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Telecommunications and information exchange between systems — Future network protocols and mechanisms —

Part 1:
Switching and routing

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Partie 1: Commutation et routage

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Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*.

A list of all parts in the ISO/IEC 21559 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

ISO/IEC TR 29181-1 describes the definition, general concept, problems and requirements for the Future Network (FN).

ISO/IEC TR 29181-3 examines the requirements for carrying data over digital networks and identifies those that are not satisfied by the current Internet. It also notes some expected characteristics of new systems that are better able to satisfy the requirements and specifies a model which supports both the existing system and the new systems. This will enable a migration to the new systems; it is also intended to make networks of all sizes easier to manage.

ISO/IEC 21558-1 specifies an architecture which meets the requirements identified in ISO/IEC TR 29181-3.

Telecommunications and information exchange between systems — Future network protocols and mechanisms —

Part 1: Switching and routing

1 Scope

This document specifies protocols and mechanisms for use within systems conforming to the future network (FN) architecture specified in ISO/IEC 21558-1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC/TR 29181-1, *Information technology — Future Network — Problem statement and requirements — Part 1: Overall aspects*

ISO/IEC/TR 29181-3, *Information technology — Future Network — Problem statement and requirements — Part 3: Switching and routing*

IEC 62379-5-1, *Common control interface for networked digital audio and video products - Part 5-1: Transmission over networks - General*

IEC 62379-5-2, *Common control interface for networked digital audio and video products – Part 5-2: Transmission over networks – Signalling*

AES51-2006 (s2017), *AES standard for digital audio - Digital input-output interfacing - Transmission of ATM cells over Ethernet physical layer* (Audio Engineering Society, New York, NY, USA)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC TR 29181-1 and ISO/IEC TR 29181-3 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org

3.1
AV flow
flow in which packets are expected to be transmitted at regular intervals, suitable for carrying live audio, video, and other media

3.2
IT flow
flow in which packets are not expected to be transmitted at regular intervals

4 Abbreviated terms

For the purposes of this document, the abbreviations given in ISO/IEC TR 29181-1 and ISO/IEC TR 29181-3 and the following apply.

AV AudioVisual

CRC Cyclic Redundancy Check

FCS Frame Check Sequence

FN Future Network

IT Information Technology

5 FN physical links

5.1 General

An FN physical link conveys a sequence of frames. There shall be a whole number of frames per allocation period.

Where an FN physical link is implemented over a physical layer that was developed for another technology, the link partners may use the negotiation procedure specified in 5.4 to manage the change from using that technology to sending FN frames. Alternatively, if FN frames are not valid frames for the other technology, either link partner may begin sending FN frames as soon as the link is established.

Once the link is established, with FN frames being sent in both directions, it can be used to exchange signalling messages, which shall be used to convey any of the information necessary to set up IT flows that was not included in a negotiation process (or all such information if there was no negotiation process), and to align frames as specified in Clause 7.

5.2 Frame format

5.2.1 Components of a frame

General provisions are specified here. Details are specified in Annex A.

Each frame on a physical link shall include:

— timing field (see below);

— slots for AV packets (see 5.2.2 and 5.2.3);

and may also include:

— trailing octets (see 5.2.3).

The timing field shall consist of four octets holding (big-endianly) a 32-bit value. The all-ones value shall show that no time is indicated. Time (modulo four seconds) shall be coded with seconds in the ms 2 bits and nanoseconds (in the range 0 to 999 999 999 inclusive) in the remaining 30 bits. Other code points are reserved.

NOTE 1 Coding time as counts of seconds and nanoseconds is compatible with PTP.

The timing field is a “framing” field. There may be other framing fields, e.g. to mark the start of a frame, to identify its position within the allocation period, or to detect transmission errors. A frame shall not contain anything that would require the recipient to buffer the data before processing it.

For each link, a "word" shall be defined as a whole number of octets. The number shall be strictly positive and shall be fixed for each format and physical layer.

A slot should consist of 64 octets. Each slot shall be a whole number of words.

The trailing octets (if present) shall be a whole number of words.

NOTE 2 On physical layers where the interface between MAC and PHY is typically 8 bits wide, such as 1Gb/s Ethernet, the word length can be a single octet. Where typical interfaces are wider, as with 10Gb/s Ethernet, the word length can match the width of the interface. The word length can be signalled in a framing field or during negotiation.

