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ITU-T

TELECOMMUNICATION
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OF ITU

X.86/Y.1323

Amendment 1

(04/2002)

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Public data networks – Transmission, signalling and switching

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE AND INTERNET PROTOCOL ASPECTS

Internet protocol aspects – Transport

Ethernet over LAPS

Amendment 1: Using Ethernet flow control as rate limiting

ITU-T Recommendation X.86/Y.1323 (2001) – Amendment 1

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ITU-T Recommendation X.86/Y.1323

Ethernet over LAPS

Amendment 1

Using Ethernet flow control as rate limiting

Summary

ITU-T Rec. X.86/Y.1323 "Ethernet over LAPS" is a simple method mapping Ethernet frames into transmission payloads that is specific to Ethernet. Because this Recommendation is specific to Ethernet and not generic, a method of limiting the data transmission rate that is specific to Ethernet can be used. IEEE 802.3x, "Ethernet Flow Control" provides Media Access Control (MAC) control frames that temporarily stop the transmission of Ethernet data frames of the full duplex operating Ethernet ports that receive them. By issuing the proper MAC control frames, an X.86 interface, on a transmission multiplex node, or directly on a data system, can limit the amount of Ethernet frames offered to the interface, thus limiting the Ethernet transmission rate. With the ability to limit the Ethernet transmission rate without loss of any data, this Recommendation can now be used to map Ethernet frames into sub-VC-4 payloads. This is a major contrast to other implementations that "shape" the data transfer rate by dropping the data that exceeds the capacity of the service interface or the service rate over a period of time. Adding Ethernet Flow Control to this Recommendation will provide a level of reliability that is inherent with standard Ethernet.

Source

Amendment 1 to ITU-T Recommendation X.86/Y.1323 (2001) was prepared by ITU-T Study Group 17 (2001-2004) and approved under the WTSA Resolution 1 procedure on 13 April 2002.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

Introduction

ITU-T Rec. X.86/Y.1323 provides a very simple and specific method of mapping Ethernet frames into SDH VC-4 payloads by encapsulating unmodified Ethernet frames with Link Access Procedure-SDH (LAPS).

Ethernet is a Media Access Control (MAC) protocol that is standardized by IEEE LAN MAN Standards Committee (LMSC) Working Group 3 (802.3). 802.3 Ethernet is referred to as an "unreliable" protocol because it does not have a method of detecting data loss at the Logical Link Level and retransmitting it. The Ethernet standard provides for a very reliable Physical Media (PHY) standard that is specific to Ethernet and provides a very reliable physical transport media for the Ethernet frames. The Ethernet PHY standards provide very simple and easy to deploy technology that is one of the primary reasons for the success of Ethernet all over the world. In many cases the PHY designations are used to signify the various types of physical infrastructure that Ethernet is deployed over. 100BaseT is the PHY designation for 100 Mbit/s base band Ethernet over twisted pair copper.

This Recommendation replaces the standard Ethernet PHY with the LAPS "bridge" that maps the Ethernet frames into a very reliable physical transport, SDH. An X.86 interface functions as a two-port transparent bridge without any 802.1 functions. One port is at the Ethernet reconciliation layer of an Ethernet PHY/MAC client service. The other port is at the SDH transport payload. The X.86 interface is transparent to the Ethernet frames. The content of the Ethernet MAC frames, except for calculating the LAPS CRC, is transparent to X.86/Y.1323 functions. Any 802.3 MAC control frames that are received by X.86/Y.1323 are handled transparently.

The reliability of the SDH transport is similar to the PHY standards adopted by 802.3. When transported over SDH by means of this Recommendation, Ethernet data communications should have the same reliability as provided by the Ethernet PHYs. As different SDH payload rates are utilized for this Recommendation, the same level of reliability needs to be maintained.

