

**INTERNATIONAL
STANDARD**

**ISO/IEC
14165-331**

First edition
2007-07

**Information technology –
Fibre channel –
Part 331: Virtual interface (FC-VI)**



PRICE CODE

X

For price, see current catalogue

CONTENTS

FOREWORD	10
Introduction.....	11
1 Scope	12
2 Normative references	12
3 Terms, definitions and abbreviations	12
3.1 FC-VI terms and definitions	12
3.2 VI Definitions	14
3.3 Abbreviations	15
3.4 Editorial conventions	15
4 Structure and concepts	17
4.1 Fibre channel structure and concepts	17
4.2 FC-VI structure and concepts	17
5 FC-VI protocol overview	21
5.1 FC-VI information units	21
5.2 FC-VI message transfer operation	21
5.2.1 FC-VI message transfer	21
5.2.2 FC-VI send message transfer operation	22
5.2.3 FC-VI RDMA write message transfer operation	24
5.2.4 FC-VI RDMA read message transfer operation	26
5.2.5 IU reception at an FC-VI edpoint	27
5.3 FC-VI connection setup operation	29
5.3.1 FC-VI client-server and peer-peer connection setup	29
5.3.2 FC-VI client-server connection setup	29
5.3.3 FC-VI Peer-to-Peer Connection Establishment	31
5.3.4 FC_VI concurrent peer-to-peer connection setup	33
5.3.5 FC-VI Disconnect Operation	35
5.4 Exchange ID reuse	36
5.5 Sequence ID reuse	37
5.6 Frame synonym detection	37
5.7 VI message length	38
5.8 FC-FS header usage for FC-VI	39
5.8.1 FC-FS header usage	39
5.8.2 CS_CTL field	39
5.8.3 TYPE field	39
5.8.4 F_CTL field	39
5.8.5 DF_CTL field	39
5.8.6 SEQ_CNT field	39
5.8.7 Parameter field	40
5.9 FC-VI device_header	40
5.9.1 FC-VI device_header description	40
5.9.2 FCVI_HANDLE field	40
5.9.3 FCVI_OPCODE field	41
5.9.4 FCVI_FLAGS field	41
5.9.4.1 FCVI_FLAGS field description	41
5.9.4.2 FCVI_FLAGS for message request IUs	41
5.9.4.3 FCVI_FLAGS for message response IUs	42
5.9.4.4 FCVI_FLAGS for connect request IUs	42
5.9.4.5 FCVI_FLAGS for connect response IUs	43

5.9.4.6 FCVI_FLAGS for disconnect IUs	44
5.9.5 Reserved fields	45
5.9.6 FCVI_MSG_ID field	45
5.9.7 FCVI_PARAMETER field	46
5.9.7.1 FCVI_PARAMETER field format.....	46
5.9.7.2 Connect response reason codes	48
5.9.7.2.1 Connect response non-error reason codes.....	48
5.9.7.2.2 Connect response error reason codes.....	48
5.9.7.3 Message response / disconnect reason codes	48
5.9.7.3.1 Descriptor error reason codes.....	48
5.9.7.3.2 Remote FC-VI port non-descriptor errors.....	49
5.9.7.3.3 Reserved for future expansion	50
5.9.7.3.4 Vendor unique reason codes	50
5.9.8 FCVI_RMT_VA field	50
5.9.9 FCVI_RMT_VA_HANDLE field	50
5.9.10 FCVI_TOT_LEN field / FCVI_CONNECTION_ID field	50
6 FC-VI Information Unit (IU) formats	51
6.1 FC-VI IU overview	51
6.2 FCVI_SEND_RQST IU	51
6.2.1 FCVI_SEND_RQST IU description	51
6.2.2 FCVI_SEND_RQST Device_Header information	51
6.3 FCVI_SEND_RESP IU	51
6.3.1 FCVI_SEND_RESP IU description	51
6.3.2 FCVI_SEND_RESP Device_Header information	52
6.4 FCVI_WRITE_RQST IU	52
6.4.1 FCVI_WRITE_RQST IU overview	52
6.4.2 FCVI_WRITE_RQST IU Device_Header information	52
6.5 FCVI_WRITE_RESP IU	53
6.5.1 FCVI_WRITE_RESP IU description	53
6.5.2 FCVI_WRITE_RESP IU Device_Header information	53
6.6 FCVI_READ_RQST IU	53
6.6.1 FCVI_READ_RQST IU description	53
6.6.2 FCVI_READ_RQST IU Device_Header information	53
6.7 FCVI_READ_RESP IU	54
6.7.1 FCVI_READ_RESP IU description	54
6.7.2 FCVI_READ_RESP IU Device_Header information	54
6.8 FCVI_CONNECT_RQST IU	55
6.8.1 FCVI_CONNECT_RQST IU description	55
6.8.2 FCVI_CONNECT_RQST Device_Header information	55
6.8.3 FCVI_CONNECT_RQST Payload Information	55
6.9 FCVI_CONNECT_RESP1 IU	57
6.9.1 FCVI_CONNECT_RESP1 IU description	57
6.9.2 FCVI_CONNECT_RESP1 Device_Header information	57
6.9.3 FCVI_CONNECT_RESP1 Payload Information	58
6.10 FCVI_CONNECT_RESP2 IU	59
6.10.1 FCVI_CONNECT_RESP2 IU description	59
6.10.2 FCVI_CONNECT_RESP2 Device_Header information	59
6.11 FCVI_CONNECT_RESP3 IU	59
6.11.1 FCVI_CONNECT_RESP3 IU description	59
6.11.2 FCVI_CONNECT_RESP3 Device_Header information	59
6.12 FCVI_DISCONNECT_RQST IU	60
6.12.1 FCVI_DISCONNECT_RQST IU description	60