5.2.2 AV packets

Each slot shall either contain an AV packet or be an "empty slot". In the case of a packet, the payload shall be any number of octets in the range 0 to 63 (inclusive). The header shall consist of one octet formatted as follows:

— bit 7 (most significant bit): set such that the total number of bits set to 1 in the octet is odd;

— bit 6: flag *f*;

— bits 5-0: length, coded as the number of payload octets.

The flag *f* shall not be used for routing, but shall be available for use by the higher layers; if it is used to guide reassembly of longer messages, it should be set to 0 in the last fragment of a message and 1 in others.

The frame format may provide for explicit indication of whether a slot is empty; otherwise, an empty slot shall be coded as a "null packet", with length zero and *f* = 1.

NOTE If *f* is used as specified above, inserting or dropping null packets in a flow will have no effect.

5.2.3 IT data stream

The octets in each slot that are not part of an AV packet (after rounding the size of the packet up to a whole number of words), together with the trailing octets if present, shall be concatenated in the order in which they are transmitted to form the "IT data stream".

NOTE 1 If the packet is not a whole number of words, the unused octets in the last word contain rubbish and are thus an overhead. Where the word length is more than one octet, this will always occur with zero-length packets (which use a whole word for one octet of information), so for frames with a longer word length a more efficient means of identifying empty slots can be useful.

The IT data stream shall carry IT packets and "idle" words. An "idle" word shall be a single word coded with a value that cannot be the first word of an IT packet header, and shall be transmitted whenever there is no IT packet available for transmission,

The recipient of an IT data stream shall interpret it according to the following three contexts:

a) Searching: this shall be the initial context when the first frame is received and shall be entered in the event of any error, including: frame of the wrong length; excessive gap between frames; parity error in the first octet of a slot; and error in integrity check fields for the frame or an IT packet header. There shall be a transition to "between packets" context when a sufficient number of consecutive "idle" words have been received.

   NOTE 2 This document does not specify how many is a "sufficient" number. It is a decision for the implementer.

b) Between packets: in this context either an "idle" word or the start of a packet is expected. An "idle" word shall be ignored and the context remain as "between packets". A word that can be the start of an IT packet shall be interpreted as such and "within packet" context entered. Any other code point should be interpreted as an error, and "searching" context entered.

c) Within packet: each word shall be interpreted as the next word of the packet. After the last word the context shall revert to "between packets".

5.3 Negotiation packets

5.3.1 Payload format

Negotiation packets shall be formatted as specified in AES51, except as follows:

a) The timing information shall use the same coding as the timing field in frames (see 5.2.1).

b) The octet string specified as the Ethernet MAC client data may instead be sent as a service data unit for a service other than Ethernet, e.g. as a UDP datagram. The UDP port numbers to be used in this case are *tbd*.

NOTE No semantics are assigned to the timing information in negotiation packets, so it will usually be coded as all-ones.

5.3.2 Information elements

5.3.2.1 Information element types

Information element types 01, 03, and 04 specified in AES51 shall not be used.

Information element type 02 specified in AES51 may be present for physical links able to carry AV flows, and if present shall be coded with the value zero. Use of this IE coded with a nonzero value is reserved.

Additional information element types specified in 5.3.2.2 to 5.3.2.5 inclusive shall also be supported.

5.3.2.2 Sender's identifier

Information element type hexadecimal 82 shall be used to convey information relevant to higher-layer management, and shall be included if, and only if, the sender has a 64-bit identifier.

The first 8 octets of the information field shall contain the sender's 64-bit identifier, as specified in IEC 62379-5-2. Where the information field is longer than 8 octets, the remaining octets are reserved.

5.3.2.3 Flow label for signalling messages

Information element type hexadecimal 83 shall be used to specify the flow label to be used on signalling messages to the sender. The information field shall be coded with the value for the part of the packet header containing the flow label (including any protection fields), using the minimum number of octets and aligned at the high end if not a whole number of octets. If there is no type 83 IE, signalling messages shall use flow label zero.

NOTE For all current link formats, the information field will be exactly two octets, containing the flow label and CRC.

5.3.2.4 Recipient's identifier

Information element type hexadecimal 84 may be used to issue a temporary 64-bit identifier to a unit which does not have a permanent one. It may also be used to confirm the link partner's identity. The first 8 octets of the information field shall contain the 64-bit identifier to be used by the recipient. Where the information field is longer than 8 octets, the remaining octets are reserved.

