IEEE P802.3bd/D2.1

**Draft Standard for Information technology—
Telecommunications and information exchange between systems—
Local and Metropolitan Area Networks—
Specific requirements**

Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

Amendment: MAC Control Frame for Priority-based Flow Control

**LAN/MAN Standards Committee
of the
IEEE Computer Society**

Prepared by the Data Center Bridging Task Group of IEEE 802.1

Abstract: This standard defines a MAC Control Frame to support 802.1~~Qbb~~Q Priority-based Flow Control
Keywords: Ethernet; Data Center Bridging; MAC Control; Priority-based Flow Control; pause

Draft Status: This draft is intended for Sponsor ballot.

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IEEE P802.3bd™/D2.1, 8 July 2010
(Amendment of IEEE Std 802.3-2008~~9~~)

IEEE P802.3bd™/D2.1

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Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

Amendment:
MAC Control Frame for Priority-based Flow Control

Prepared by the

LAN/MAN Standards Committee
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IEEE Computer Society

This draft is an amendment of IEEE Std 802.3-2008. This amendment defines a MAC Control Frame to support 802.1~~Qbb~~Q Priority-based Flow Control. Draft D2.1 is prepared by the IEEE 802.1 Data Center Bridging Task Group for Sponsor Ballot recirculation. This draft expires 6 months after the date of publication or when the next version is published, whichever comes first.

IEEE Standards Activities Department
445 Hoes Lane
Piscataway, NJ 08854, USA

Abstract: This amendment to IEEE Std 802.3–2008 defines a MAC Control Frame to support 802.1~~Qbb~~Q Priority-based Flow Control.

Keywords: Ethernet; Data Center Bridging; MAC Control; Priority-based Flow Control; pause

Introduction

Editor's Note (to be removed prior to publication):

This front matter is provided for comment only. Front matter is not part of a published standard and is therefore, not part of the draft standard. You are invited to review and comment on it as it will be included in the published standard after approval.

One exception to IEEE style that is consciously used to simplify the balloting process is the numbering of the front matter. Instead of the front matter being lower case Roman numeral page numbers, with the draft restarting at 1 with arabic page numbers, balloted front matter and draft are numbered consecutively with arabic page numbers.

This introduction is not part of IEEE Std 802.3bd-20XX, IEEE Standard for Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements, Part 3: CSMA/CD Access Method and Physical Layer Specifications, Amendment: ~~INSERT AMENDMENT NAME HERE~~MAC Control Frame for Priority-based Flow Control

IEEE Std 802.3™ was first published in 1985. Since the initial publication, many projects have added functionality or provided maintenance updates to the specifications and text included in the standard. Each IEEE 802.3 project/amendment is identified with a suffix (e.g., IEEE 802.3an-2006). ~~A historical listing of all projects that have added to or modified IEEE Std 802.3 follows as a part of this introductory material. The listing is in chronological order of project initiation and for each project describes: subject, clauses added (if any), approval dates, and committee officers.~~

The Media Access Control (MAC) protocol specified in IEEE Std 802.3 is Carrier Sense Multiple Access with Collision Detection (CSMA/CD). This MAC protocol was included in the experimental Ethernet developed at Xerox Palo Alto Research Center. While the experimental Ethernet had a 2.94 Mb/s data rate, IEEE Std 802.3-1985 specified operation at 10 Mb/s. Since 1985 new media options, new speeds of operation, and new capabilities have been added to IEEE Std 802.3.

Some of the major additions to IEEE Std 802.3 are identified in the marketplace with their project number. This is most common for projects adding higher speeds of operation or new protocols. For example, IEEE Std 802.3u added 100 Mb/s operation (also called Fast Ethernet), IEEE Std 802.3x specified full duplex operation and a flow control protocol, IEEE Std 802.3z added 1000 Mb/s operation (also called Gigabit Ethernet), IEEE Std 802.3ae added 10 Gb/s operation (also called 10 Gigabit Ethernet) and IEEE Std 802.3ah specified access network Ethernet (also called Ethernet in the First Mile). These major additions are all now included in, and are superseded by, IEEE Std 802.3-2008 and are not maintained as separate documents.

At the date of IEEE Std 802.3bd-20XX publication, IEEE Std 802.3 comprises the following documents:

<<The following list of documents has been updated with the latest from the IEEE 802.3 frommatter.>>

IEEE Std 802.3-2008

Section One -- Includes Clause 1 through Clause 20 and Annex A through Annex H and Annex 4A. Section One includes the specifications for 10 Mb/s operation and the MAC, frame formats and service interfaces used for all speeds of operation.

Section Two -- Includes Clause 21 through Clause 33 and Annex 22A through Annex 33E. Section Two includes management attributes for multiple protocols and speed of operation as well as specifications for providing power over twisted pair cabling for multiple operational speeds. It also includes general information on 100 Mb/s operation as well as most of the 100 Mb/s physical layer specifications.

