Hexadecimal notation may be used to represent some fields. When this is done, the value is enclosed in single quotation marks and preceded by the word hex. For example, a four-byte field containing a binary value of ‘00000000 11111111 10011000 11111010’b is shown in hexadecimal format as hex ‘00 FF 98 FA’.

4 FC-AE-ASM features

4.1 Applicability and use of this technical report

The usual definitions of the following words do not apply. The following definitions shall be read carefully.

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. Each Required feature will include a note that describes the condition(s) in which the feature shall be used.

Invocable: If a feature or parameter value is Invocable, it means that it may be used between compliant implementations. Compliant implementations are required to implement the feature. Invocable is different from Required in that an implementation may use the feature if needed, but is not required to use it. No discovery process is necessary prior to use of an Invocable feature.

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. This report does not Prohibit the implementation of features, only their use between compliant implementations. However, interoperability is not guaranteed if prohibited features are used.

Table 1 summarizes the above definitions.

Table 1 – Summary of implementation and use of features

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

Tables 2 to 4 list features described in the various Fibre Channel standards, technical specifications and technical reports. These tables indicate whether the features are Required, Prohibited, Invocable, or Allowed for compliance with this report; or whether a parameter is Required to be a particular value for compliance with this technical report. Features or parameters that are not listed do not influence the interoperability of FC-AE-ASM devices.

The following legend is used for table entries in these clauses:

- ‘R’ Required
- ‘I’ Invocable
- ‘A’ Allowed
- ‘P’ prohibited
- ‘n’ the parameter shall be set to this value
- ‘X’ this parameter has no required value; any value is Allowed
- ‘–’ this parameter or feature is not meaningful

4.2 Overview

This technical report is a protocol and profile document. It lists features described in the Fibre Channel Framing and Signaling-2 (*FC-FS-2*), Fibre Channel Link Services (*FC-LS*) and Fibre Channel Arbitrated Loop-2 (*FC-AL-2*) standards and indicates whether the features are Required, Prohibited, Allowed, or Invocable.

This FC-AE-ASM profile follows the *FC-FS-2* and *FC-AL-2* standards in its definition of the services necessary to support deterministic, secure, low-latency and low overhead communication elements of a mission-critical avionics system.

FC-AE-ASM objects shall be easily mapped to other physical transports. Therefore, according to that practice no FC-AE-ASM objects may be mapped to Fibre Channel unique framing fields without also appearing in the appropriate FC-AE-ASM header field (i.e., all FC-AE-ASM objects are mapped into the payload).

4.3 FC-AE-ASM protocol

4.3.1 Overview

Every message in FC-AE-ASM is originated in a single Sequence unidirectional Exchange. The recipient may be expecting the message to arrive at a predetermined rate and does not know where the message is physically originating, only that it will arrive. Therefore, all messages shall use the Unsolicited Data Information Category (Routing Bits hex '0' and Information Category hex '4'). A single message originating from multiple sources shall only be a single frame Sequence from each source. Multiple frame messages shall only come from a single source. Multiple frame sequences shall be reassembled based on Message ID and relative offset. The Relative Offset of the first frame of each sequence shall be set to 0.

Relative Offset shall include the sum of all previous payloads in the sequence. The ASM Header shall be removed on all Frames before reassembly occurs.

All devices complying with this protocol shall support the following F_CTL options:

- Bit 17 Priority Enable – Priority Enable shall be asserted on each frame of an ASM Sequence when Priority is required;
- Bit 3 Relative Offset Present – Relative Offset Present shall be set to '1'b on all frames of each ASM Sequence.

DF_CTL shall be set to hex '00' (ASM Frames Only) and the Type code shall be set to hex '49' on each frame.

ELS Sequences are not considered ASM Sequences. ELS Sequences shall conform to the rules specified in FC-FS-2 and FC-LS.

4.3.2 ASM header

The first four words (or 16 bytes) of the Payload of each FC-AE-ASM Frame are reserved for the FC-AE-ASM header. In multi-frame sequences, all frames shall contain a copy of the FC-AE-ASM header. The format of the FC-AE-ASM header is specified in Table 2. The ASM Header shall have the same content in each frame in a multi-frame Sequence.

Table 2 – FC-AE-ASM header format

Bytes	0	1	2	3
0 to 3	Message ID			
4 to 7	Reserved – Security			
8 to 11	Reserved			
12 to 15	L	Priority	Message Payload Length (bytes)	

Bytes 0 through 3 are the Message ID field. The Message ID field contains a 32-bit pattern that uniquely identifies the message within each system. No other information is required, other than the message ID, for a recipient to properly interpret a message.

The Message ID values of hex '00 00 00 00' and hex 'FF FF FF FF' are reserved. The action to be taken if either of these values is received is beyond the scope of this technical report.

Bytes 4 through 7 are reserved for implementation-dependent security information. When not used to carry security information, this field shall be set to hex '00 00 00 00'.

Bytes 8 through 11 are reserved and shall be set to hex '00 00 00 00'.

Byte 12 contains an optional routing priority and message length modifier.

The L field of byte 12 shall modify the meaning of hex '00 00 00' in the Message Payload Length field. See Table 3.