This Recommendation fully encapsulates the Ethernet MAC frames in LAPS frames. The Ethernet Inter-Packet Gap (IPG), Preamble, and Start of Frame Delimiter (SFD) that are normally part of Ethernet transmission are not carried by this Recommendation. The SDH VC-4 payload rate is approximately 150 Mbit/s. When linked to an Ethernet full duplex 100 Mbit/s interface, this Recommendation needs to limit the amount of Ethernet frames offered by the Ethernet Interface. The approved version of this Recommendation for use with SDH VC-4 payload has a rate adaptation that expands the Ethernet traffic rate to fill the SDH VC-4 payload rate.

When sub-VC-4 payloads are to be used, a method of limiting the Ethernet transfer rate must now be used. Also if Ethernet interfaces at data rates higher than VC-4 are used, then that same method of limiting the Ethernet transfer rate must also be used. If a method of limiting the Ethernet transfer rate is not used, then the interfaces can offer a continuous stream of data frames that will exceed the capacity of the SDH payload rates, and thus cause the loss of data. If a method is used that limits the Ethernet transfer rate without dropping data frames then this Recommendation can be used on transmission equipment to map Ethernet frames into SDH, as well as data equipment.

Standard 802.3 provides a method that is specific to Ethernet that will dynamically limit the data transmission rate of Ethernet interfaces by temporarily inhibiting the transmission of Ethernet frames. Clause 31, Annex 31A, and Annex 31B cover the functionality of MAC Control and MAC Control Frames within standard Ethernet interfaces. Clause 31 describes an optional MAC control sublayer that exists between the MAC/Reconciliation sublayer at Physical Layer, and the MAC Control Client. In this case, the MAC Control Client replaces the MAC Client that is represented in other clauses. Most customer (CPE) Ethernet data equipment that is available today, with full duplex operation, support this option.

Annex 31B of IEEE 802.3 describes the MAC Control Pause operation that provides the functionality for 802.3x "flow control". It defines how an Ethernet port receiver acts when it receives a MAC Control Frame with a pause control function, known as a "Pause" frame. It also defines how the transmitter acts when the receiver has received a Pause frame. An opcode in the MAC Control frames known as "pause_time" which is expressed in "pause_quanta" determines the amount of time that the Ethernet interface will inhibit transmission of Ethernet frames.

ITU-T Recommendation X.86/Y.1323

Ethernet over LAPS

Amendment 1

Using Ethernet flow control as rate limiting

1) Clause 2.1.2

Change the reference in clause 2.1.2 to:

– IEEE 802.3 (2001), *CSMA/CD Access Method and Physical Layer Specifications*.

2) Clause 10

Add the following text at the beginning of clause 10:

There are two situations in which rate adaptation is required. The situation in which the VC-4 payload rate exceeds the Ethernet port data transfer rate is covered in this clause. The situation in which the transfer rate of the SDH payload is less than the Ethernet port data transfer rate is covered in Annex A "Rate Limitation".

3) New Annex A

Add the following as Annex A:

Annex A

Rate limitation

A.1 Rate limiting for Ethernet transfer rates that exceed SDH payload rates

This Recommendation, "Ethernet over LAPS" is a method of mapping Ethernet frames directly into different transmission payload rates. Clause 10 "Rate Adaptation" covers the adaptation needed when the payload rate exceeds the data transfer rate of the supported Ethernet ports. This annex covers the use of generating 802.3x Flow Control Pause Frames by the X.86 interface to control the transmission rate of the Ethernet interface to match sub-VC-4 and other transmission payload rates that are less than the standard Ethernet interfaces being supported. The use of Ethernet Flow Control to X.86 will also enable X.86 interfaces on transmission ADMs (Add/Drop Multiplex) and LTEs (Line Termination Equipment) to rate match CPE Ethernet ports to sub-VC-4 transmission payload rates. The use of Ethernet Flow Control to X.86 will also tend to prevent the loss of data over highly utilized transmission links. This is a preferred alternative to "rate shaping" that drops data when it exceeds the configured transmission payload rate.