Section Three -- Includes Clause 34 through Clause 43 and Annex 36A through Annex 43C. Section Three includes general information on 1000 Mb/s operation as well as most of the 1000 Mb/s physical layer specifications.

.Section Four -- Includes Clause 44 through Clause 55 and Annex 44A through Annex 55B. Section Four includes general information on 10 Gb/s operation as well as most of the 10 Gb/s physical layer specifications.

Section Five -- Includes Clause 56 through Clause 74 and Annex 57A through Annex 74A. Clause 56 through Clause 67 and associated annexes specify subscriber access physical layers and sublayers for operation from 512 kb/s to 1000 Mb/s, and defines services and protocol elements that enable the exchange of IEEE Std 802.3 format frames between stations in a subscriber access network. Clause 68 specifies a 10 Gb/s physical layer specification. Clause 69 through 74 and associated annexes specify Ethernet operation over electrical backplanes at speeds of 1000 Mb/s and 10 Gb/s.

IEEE Std 802.3av-2009

This amendment includes changes to IEEE Std 802.3-2008 and adds Clause 75 through Clause 77 and Annex 75A through Annex 76A. This amendment adds new Physical Layers for 10 Gb/s operation on point-to-multipoint passive optical networks.

IEEE Std 802.3bc™-2009

This amendment includes changes to IEEE Std 802.3-2008 and adds Clause 79. This amendment moves the Ethernet Organizationally Specific Type, Length, Value (TVL) information elements that were specified in IEEE Std 802.1AB to IEEE Std 802.3.

IEEE Std 802.3at™-2009

This amendment includes changes to IEEE Std 802.3-2008. This amendment augments the capabilities of IEEE Std 802.3-2008 with higher power levels and improved power management information.

IEEE Std 802.3-2008™/Cor 1–2000

This corrigendum corrects the PAUSE reaction timing delay value for the 10GBASE-T PHY type.

IEEE Std 802.3ba™-20XX

This amendment includes changes to IEEE Std 802.3-2008 and adds Clause 80 through Clause 88 and Annex 83A through Annex 83C, Annex 85A and Annex 86A. This amendment adds MAC parameters, Physical Layers, and management parameters for the transfer of IEEE 802.3 format frames at 40 Gb/s and 100 Gb/s.

IEEE Std 802.3az™-20XX

This amendment includes changes to IEEE Std 802.3-2008 and adds Clause 78. This amendment adds changes required to enable energy efficient operation of several existing Physical Layers.

IEEE Std 802.3bd-20XX

This amendment includes changes to IEEE Std 802.3-2008. This amendment add changes required to define a MAC Control Frame to support Priority-based Flow Control.

IEEE Std 802.3 will continue to evolve. New Ethernet capabilities are anticipated to be added within the next few years as amendments to this standard.

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Participants

IEEE Std 802.3bd was developed in the IEEE 802.1 Working Group to define a MAC Control Frame to support IEEE Std 802.1Qbb. The balloting Committee for Working Group ballot was formed from IEEE 802.1 Working Group members and any IEEE 802.3 Working Group members who wished to join it. The following list includes the members of IEEE 802.1 Working Group at the beginning of the P802.3bd Working Group ballot and the IEEE 802.3 members who participated in the ballot.

Tony Jeffree, *Working Group Chair*
Paul Congdon, *Working Group Vice Chair*

Pat Thaler, *Chair, Data Center Bridging Task Group*

xxx

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

xxx

xxx

When the IEEE–SA Standards Board approved this standard on 15 September 200X, it had the following membership:

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IEEE Standards Program Manager, Technical Program Development

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For the benefit of those who have received this document by electronic means, what follows is a list of special symbols and operators. If any of these symbols or operators fail to print out correctly on your machine, the editors apologize, and hope that this table will at least help you to sort out the meaning of the resulting funny-shaped blobs and strokes.