5.3.2.5 Link type

Information element type hexadecimal 85 shall be used to specify the type of link. In a Link Accept the information field shall consist of four octets containing (big-endianly) a 32-bit record in the following form:

— 4 bits: protocol version: shall be coded with the value 1;

— 4 bits: link type: 1 = virtual link, 2 = physical link, other code points reserved;

— 22 bits: reserved: code as zero on transmission, ignore on reception;

— 1 bit: 1 if timing information is to be exchanged, 0 if not;

— 1 bit: 1 if FindRoute requests can be sent to the sender of the Link Request, 0 if not.

In other packet types it shall consist of one or more 4-octet records in the same format, in decreasing order of preference, showing all the link types the sender can support. When requesting a physical link, all supported link types (physical and virtual) should be shown, with physical link types listed first.

NOTE This allows a virtual link format to be used as a fall-back if the link partner does not support any of the offered physical link formats.

For each of the flags in the last two bits, if the bit is set in the Link Request it may be clear in the Link Accept, to show that the responder does not implement the facility.

If the penultimate bit is set for a physical link, the timing field shall be set as described in 8.1 in each frame; if not, it may be coded as all-ones. If the penultimate bit is set for a virtual link, both partners shall send link timing packets.

On a physical link or an internal virtual link, both bits should be set. On an external virtual link, they should be set to show what functions each link partner implements.

5.4 Link establishment procedure

5.4.1 General

Link establishment occurs in the following three stages:

a) physical layer communication established;

b) exchange of negotiation packets and/or exchange of identity etc information in signalling messages;

c) exchange of synchronisation information and amalgamation of synchronisation domains.

In stage (b), exchange of negotiation packets is not required if both sides default to sending FN frames, or one side defaults to sending FN frames and the other can detect that it does so.

On completion of stage (b), IT flows can be set up across the link. On completion of stage (c), AV flows can be set up across the link.

The negotiation procedure in stage (b) is outlined in 5.4.2 to 5.4.6 inclusive, and details, including the encapsulation of negotiation packets, are given in Annex A. Stage (c) is specified in Clause 7.

5.4.2 Transmission of request

Negotiation of the use of the FN frame format on a network interface shall begin with transmission of a Link Request packet requesting a physical link as the first preference.

When a request has been sent, the interface shall enter “requesting” state.

The Link Request message should be repeated if no reply is received. The number of repetitions and the interval between them are specified in Annex A.

If there is no reply after the specified number of repetitions, and the interface supports virtual links over the network to which the interface is connected, it may attempt to establish one or more virtual links as specified in Clause 6, otherwise it should enter the “passive” state.

5.4.3 Response to incoming Link Request

If there is no compatible format, a Link Reject packet shall be sent and "passive" state entered as specified in AES51.

NOTE Having established that the link partner is an FN network element but there is no format that both support, there is no point in attempting to set up a virtual link, assuming the Link Request packet included all supported link formats.

Otherwise the actual configuration shall be transmitted in a Link Accept packet as specified in AES51, but the new state shall be "accepting" rather than "active".

5.4.4 Response to incoming Link Reject

As specified in AES51, on receiving a Link Reject packet in any state the recipient shall enter the "passive" state.

5.4.5 Response to incoming Link Accept

The action for an incoming Link Accept packet shall be as specified in AES51 except that instead of entering "active" state the recipient shall switch to “transition” state.

In “transition” state it shall be configured to send FN frames, but transmission of the first complete frame might not have begun, so it cannot transmit any FN packets. After a delay long enough to ensure FN frames are being transmitted correctly, it shall switch to “await sync” state.

NOTE Implementers will usually find it convenient for outgoing frames on all interfaces to begin at the same time, so it can take up to one frame time before the first frame header is transmitted; an additional delay is then needed until the recipient's IT stream enters “between packets” state (see 5.2.3).

The link partner shall switch to “await sync” state either when it detects incoming FN frames or when it receives a signalling message; if the signalling message is a SyncInfo message with appropriate content, it shall switch directly to "aligning" state.

In "await sync" state it can connect IT flows but not AV flows.

After switching to the “await sync” state, each unit shall send a SyncInfo signalling request message (see 8.2); it shall transition to “aligning” state when appropriate, as specified in 7.6. In “aligning” state, the phase relationship between incoming frames on the link and outgoing frames shall be measured, and the transition to “active” state shall occur when the phase has been established.

AV flows can only be set up in “active” state.

5.4.6 Errors and unexpected packets

Packets received in the wrong state may be either ignored or treated as errors.

Persistent errors in FN frames should cause "reset" state to be entered, which may include ceasing to send FN frames.