6.12.2 FCVI_DISCONNECT_RQST Device_Header information	60
6.13 FCVI_DISCONNECT_RESP IU	61
6.13.1 FCVI_DISCONNECT_RESP IU description	61
6.13.2 FCVI_DISCONNECT_RESP Device_Header information	61
7 FC-VI Addressing and naming	62
7.1 FC-VI Addressing and naming overview	62
7.2 FCVI_NET_ADDRESS format	62
7.3 FCVI_ATTRIBUTES format	63
7.4 FC-VI address resolution	65
7.5 FARP ELS	66
7.6 Name server queries	67
7.7 Validation of host address to N_Port Identifier mappings	67
7.7.1 Address mapping overview	67
7.7.2 Point-to-point topology	67
7.7.3 Private loop topology	67
7.7.4 Public loop topology	68
7.7.5 Fabric topology	68
8 FC-VI Error detection and recovery	69
8.1 FC-VI error detection and recovery overview	69
8.2 FC-VI endpoint states	69
8.3 FCVI_ULP_TIMEOUT definition	69
8.4 Message transfer error detection and recovery rules	70
8.4.1 Message error detection	70
8.4.2 Message transfer error recovery	70
8.5 Connection setup error detection and recovery rules	71
8.5.1 Connection setup error handling overview	71
8.5.2 Connection setup error detection	71
8.5.3 Connection setup error recovery	71
8.5.4 Connection setup originator retry rules	72
8.6 Disconnect operation error detection and recovery rules	72
8.6.1 Disconnect operation error handling overview	72
8.6.2 Disconnect operation error detection	72
8.6.3 Disconnect operation error recovery rules	73
Annex A (normative) Concurrent matching peer requests example.....	74
A.1 Overview.....	74
A.2 Case 1	75
A.3 Case 2	75
A.4 Case 3	76
A.5 Case 4	76
A.6 Case 5	77
A.7 Case 6	78
Annex B (informative) FC-VI message transfer error handling examples	79
B.1 Overview.....	79
B.2 Message transfer error handling operation.....	79
B.2.1 Message transfer error handling operation overview	79
B.2.2 Message transfer error definitions	79
B.2.3 Error Detection and Recovery Rule Processing	80
B.2.4 Message responder and message originator error recovery actions	80
B.2.5 Message responder error detection actions	81
B.2.6 Message originator Class 2 error detection actions	83
B.2.6.1 Message originator Class 2 error detection overview.....	83