Special symbols and operators

Printed character	Meaning	Keystrokes	Character code	Font
∗	Boolean AND	*	ALT-042	Symbol
+	Boolean OR, arithmetic addition	+	ALT-043	Symbol
^	Boolean XOR	^	ALT-094	Times New Roman
!	Boolean NOT	!	ALT-033	Symbol
×	Multiplication	Ctrl-q 4	ALT-0180	Symbol
<	Less than	<	ALT-060	Symbol
≤	Less than or equal to	Ctrl-q #	ALT-0163	Symbol
>	Greater than	>	ALT-062	Symbol
≥	Greater than or equal to	Ctrl-q 3	ALT-0179	Symbol
=	Equal to	=	ALT-061	Symbol
≠	Not equal to	Ctrl-q 9	ALT-0185	Symbol
⇐	Assignment operator	Ctrl-q \	ALT-0220	Symbol
∈	Indicates membership	Ctrl-q Shift-n	ALT-0206	Symbol
∉	Indicates nonmembership	Ctrl-q Shift-o	ALT-0207	Symbol
±	Plus or minus (a tolerance)	Ctrl-q 1	ALT-0177	Symbol
°	Degrees	Ctrl-q 0	ALT-0176	Symbol
∑	Summation	Esc ^ Shift-a	ALT-0229	Symbol
√	Square root	Ctrl-q Shift-v	ALT-0214	Symbol
—	Big dash (em dash)	Ctrl-q Shift-q	ALT-0151	Times New Roman
–	Little dash (en dash), subtraction	Ctrl-q Shift-p	ALT-0150	Times New Roman
|	Vertical bar	|	ALT-0124	Times New Roman
†	Dagger	Ctrl-q Space	ALT-0134	Times New Roman
‡	Double dagger	Ctrl-q ‘	ALT-0135	Times New Roman
α	Lower case alpha	a	ALT-097	Symbol
β	Lower case beta	b	ALT-098	Symbol
γ	Lower case gamma	g	ALT-103	Symbol
δ	Lower case delta	d	ALT-100	Symbol
ε	Lower case epsilon	e	ALT-101	Symbol
λ	Lower case lambda	l	ALT-0108	Symbol
μ	Lower case omicron	Ctrl-q 5	ALT-0181	Times New Roman
Π	Capital pi	Shift-p		Symbol
Ω	Capital omega	W	ALT-087	Symbol

Table of Contents

1.3 Normative references 15
1.4 Definitions 15
1.5 Abbreviations 15

30.Management 16

31.MAC Control 18

Annex 31A 19

Annex 31B 21
31B.1 PAUSE description 21

Annex 31D 22
31D.1 PFC description 22
31D.2 Parameter semantics 22
31D.3 PFC transmit 23
31D.4 Transmit state diagram for PFC operation 24
31D.5 PFC receive 25
31D.6 Receive state diagram for PFC operation 25
31D.7 Protocol implementation conformance statement (PICS) proforma for MAC Control PFC operation28

P802.3bd/D2.1

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Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

Amendment: MAC Control Frame for Priority-based Flow Control

~~<<Editor's Note: This amendment specifies the changes to IEEE Std 802.3 to define a MAC Control Frame to support IEEE P802.1Qbb Priority-based Flow Control. Changes are applied to the base text of IEEE Std 802.3-2008. Text shown in bold italics in this amendment defines the editing instructions necessary to apply the changes to the base text. Three editing instructions are used: ***change***, ***delete***, and ***insert***. ***Change*** is used to make a change to existing material. The editing instruction specifies the location of the change and describes what is to be changed. Changes to existing text may be clarified using strikethrough markings to indicate removal of old material, and underscore markings to indication addition of new material. ***Delete*** removes existing material. ***Insert*** adds new material without changing existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction.>>~~

NOTE—The editing instructions contained in this <amendment/corrigendum> define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.

The editing instructions are shown in ***bold italic***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~strikethrough~~ (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Deletions and insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editing instructions, change markings, and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.

1.3 Normative references

Insert the following reference in the alphanumeric order:

IEEE Std 802.1Q~~bb~~, IEEE Standard for Local and Metropolitan Area Networks~~—Amendment: Priority-based Flow Control~~[1]

1.4 Definitions

Insert the following definition in alphanumeric order:

Priority-based Flow Control (PFC): A mechanism for applying flow control to frames with a given priority on a full duplex link. (See IEEE Std 802.1~~Qbb~~Q.)

1.5 Abbreviations

Insert the following abbreviation in alphanumeric order:

PFC Priority-based Flow Control

[1] At the time of publication, the relevant content was contained in IEEE Std 802.1Qbb IEEE Standard for Local and Metropolitan Area Networks — Virtual Bridged Local Area Networks — Amendment: Priority-based Flow Control

30. Management

30.2.5 Capabilities

Insert aPFCEnableStatus to the MACControlEntity managed object class in Table Annex 30–1a as shown below.

Table 30–1a—Capabilities

				DTE								Repeater					MAU						
				Basic Package (mandatory)	Mandatory Package (mandatory)	Recommended Package (optional)	Optional Package (optional)	Array Package (optional)	Excessive Deferral Package (optional)	Multiple PHY Package (optional)	PHY Error Monitor Capability (optional)	Basic Control Capability (mandatory)	Performance Monitor Capability (optional)	Address Tracking Capability (optional)	100/1000 Mb/s Monitor Capability (optional)	1000 Mb/s Burst Monitor Capability (optional)	Basic Package (mandatory)	MAU Control Package (optional)	Media Loss Tracking Package (conditional)	Broadband DTE MAU Package (conditional)	MII Capability (conditional)	PHY Error Monitor Capability (optional)	Auto-Negotiation Package (mandatory)
oMACControlEntity managed object class (30.3.3)																							
	aMACControlID	ATTRIBUTE	GET		X																		
	aMACControlFunctionsSupported	ATTRIBUTE	GET-SET		X																		
	aMACControlFramesTransmitted	ATTRIBUTE	GET			X																	
	aMACControlFramesReceived	ATTRIBUTE	GET			X																	
	aUnsupportedOpcodesReceived	ATTRIBUTE	GET			X																	
	aPFCEnableStatus	ATTRIBUTE	GET		X*																		
~~NOTE 2: The aPFCEnable attribute is mandatory in systems that support the PFC MAC Control Function. It is optional in systems that do not support the PFC MAC Control Function.~~																							

*The aPFCEnable attribute is mandatory in systems that support the PFC MAC Control Function. It is optional in systems that do not support the PFC MAC Control Function.