Table 3 – Definition of the L field

L bit value	Meaning
0	Message has a payload length of 16 777 216 bytes
1	Message has a payload length of zero bytes

NOTE 1 The L bit has no meaning when the Message Payload Length field has a value other than hex '00 00 00'.

Details of the implementation of priority are system and network layer specific. When implemented, Priority shall be identical to the CS_CTL field in the Fibre Channel header as defined in *FC-FS-2*.

NOTE 2 Some network implementations may not provide priority message delivery, or may limit available priority levels.

Bytes 13 through 15 are the Message Payload Length field. The Message Payload Length field specifies the total number of bytes of information in the payload contained in an entire message (including multi-frame messages) associated with a Message ID. This field value shall exclude the length of all ASM Headers.

4.4 FC-AE-ASM profile

4.4.1 Overview

Table 4 gives the FC-AE-ASM profile. Devices that are compliant with FC-AE-ASM shall comply with the mandatory features defined in *FC-FS-2* unless noted herein. Implementation of *FC-AL-2* is Allowed, but not mandatory to be compliant with FC-AE-ASM. However, if *FC-AL-2* is implemented, compliant devices shall comply with the mandatory features of *FC-AL-2*. Optional features defined in *FC-FS-2*, *FC-LS* and *FC-AL-2*, with no corresponding entry (see Table 4) are Allowed.

Table 4 identifies features that represent potential interoperability concerns and indicates whether they are Required, Invocable, Allowed, or Prohibited for FC-AE-ASM compliance. Features that are not listed do not affect interoperability of FC-AE-ASM devices. In addition to interoperability concerns, this profile addresses certain features that are needed in order to achieve the performance necessary for real-time mission critical systems.

Mandatory items that are defined in *FC-FS-2*, *FC-LS* or *FC-AL-2* are not restated here. In many cases, the features specified in Table 4 have Login Parameters associated with them. For features that are Required or Invocable, the corresponding login parameters shall indicate that the feature is supported. For features that are Prohibited, the corresponding login parameters may indicate that the feature is supported, even though the feature shall not be used by compliant implementations. For features that are Allowed, the corresponding login parameters shall reflect whether or not the feature is supported by the implementation.

Table 4 – FC-FS-2 and FC-AL-2 Features for FC-AE-ASM

Feature	Nx_Port	Fx_Port	Notes
Point-to-Point link support	A	A	See 4.4.6
Link Protocols (point-to-point links)			
Link Initialization	R	R	
Link Failure	R	R	
Link Reset	R	R	
Arbitrated Loop link support	A	A	See 4.4.6
At Power on use an assumed AL_PA and go to Monitoring State	R	R	
Implicit Fabric Login/Logout	R	R	See 4.4.4
Implicit N_Port Login/Logout	R	–	See 4.4.5
TYPE Code hex '49' (ASM Frames only)	R	–	
R_CTL (ASM Frames Only)			
Routing Bits set to hex '0'	R	–	
Information Category set to hex '4'	R	–	

Feature	Nx_Port	Fx_Port	Notes
F_CTL (ASM Frames Only)			
Priority Enable	I	R	
Abort Discard Single Sequence	I	–	
Relative Offset Present	R	–	
DF_CTL = hex '00' (ASM Frames Only)	R	R	
Login Common Service Parameters			
BB_Credit > 2	R	R	
Max BB Receive Data Field Size > 2 048	R	R	
Continuously Increasing Relative Offset	R	–	
Random Relative Offset	P	–	
Class 3 Broadcast	–	R	
Total Concurrent Sequences > 16 (Both Transmit and Receive)	I	–	
E_D_TOV = 10 milliseconds (default value)	R	R	
R_A_TOV = E_D_TOV (default value)	R	R	
R_T_TOV Value = 1 (i.e. R_T_TOV = 100 µs)	R	R	
Login Class Specific Service Parameters			
Class of Service			
Class 1	P	–	
Class 3	R	R	
Class 4	P	–	
Class 6	P	–	
Sequential Delivery = 1	R	R	
Priority = 1	I	R	See 4.4.2
Clock Sync ELS Capable	I	R	See 4.4.3
Initiator Clock Sync ELS Capable	P	–	Server is in the fabric
Recipient Clock Sync ELS Capable	I	–	
Well Known Address Support			
Hex 'FF FF F6' Clock Synchronization Server	I	R	
Hex 'FF FF FF' Broadcast	I	R	
ELS Support	See 4.4.3		
CSR	I	R	
CSU	R	I	

4.4.2 Priority

All fabrics shall route frames in order of their priority, highest priority first when bit 17 in the F_CTL field is asserted. When 3 or more priority levels are supported, priority proceeds in descending order from 127 as the highest level to 0 as the lowest. If implementing 2 priority levels only, priority level 1 (Word 1, bits 31:25 equals a non-zero value) shall be the high priority and priority level 0 (Word 1, bits 31:25 = hex '00') shall be the low priority. Frames where priority is not enabled (CTL field bit-17 not asserted) shall be treated as frames having a priority level of 0.

4.4.3 Extended Link Services

CSR ELS is Invocable where the Nx_Port is the Initiator. CSU support is required as a recipient if the CSR has been sent to the Clock Synchronization Server. All other ELS