B.2.6.2 Message response timeout at message originator	84
B.3 Message transfer error detection and recovery examples.....	84
B.3.1 Error examples overview	84
B.3.2 Mrcv > Mexp error example	85
B.3.2.1 Mrcv > Mexp example description	85
B.3.2.2 Mrcv > Mexp: In-order fabric and unreliable	85
B.3.2.3 Mrcv > Mexp: In-order fabric and reliable delivery.....	85
B.3.2.4 Mrcv > Mexp: Out-of-order fabric.....	86
B.3.3 Mrcv = Mexp error example	86
B.3.3.1 Mrcv = Mexp example description	86
B.3.3.2 Mrcv = Mexp: In-order fabric and unreliable	87
B.3.3.3 Mrcv = Mexp: Out-of-order fabric.....	87
Annex C (informative) Connection setup error handling examples Overview	89
C.1 Connection setup error handling definitions	89
C.2 Connect request originator and connect request responder rules.....	89
C.3 Connect request originator rules	89
C.4 Connect request responder rules	91
C.4.1 Connect request responder retry rules	92
C.5 Error detection and recovery examples for connection setup	93
C.5.1 Overview	93
C.5.2 FC-VI connection setup timers	94
C.5.3 VipConnectRequest completion	95
C.5.4 VipConnectAccept completion	95
C.5.5 Enabling message transmission and reception	95
C.5.6 Client timeout of VipConnectRequest	96
C.5.7 Lost FCVI_CONNECT_RQST IU	96
C.5.7.1 Lost FCVI_CONNECT_RQST IU example.....	96
C.5.7.2 Retried connection setup.....	97
C.5.8 Lost FCVI_CONNECT_RESP1 IU	98
C.5.9 Lost FCVI_CONNECT_RESP2 IU	99
C.5.9.1 Lost FCVI_CONNECT_RESP2 IU example.....	99
C.5.9.2 Server timing out connection setup	100
C.5.10 Lost FCVI_CONNECT_RESP3 IU	101
C.5.10.1 Lost FCVI_CONNECT_RESP3 IU example.....	101
Annex D (informative) Disconnect operation error handling examples	102
D.1 Disconnect operation example description.....	102
D.2 FC-VI disconnect operation example	103
Annex E (informative) Message streaming for reliable reception	105
Annex F (informative) Enabling Message transmission in the FC-VI NIC	106
Documents for VI Architecture (see Clause 2 for further explanation)	
Virtual Interface Architecture Specification, V1.0 (VI-ARCH)	111
Virtual Interface (VI) Architecture Developer's Guide, V1.0 (VI-DG)	195
Virtual Interface (VI) Architecture Developer's Guide Error Table Supplement, V1.0	291
IP Version 6 Addressing Architecture, RFC 2373, July 1998 (RFC2373)	321

Table 1 – FC-VI Information unit summary.....	21
Table 2 – Peer B actions based on connect responses from peer A	36
Table 3 – 16-byte FC-VI device_header.....	40
Table 4 – 32-byte FC-VI device_header.....	40
Table 5 – FCVI_FLAGS Bit definitions for message request IUs	41
Table 6 – FCVI_FLAGS Bit definitions for message response IUs	42
Table 7 – FCVI_FLAGS Bit definitions for connect request IUs	42
Table 8 – FC-VI connection mode definition	43
Table 9 – FCVI_FLAGS Bit definitions for connect response IUs	43
Table 10 – FCVI_FLAGS Bit definitions for disconnect IUs	44
Table 11 – FCVI_PARAMETER field for connect response and disconnect IUs	46
Table 12 – Reason code for CONN_STS.....	47
Table 13 – FCVI_CONNECT_RQST IU payload format	56
Table 14 – FCVI_CONNECT_RESP1 IU Payload Format.....	58
Table 15 – FCVI_NET_ADDRESS Format	63
Table 16 – FCVI_ATTRIBUTES format.....	63
Table 17 – Format of FCVI_ATTR_FLAGS in FCVI_ATTRIBUTES	64
Table 18 – FCVI_QOS format	64
Table A.1 – Peer B actions based on connect responses from peer A	74

