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Telecommunications and information exchange between systems — Future network architecture—

Part 1: Switching and routing

Télécommunications et échange d'informations entre systèmes — Architecture du réseau du futur —

Partie 1: Commutation et routage

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Contents

Page

Foreword ..... **iv**
Introduction ..... **v**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 Abbreviated terms **1**
5 Network elements and links **2**
5.1 Levels of service 2
5.2 Links 2
5.3 Topology 2
6 Service interfaces **2**
6.1 Service provided to the layers above 2
6.2 Service required from the layers below 3
7 Flows **3**
7.1 General 3
7.2 AV flows 3
7.3 Connection-oriented IT flows 3
7.4 Connectionless IT flows 3
8 IT services **4**
8.1 Packet format 4
8.2 QoS considerations 4
8.3 Carriage over other technologies 4
9 AV services **4**
9.1 Synchronisation domains 4
9.2 Packet format 5
9.3 QoS considerations 5
9.3.1 Flows within an island 5
9.3.2 AV flows not within an island 5
9.3.3 All AV flows 5
9.4 Slots and allocations 5
9.5 Virtual links 6
10 Signalling service **6**
Bibliography **7**

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 21558 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 the requirements 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.

This document specifies the FN architecture which is designed to meet the requirements identified in ISO/IEC TR 29181-3. Protocols to support this architecture are specified in ISO/IEC 21559-1.

FN is a packet network which, as well as carrying data between computers, also meets the rather different requirements of live digital audio and video, which form an increasing proportion of the traffic on today's networks.

Whereas in IP all addressing information needs to be present in the packet headers, in FN the information needed to route packets is carried separately from the packets themselves. This reduces the size of the encapsulation by an order of magnitude and simplifies the process of forwarding the packets in switches.

Most importantly, it allows different addressing mechanisms to be used without changing the packet format and supports mobility without needing artificial devices such as IP-in-IP tunnels.

FN offers two main services: an ultra-low-latency "AV" service tailored to the needs of constant-bit-rate traffic such as audio and video, and a best-effort "IT" service suitable for the kind of unpredictable demand for which IP was intended. The AV service can also be used for file transfer, where it eliminates the need for the kind of empirical throughput testing that is a feature of TCP.

Some details of the services (particularly the slot size for the AV service, which was originally envisaged as being much more flexible) are a result of experimentation with a prototype implementation.

Telecommunications and information exchange between systems — Future network architecture —

Part 1:
Switching and routing

1 Scope

This document specifies the switching and routing architecture of the Future Network (FN).

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 21559-1, *Telecommunications and information exchange between systems — Future network protocols and mechanisms — Part 1: Switching and routing*

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

3 Terms and definitions

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

AV AudioVisual

IT Information Technology

5 Network elements and links

5.1 Levels of service

Services offered by packet networks can be divided into three levels:

a) best-effort: latency is undefined; packets may be dropped if there is congestion.

b) asynchronous: latency is bounded; packets will not be dropped due to congestion.

c) synchronous: latency is well-defined; packets will not be dropped due to congestion.

Level b) requires resource reservation, which may be per class or per flow, and relies on sources not sending more data than is supported by the reservation.

Level c) requires network elements to be synchronised; each source is allocated specific timeslots in which to transmit.

5.2 Links

A link is a two-way data path between two network elements.

Links are classified as “physical” and “virtual”. Physical links are those that implement “tight synchronisation” as specified in Clause 9, using the protocols specified in ISO/IEC 21559-1, and can thus support a synchronous service. Virtual links are those that do not meet that requirement; they are typically implemented over non-FN packet technologies.

5.3 Topology

An FN “island” is a group of network elements connected to each other by physical links, or a single network element.

An FN “cloud” is a group of islands connected to each other by virtual links, or a single island.

An “external” network element is one which is not capable of supporting physical links.

An “internal” virtual link connects two islands. An “external” virtual link connects an external network element to an island.

6 Service interfaces

6.1 Service provided to the layers above

The service provided by FN switching and routing shall be delivery of packets.

Each packet shall consist of encapsulation and a payload, and shall be delivered to one or more destinations, defined by the flow of which it is a part.

The payload shall be an octet string which shall not be processed by intermediate network elements and shall be delivered verbatim except for the effect of transmission errors.

The encapsulation shall code information necessary for the forwarding of the packet, as specified in Clauses 8 and 9.

6.2 Service required from the layers below

The service required from the layers below shall be as follows.

In the case of a point-to-point physical link, the service shall be conveyance of a stream of data octets, along with formatting which allows the position of each octet in the stream to be identified.

NOTE One possible kind of formatting is the division of the octet string into frames; another is the periodic insertion of non-data symbols.

In the case of virtual links, the service is specified in ISO/IEC 21559-1.

7 Flows

7.1 General

Each packet shall be part of a "flow". The action to be taken when a packet arrives at a network element shall be defined by the flow to which it belongs.