30.3.3.2 aMACControlFunctionsSupported

Insert PFC in the SEQUENCE definition for aMACControlFunctionsSupported:

PFC PFC implemented

Insert the following subclause after 30.3.3.5

30.3.3.6 aPFCEnableStatus

ATTRIBUTE

APPROPRIATE SYNTAX:

An ENUMERATED VALUE that has one of the following entries:
enabled
disabled

BEHAVIOUR DEFINED AS:

A ~~read-only~~read-only value that indicates whether PFC MAC Control operation is enabled. The value enabled indicates that operation of PFC MAC Control is enabled and operation of PAUSE MAC Control is disabled. The value disabled indicates that transmission and reception of PFC MAC Control is not enabled and PAUSE MAC Control may operate if it has been enabled through another mechanism.;

NOTE 1—aPFCEnableStatus is ~~read-only~~read-only to avoid the risk of it being set to a conflicting value with enablement of PFC in the MAC Control Client. It is intended that an implementation locally sets the value to enabled when the MAC Control Client has PFC enabled for any priority and to disabled when the MAC Control Client has PFC disabled for all priorities.

NOTE 2—There is no mechanism in this Clause to enable and disable PAUSE transmit and receive for PHYs without autonegotiation. IEEE 802.3.1 provides dot3PauseAdminMode to enable and disable PAUSE in the absence of autonegotiation.

31. MAC Control

31.3.1.2 Semantics of the service primitive

Change the last sentence to:

The valid opcodes and their respective meanings are defined in Annex 31A~~, Annex 31B, and Clause 64~~.

31.3.2.2 Semantics of the service primitive

Change the last sentence to:

The valid opcodes and their respective meanings are defined in Annex 31A~~, Annex 31B, and Clause 64~~.

31.5.2 Control frame reception

Validly received MAC Control frames are further parsed to determine the opcode. The location of the opcode within a valid MAC Control frame and its format are specified in 31.4.1.4 and Figure 31-3. If the MAC Control sublayer entity supports the function requested by the specified opcode, it interprets and acts upon the MAC Control frame in an opcode- and request_operand-specific manner. (See Annex 31A~~ and Annex 31B or Clause 64~~.) This action may change the state of the MAC Control sublayer, affecting its behavior with respect to data transmission requests by the MAC client, future control frame receptions, or control indications to the MAC client.

31.5.3.4 Opcode-independent MAC Control Receive state diagram

Change the note on Figure 31-4 to:

NOTE—The opcode-specific operation (~~per~~see Annex 31A~~ and Annex 31B, and Clause 64~~) is launched as a parallel process by the MAC Control sublayer, and not as a synchronous function. Progress of the generic MAC Control Receive state diagram (as shown in this figure) is not implicitly impeded by the launching of the opcode-specific function.

Change the last sentence to:

The functions performed in the INITIATE MAC CONTROL FUNCTION state are opcode-specific~~, and are provided in~~ (see Annex 31A)~~, Annex 31B, and Clause 64~~.

Annex 31A

(normative)

MAC Control opcode assignments

Delete the row of Table 31A-1 for Opcodes 00-07 through FF-FD and ~~I~~insert the three rows below in its place~~Table 31A-1 and update the reserved value row~~.

Table 31A–1—MAC Control opcodes

Opcode (Hexadecimal)	MAC Control function	Specified in	Value/Comment	Timestamp[a]
00-7 through 01-00	Reserved			
01-01	PFC	Annex 31D and IEEE Std 802.1~~Qbb~~Q	Requests that the recipient stop transmissions in the priorities indicated in the parameters of the function for a period of time also indicated in the parameters	No
~~00-07 through 01-00 and~~ 01-02 through FF-FD	Reserved			

[a]The timestamp field is generated by MAC Control and is not exposed through the client interface.

Insert Table 31A–9 for PFC MAC Control indications and change the paragraph listing the tables to include the additional table:

Table 31A–2 through ~~Table 31A–7~~Table 31A–9 show the elements and semantics of the indication_operand_list for MA_CONTROL.indication primitives for each currently defined opcode value in Table 31A–1.