Figure 1 – FC-VI addressing objects	20
Figure 2 – FC-VI send for Unreliable Delivery or Reliable Delivery.....	23
Figure 3 – FC-VI send for Reliable Reception.....	24
Figure 4 – FC-VI RDMA write for Unreliable Delivery or Reliable Delivery	25
Figure 5 – FC-VI RDMA write for Reliable Reception	26
Figure 6 – FC-VI RDMA read for Reliable Reception and Reliable Delivery.....	27
Figure 7 – Concurrent Receive Streams at a FC-VI Endpoint.....	28
Figure 8 – FC-VI client-server connection setup	30
Figure 9 – Peer-to-peer connection setup	32
Figure 10 – Peer-to-peer connection setup, concurrent matching peer requests	34
Figure 11 – FC-VI disconnect operation.....	36
Figure 12 – FC-FS header for send operation.....	38
Figure A.1 – Case 1.....	75
Figure A.2 – Case 2.....	75
Figure A.3 – Case 3.....	76
Figure A.4 – Case 4.....	77
Figure A.5 – Case 5.....	77
Figure A.6 – Case 6.....	78
Figure B.1 – Mrcv > Mexp	85
Figure B.2 – Mrcv = Mexp	87
Figure C.1 – Client-server connection setup	93
Figure C.2 – Client timeout of VipConnectRequest.....	96
Figure C.3 – Lost FCVI_CONNECT_RQST IU	97
Figure C.4 – Lost FCVI_CONNECT_RESP1 IU.....	98
Figure C.5 – Lost FCVI_CONNECT_RESP2	99
Figure C.6 – Lost FCVI_CONNECT_RESP3 IU.....	101
Figure D.1 – FC-VI disconnect operation	103

INFORMATION TECHNOLOGY – FIBRE CHANNEL –

Part 331: Virtual interface (FC-VI)

FOREWORD

- 1) ISO (International Organization for Standardization) and IEC (International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards. Their preparation is entrusted to technical committees; any ISO and IEC member body interested in the subject dealt with may participate in this preparatory work. International governmental and non-governmental organizations liaising with ISO and IEC also participate in this preparation.
- 2) In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.
- 3) The formal decisions or agreements of IEC and ISO on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC and ISO member bodies.
- 4) IEC, ISO and ISO/IEC publications have the form of recommendations for international use and are accepted by IEC and ISO member bodies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC, ISO and ISO/IEC publications is accurate, IEC or ISO cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 5) In order to promote international uniformity, IEC and ISO member bodies undertake to apply IEC, ISO and ISO/IEC publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any ISO/IEC publication and the corresponding national or regional publication should be clearly indicated in the latter.
- 6) ISO and IEC provide no marking procedure to indicate their approval and cannot be rendered responsible for any equipment declared to be in conformity with an ISO/IEC publication.
- 7) All users should ensure that they have the latest edition of this publication.
- 8) No liability shall attach to IEC or ISO or its directors, employees, servants or agents including individual experts and members of their technical committees and IEC or ISO member bodies for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication of, use of, or reliance upon, this ISO/IEC publication or any other IEC, ISO or ISO/IEC publications.
- 9) Attention is drawn to the normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 10) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 14165-331 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

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

This International Standard 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.

INTRODUCTION

This International Standard defines an upper-layer protocol within the domain of Fibre Channel, that is designed to permit efficient peer-to-peer or client-server messaging between nodes, and to comply with the Virtual Interface (VI) Architecture. Vendors that wish to implement devices that connect to FC-VI may follow the requirements of this and other normatively referenced standards to manufacture an FC-VI compliant device.

INFORMATION TECHNOLOGY – FIBRE CHANNEL –

Part 331: Virtual interface (FC-VI)

1 Scope

This part of ISO/IEC 14165 defines the Fibre Channel mapping protocol for the Virtual Interface (VI) Architecture (FC-VI). FC-VI defines the Fibre Channel Information Units in accordance with the VI Architecture model. FC-VI additionally defines how Fibre Channel services are used to perform the services required by the VI Architecture model of its network transport.

2 Normative references

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

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

ISO/IEC 14165-251, *Information technology – Fibre channel – Framing and Signalling Interface (FC-FS)* (To be published)

ISO/IEC 14165-414, *Information technology – Fibre channel – Generic services-4 (FC-GS-4)*

The following references for VI Architecture are the product of Intel, Microsoft and Compaq. The VI Architecture 1.0 specification is completely defined in these three documents. For the convenience of the reader they are added as supplementary documents.

Virtual Interface Architecture Specification, V1.0 (VI-ARCH)

Virtual Interface (VI) Architecture Developer's Guide, V1.0 (VI-DG)

Virtual Interface (VI) Architecture Developer's Guide Error Table Supplement, V1.0

IP Version 6 Addressing Architecture, RFC 2373, July 1998 (RFC2373)
(can be downloaded from the Internet)