A.2 Pause frame generation

Clause 31- "MAC Control", Annex 31A- " MAC Control Opcode Assignments", and Annex 31B – "MAC Control Pause Operation" in IEEE 802.3 *CSMA/CD Access Method and Physical Layer Specifications, 2001 Edition*, covers the functional definition and functions of Pause frames in Ethernet interfaces. In order for X.86 interfaces to make use of this functionality, X.86 entity must be able to send the required Pause frames, to the correct Ethernet interface or sublayer, in such a way as to prevent overrunning of the LAPS encapsulation and mapping into the SDH payload rate. The initiation of sending the required Pause frames is at the location of determining the remaining capacity in the SDH payload rate to accept additional Ethernet frames after Encapsulation in LAPS. This will be at the SDH payload insertion buffer/FIFO.

The Ethernet Pause frames will be generated out of the Transmission SDH payload insertion buffer/FIFO and inserted into the data stream that was removed from the reception SDH payload buffer/FIFO and de-encapsulated at the LAPS sublayer. The Pause frames that are generated by the SDH payload insertion buffer/FIFO are queued ahead of any de-encapsulated Ethernet frames that have not yet been sent to the Ethernet reconciliation layer. Any de-encapsulated Ethernet frames that have started processing through the reconciliation layer will not be disturbed.