Table 31A–9—PFC MAC Control indications

PFC (opcode 0x01-01~~TBD~~)		
indication_operand_list element	**Value**	**Interpretation**
priority_enable_vector	2 octets	The most significant octet is reserved (i.e., set to zero on transmission and ignored on receipt)~~set to zero~~. Each bit of the least significant octet indicates if the corresponding field in the time_vector parameter is valid. The bits of the least significant octet are named e[0] (the least significant bit) to e[7] (the most significant bit). Bit e[n] refers to Priority n. For each e[n] bit set to one, the corresponding time[n] value is valid. For each e[n] bit set to zero, the corresponding time[n] value is invalid.
time_vector	a list of eight 2-octet unsigned integers	A list of eight 2-octet fields named time[0] to time[7]. The eight time[n] values are always present regardless of the value of the corresponding e[n] bit. Each time[n] field is a 2-octet, unsigned integer containing the length of time for which the receiving station is requested to inhibit transmission of data frames associated with Priority n. The field is transmitted most significant octet first, and least significant octet second. ~~Time[0] is transmitted before time[7].~~ The Time[n] fields are transmitted sequentially, with Time[0] transmitted first and Time[7] transmitted last. Each time[n] value is measured in units of pause_quanta, equal to the time required to transmit 512 bits of a frame at the data rate of the MAC. Each time[n] field can assume a value in the range of 0 to 65 535 pause_quanta.

Annex 31B

(normative)

MAC Control PAUSE operation

31B.1 PAUSE description

Insert the following at the end of subclause 31B.1:

When MAC Control PFC operation (see Annex 31D and IEEE Std 802.1~~Qbb~~Q) has been enabled, MAC Control PAUSE operation shall be disabled.

31B.4.4 PAUSE command requirements

Insert to the following row at the end of the table:

Item	Feature	Subclause	Value/Comment	Status	Support
PCR3	PAUSE operation on PFC enable	31B.1	Disabled	PFC: M	Yes [ ]

Annex 31D

(normative)

MAC Control PFC operation

31D.1 PFC description

The PFC operation is used to inhibit transmission of data frames on one or more priorities for a specified period of time. The behavior of a MAC Control client supporting PFC operation is specified in IEEE Std 802.1~~Qbb~~Q. A MAC Control client wishing to inhibit transmission of data frames from the link partner generates a MA_CONTROL.request primitive specifying:

a) The globally assigned 48-bit multicast address 01-80-C2-00-00-01,
b) The PFC opcode,
c) A request_operand list with two operands: priority_~~request~~enable_vector and time_vector. (See 31D.2)

Unlike the MAC Control PAUSE operation, the inhibition of frames for the PFC operation occurs in the MAC Control client. Upon receiving a PFC frame, the only action in MAC Control is to generate a MA_CONTROL.indication primitive with the indication_operand list specified in Table 31A–9.

The PFC operation does not inhibit transmission of MAC Control frames.

PFC operation shall not be enabled on DTEs configured to the half-duplex mode of operation. PFC is intended for use over full-duplex point-to-point links. Use on shared media such as EPON is out of the scope of this standard.

The globally assigned 48-bit multicast address 01-80-C2-00-00-01 has been reserved for use in MAC Control frames. Bridges conformant to IEEE Std 802.1D or IEEE Std 802.1Q will not forward frames sent to this multicast destination address, regardless of the state of the bridge's ports, and whether or not the bridge implements the MAC Control sublayer. To allow PFC full duplex flow control, stations implementing the PFC operation shall instruct the MAC (e.g., through layer management) to enable reception of frames with destination address equal to this multicast address.

NOTE—By definition, an IEEE 802.3 LAN operating in full duplex mode comprises exactly two stations, thus there is no ambiguity regarding the destination DTE's identity. The use of a well-known multicast address relieves the MAC Control sublayer and its client from having to know, and maintain knowledge of, the individual 48-bit address of the other DTE in a full duplex environment.

31D.2 Parameter semantics

The PFC opcode takes the following request_operand_list:

priority_enable_vector:
A 2-octet vector. The most significant octet is reserved (i.e., set to zero on transmission and ignored on receipt)~~set to zero~~. Each bit of the least significant octet indicates if the corresponding field in the time_vector parameter is valid. The bits of the least significant octet are named e[0] (the least significant bit) to e[7] (the most significant bit). Bit e[n] refers to Priority n. For each e[n] bit set to one, the corresponding time[n] value is valid. For each e[n] bit set to zero, the corresponding time[n] value is invalid.

time_vector:

A list of eight 2-octet fields named time[0] to time[7]. The eight time[n] values are always present regardless of the value of the corresponding e[n] bit. Each time[n] field is a 2-octet, unsigned integer containing the length of time for which the receiving station is requested to inhibit transmission of data frames associated with Priority n. The field is transmitted most significant octet first, and least significant octet second. ~~Time[0] is transmitted before time[7].~~The Time[n] fields are transmitted sequentially, with Time[0] transmitted first and Time[7] transmitted last. Each time[n] value is measured in units of pause_quanta, equal to the time required to transmit 512 bits of a frame at the data rate of the MAC. Each time[n] field can assume a value in the range of 0 to 65 535 pause_quanta.

31D.3 PFC transmit

Upon receipt of a MA_CONTROL.request primitive containing the PFC opcode from a MAC client, the MAC Control sublayer calls the MAC sublayer MAC:MA_DATA.request service primitive with the following parameters:

a) The destination_address is set equal to the destination_address parameter of the MA_CONTROL.request primitive. This parameter is currently restricted to the value specified in 31D.1.
b) The source_address is set equal to the 48-bit individual address of the station.
c) The length/type field (i.e., the first two octets) within the mac_service_data_unit parameter is set to the IEEE 802.3 MAC Control type value assigned in 31.4.1.3.
d) The remainder of the mac_service_data_unit is set equal to the concatenation of the PFC opcode encoding (see Annex 31A), the priority_enable_vector and the time_vector specified in the MA_CONTROL.request primitive, and a field containing zeros of the length specified in 31.4.1.6.
e) The frame_check_sequence is omitted.

Figure 31D–1 depicts the MAC Control PFC Frame transmitted in response to an MA_Control.request primitive with the PFC opcode.

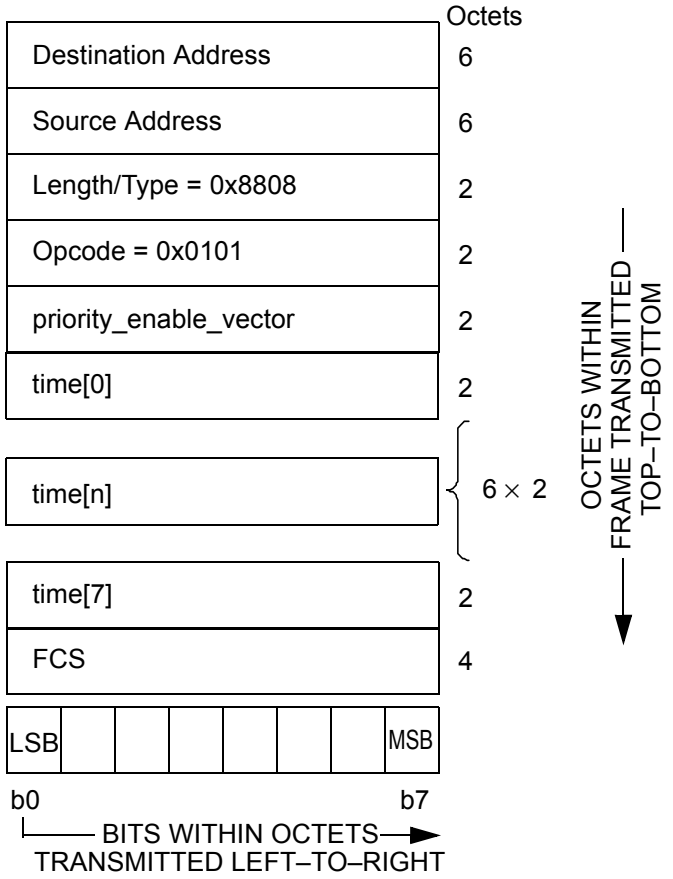

Figure 31D–1—MAC Control EXTENSION Frame

31D.4 Transmit state diagram for PFC operation

MAC Control sublayer entities that transmit PFC frames shall implement the Transmit state diagram specified in this subclause.

31D.4.1 Constants

pfc_command
: The 2-octet encoding of the PFC opcode, as specified in Annex 31A.

phys_Address
: A 48-bit value, equal to the unicast address of the station implementing the MAC Control sublayer.

reserved_multicast_address
: The 48-bit address specified in 31D.1 (a).

802.3_MAC_Control
: The 16 bit type field assignment for 802.3 MAC Control specified in 31.4.1.3.

31D.4.2 Variables

transmitEnabled
: A Boolean set by network management to indicate that the station is permitted to transmit on the network.
: Values: true; Transmitter is enabled by management
false; Transmitter is disabled by management

pfc_operand_list
: The priority_enable_vector and time_vector from the MA_CONTROL.request.

pfc_mac_service_data_unit
: The concatenation of IEEE 802.3_MAC_Control, pfc_command, priority_enable_vector, time_vector, zeros.

31D.4.3 Messages

MA_CONTROL.request
: The service primitive used by a client to request a MAC Control sublayer function with the specified request_operands.

MCF:MA_DATA.request
: The service primitive used by a client to request MAC data transmission with the specified parameters.

MAC:MA_DATA.request
: The service primitive issued by the MAC Control sublayer to transmit a MAC frame with the specified parameters.