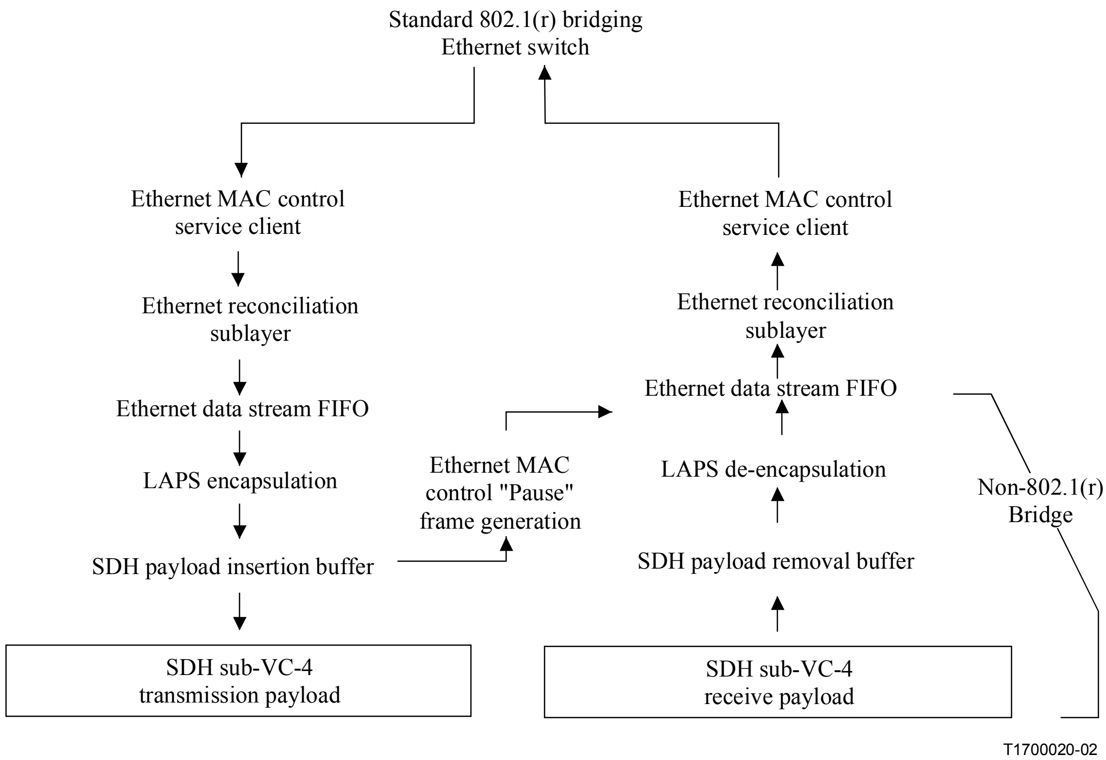

Figure A.1/X.86/Y.1323 – Process flow of 802.3x in X.86 data system interface

There will be difference in when the Pause frames are generated between an X.86 interface co-located on a data switch and an X.86 interface on a transmission node which is remote from the Ethernet transmitting interface. When the X.86 interface is co-located on an Ethernet data switch, then process interconnection will only be through the Ethernet reconciliation sublayer directly to the MAC Control sublayer. Figure A.1 shows a flow of processing Ethernet frames and the generation of Pause Frames of an X.86 interface on an Ethernet bridge/switch. The MAC control sublayer will function, using the pause frames generated by the X.86 sublayers, as back pressure to reduce the transmission rate to the payload rate. The MAC control sublayer will also react to Pause Frames that are received over the transmission link through the X.86 interface.

When the X.86 interface is remote, as on a transmission equipment node, then the Pause service process must go through the Ethernet link between the transmission equipment and the CPE Ethernet transmitting interface. Figure A.2 shows a process flow for an X.86 interface on an ADM. The X.86 interface injects pause frames into the Ethernet link to the CPE to provide back pressure at the MAC control sublayer. With properly configured threshold levels and correct "pause_time" opcodes in the Pause Frames, the CPE data transmission rate will be reduced to the transmission system payload rate. The MAC control function on the CPE equipment will rate match the linked customer Ethernet ports to the configured payload rates on the transmission ADM or LTE that has an X.86 interface.

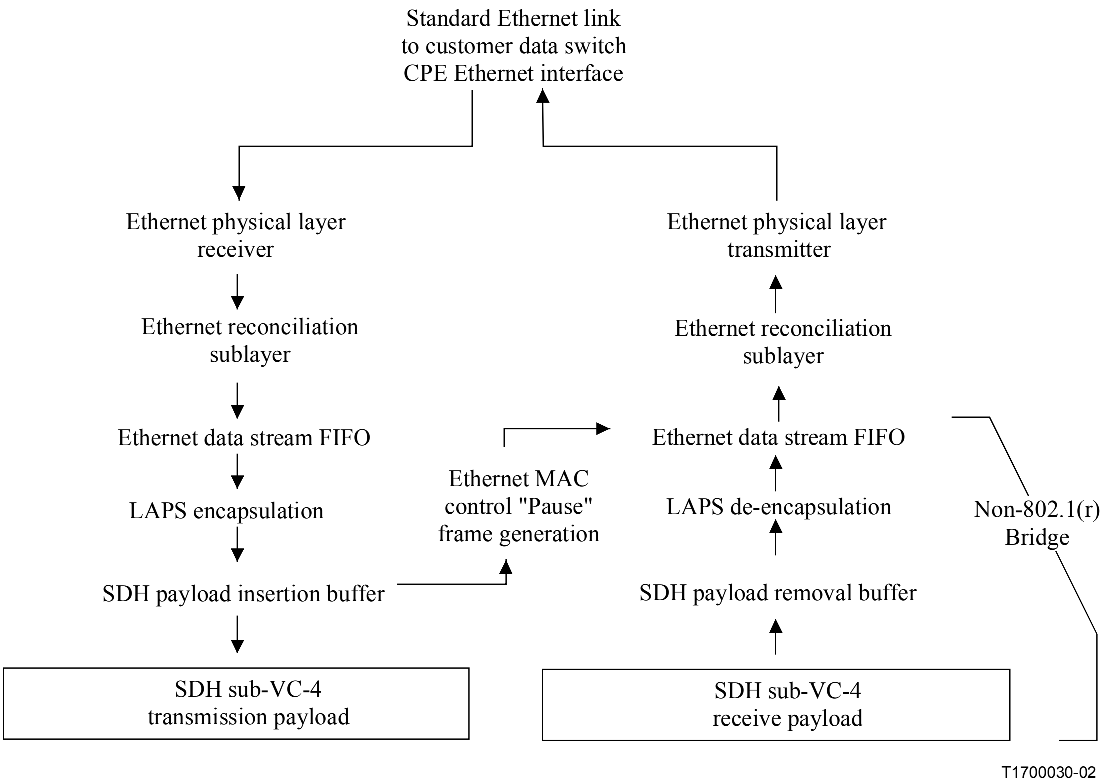

Figure A.2/X.86/Y.1323 – Process flow of 802.3x in X.86 transmission system interface