31D.4.4 Transmit state diagram for PFC operation

Figure 31D–2 depicts the Transmit state diagram for a MAC Control sublayer entity implementing the PFC operation.

31D.5 PFC receive

The opcode-independent MAC Control sublayer Receive state diagram accepts and parses valid frames received from the MAC sublayer. The functions specified in this subclause are performed upon receipt of a valid Control frame containing the PFC opcode, and define the function called by the INITIATE MAC CONTROL FUNCTION state of Figure 31–4. (See 31.5.3.) Upon receipt of a valid MAC Control frame with the opcode indicating PFC and the destination address indicating the reserved multicast address specified in 31D.1, the MAC Control sublayer generates the MA_CONTROL.indication to the MAC Control Client.

31D.6 Receive state diagram for PFC operation

MAC Control sublayer entities that transmit PFC frames shall implement the Receive state diagram specified in this subclause.

31D.6.1 Constants

pfc_command
: The 2-octet encoding of the PFC opcode, as specified in Annex 31A.

reserved_multicast_address
: The 48-bit address specified in 31D.1 (a).

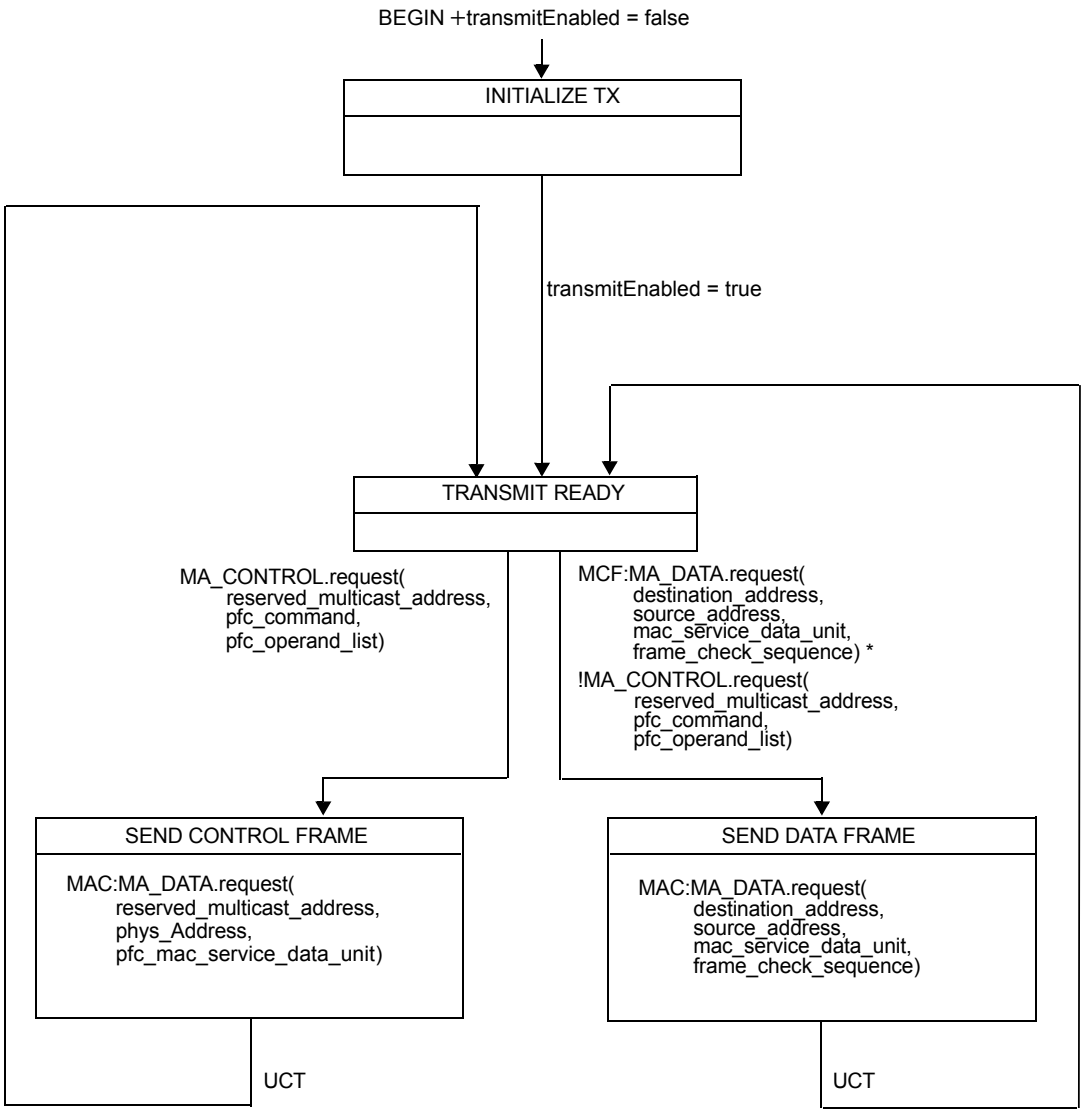

Figure 31D–2—PFC Operation Transmit state diagram

31D.6.2 Variables

opcode
: The opcode parsed from the received MAC frame.