A.3 Determining when to send a pause frame

The determination of when to send the Pause frames will be a threshold of the payload insertion buffer/FIFO capacity that will prevent an overrun condition and the loss of data frames. The threshold will need to take into account the latency of the Ethernet link speed, the distance to the first MAC Control Sublayer, and the remaining capacity in the SDH payload insertion process minus the potential capacity of Ethernet frames that are already in the transmit process. The potential capacity of transmit queued Ethernet frames is the maximum size Ethernet frame that may already be in the transmit process at the CPE Ethernet interface and the maximum size Ethernet frame that may also be already in the transmit process from the X.86 interface. Also, the latency of the LAPS encapsulation process must be included. These things will be implementation specific because there are various technologies that can be used to do the X.86 LAPS encapsulation process and SDH payload insertion. There are also different Ethernet maximum link distances and speeds depending on the type of Ethernet interfaces supported when X.86 is used to map Ethernet frames into SDH payloads on transmission systems. IEEE 802.3 Clause 31B also includes the timing considerations for the pause operation within the transmitter of the CPE Ethernet interface, based on the speed of the interface. These considerations will create a threshold level in the payload insertion process that will initiate the generation of Pause frames. The threshold level can be used to determine the "pause_quanta" that is used to determine the "pause_time" opcode that is used in the generated Pause frame. Also, IEEE 802.3 Clause 31B includes recommended interface speed considerations for the determination of the "pause_time" operand. The number and speed of Pause frames generated as well as the "pause_time" will be specific to the above implementation considerations. There will be other considerations that implementers will take into consideration to make their implementations more reliable.

A.4 State diagram for sending pause frames from and X.86 Ethernet interface

A state diagram of sending MAC Control "Pause" frame will look like (see Figure A.3):

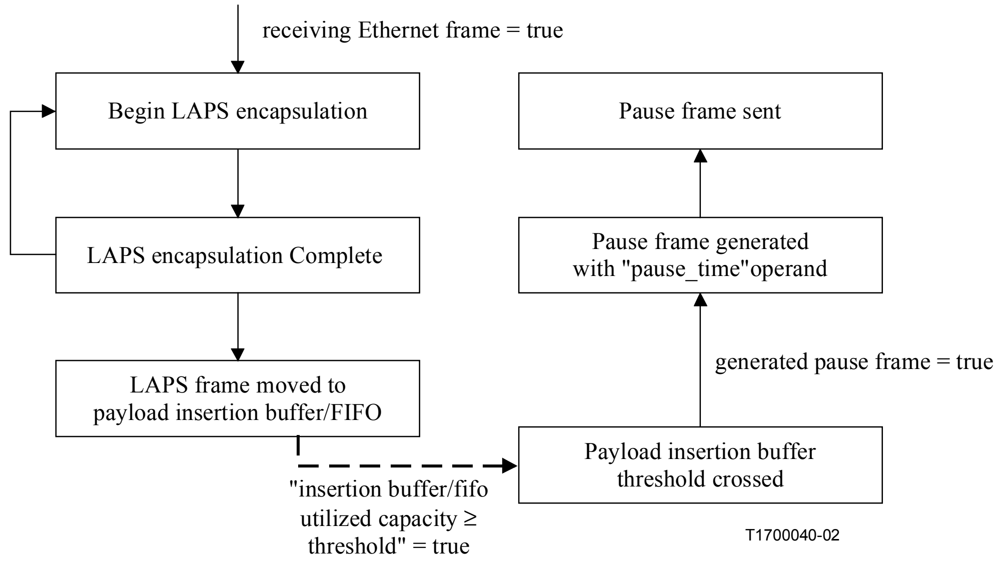

Figure A.3/X.86/Y.1323 – State diagram for sending pause frames

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