DA
: The destination address from the MAC:MA_DATA.indication service primitive.

pfc_operand_list
: The priority_enable_vector and time_vector parsed from the received frame.

31D.6.3 Receive state diagram (INITIATE MAC CONTROL FUNCTION) for PFC operation

Figure 31D–3 depicts the INITIATE MAC CONTROL FUNCTION for the PFC operation. (See 31.5.3.)

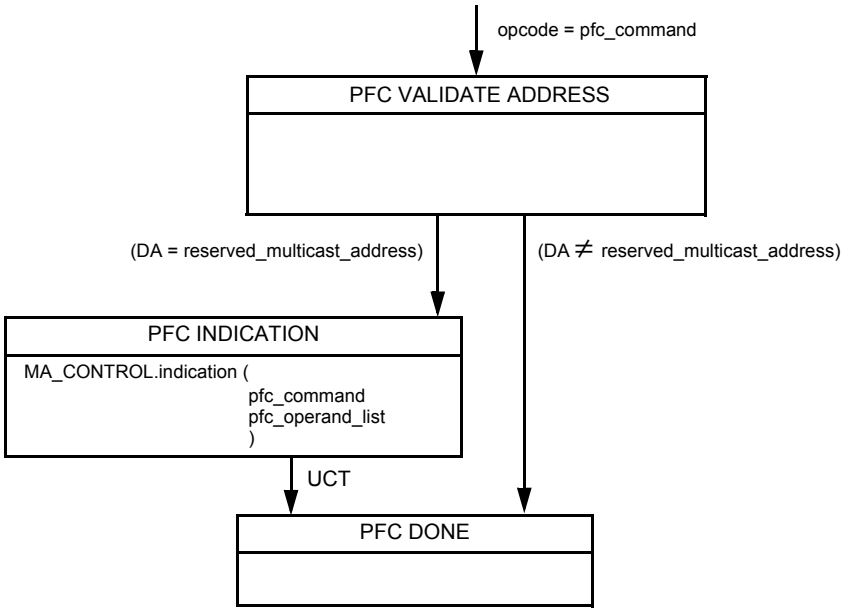

Figure 31D–3—PFC Operation Receive state diagram

31D.7 Protocol implementation conformance statement (PICS) proforma for MAC Control PFC operation[2]

31D.7.1 Introduction

The supplier of a protocol implementation that is claimed to conform to Annex 31D, MAC Control PFC operation, shall complete the following PICS proforma in addition to the PICS of Clause 31.

A detailed description of the symbols used in the PICS proforma, along with instructions for completing the PICS proforma, can be found in Clause 21.Identification

31D.7.1.1 Implementation identification

Supplier	
Contact point for queries about the PICS	
Implementation Name(s) and Version(s)	
Other information necessary for full identification—e.g., name(s) and version(s) for machines and/or operating systems; System Name(s)	
NOTE 1—Only the first three items are required for all implementations, other information may be completed as appropriate in meeting the requirements for the identification. NOTE 2—The terms Name and Version should be interpreted appropriately to correspond with a supplier's terminology (e.g., Type, Series, Model).	

31D.7.1.2 Protocol summary

Identification of protocol specification	IEEE Std 802.3bd-200x~~8~~, Annex 31D, MAC Control PFC operation
Identification of amendments and corrigenda to this PICS proforma that have been completed as part of this PICS	
Have any Exception items been required? No [ ] Yes [ ] (See Clause 21; The answer Yes means that the implementation does not conform to IEEE Std 802.3bd)	

Date of Statement	

[2]*Copyright release for PICS proformas:* Users of this standard may freely reproduce the PICS proforma in this annex so that it can be used for its intended purpose and may further publish the completed PICS.

31D.7.2 Major capabilities/options

Item	Feature	Subclause	Value/Comment	Status	Support
PFC	Support for transmit and reception of PFC frames	31D.3 and 31D.5	N/A	M	Yes [ ]

31D.7.3 PFC command requirements

Item	Feature	Subclause	Value/Comment	Status	Support
PFC1	Duplex mode of DTE	31D.1	Full duplex	M	Yes [ ]
PFC2	Reception of frames with destination address equal to the multicast address 01-80-C2-00-00-01	31D.1	Enabled	M	Yes [ ]

31D.7.4 PFC command state diagram requirements

Item	Feature	Subclause	Value/Comment	Status	Support
PSDT	Transmit state diagram for ~~PAUSE~~PFC operation	31D.4	Meets requirements of Figure 31D–2	M	Yes [ ]
PSDR	Receive state diagram for ~~PAUSE~~PFC operation	31D.6	Meets requirements of Figure 31D–3	M	Yes [ ]