Globally-significant identifiers for flows, and procedures for setting up flows, shall be as specified in IEC 62379-5-2.

NOTE Flow identifiers are used in signalling messages, but not in packets.

Three types of flow are supported by FN, as specified in the following subclauses.

7.2 AV flows

An AV flow shall carry AV packets (see Clause 9). It shall have a single source, and one or more destinations. Each packet transmitted by the source shall be delivered to all the destinations. There shall be no upper limit to the number of destinations that an AV flow can support.

NOTE 1 This is similar to the service provided by cross-point audio and video routers.

NOTE 2 Because there is only a single source, the sender of each packet arriving on an AV flow is well-defined.

7.3 Connection-oriented IT flows

A connection-oriented IT flow shall carry IT packets (see Clause 8). It shall have a single source and a single destination.

NOTE Because there is only a single source, the sender of each packet on a connection-oriented IT flow is well-defined.

Control plane procedures should support bi-directional flows that are implemented as two connection-oriented IT flows, one in each direction.

7.4 Connectionless IT flows

A connectionless IT flow shall carry IT packets (see Clause 8). It shall have one or more sources, and a single destination.

NOTE 1 Connectionless flows are intended for carrying packets from other network technologies such as IP. This document does not specify how the sender of each packet on a connectionless IT flow is identified.

NOTE 2 The form of connectionless service envisaged in ISO/IEC TR 29181-3, with "uplink" and "downlink" paths, is no longer thought to be useful.

8 IT services

8.1 Packet format

The encapsulation of an IT packet shall code the payload length and a label; the format shall depend on the formatting of the link across which the flow passes.

NOTE 1 The length can be coded explicitly, for instance as the number of octets, or implicitly by marking the end of the packet in some way, for instance by a non-data symbol.

The label shall identify the flow; this identification shall be local to each link over which the flow passes and shall be chosen by the receiving network element.

NOTE 2 A possible value to use for the label is the address of the flow's entry in the receiving network element's routing table.

NOTE 3 The label value, and possibly also the format of the encapsulation, is changed at each switch through which the packet passes.

The encapsulation should include appropriate error detection for the length and the label. The packet format should not include error detection for the payload.

Error detection for the application's data, if required, should be end-to-end and thus included in the payload. It may be part of encapsulation at the layer above.

8.2 QoS considerations

Packets on an IT flow experience a best-effort service.

Error detection in the encapsulation should be used to reduce the likelihood of packets being misrouted.

The probability of corruption of payloads should be low, and an estimate of it should be included in the signalling messages that set flows up. On links that use an unreliable physical medium, the data link layer shall include measures to ensure an acceptable level of service.

NOTE End-to-end detection of errors in payloads, and correction methods appropriate to the application, can be implemented in the transport layer.

8.3 Carriage over other technologies

IT flows may be tunnelled over non-FN technologies by encapsulating the IT packets according to the underlying technology. Encapsulation according to AES51 should be used.

9 AV services

9.1 Synchronisation domains

Two kinds of AV service are specified in this document: "tightly synchronised" and "loosely synchronised".

On a tightly-synchronised link, AV packets can be identified by their time of arrival or, equivalently, their position in an allocation period (see 9.4).

Each network element shall ensure that all the physical links to which it is connected are phase-aligned to within a specified tolerance, using the protocols specified in ISO/IEC 21559-1.

The tightly synchronised AV service, which provides the lowest possible latency, can only be used within an island.

The loosely synchronised AV service is used for flows which pass over virtual links. The latency is greater, and de-jitter buffers are required at the receiving end. Islands within a cloud shall be frequency-locked to a common reference, but do not need to be phase-aligned.

9.2 Packet format

The encapsulation of an AV packet shall code the payload length; the format should be as specified in ISO/IEC 21559-1.

9.3 QoS considerations

9.3.1 Flows within an island

Packets on an AV flow that is contained within an island experience a level c) service as specified in 5.1.

The transit time shall be reported in the signalling messages that set the flow up.

9.3.2 AV flows not within an island

Packets on an AV flow that passes over one or more virtual links experience the lowest of the service levels provided by those links.

Signalling messages that set up an AV flow shall report that a synchronous service is not provided, and should include an estimate of the maximum and minimum transit time and whether packets on virtual links are likely to be dropped.

9.3.3 All AV flows

The probability of corruption of packets should be low, and an estimate of it should be included in the signalling messages that set flows up. On links that use an unreliable physical medium, the data link layer shall include measures to ensure an acceptable level of service.

NOTE 1 The encapsulation is not used for routing, so corruption of the encapsulation cannot cause a packet to be misrouted, though it can cause data to be lost from the end of the packet or spurious data to be added.

NOTE 2 For many applications it is better to deliver a corrupted AV stream than to delete a whole packet for what may be a single bit error, or to incur the added latency required for error correction.

If a flow is re-routed around a failure, the revised transit time should be reported as soon as possible. If a change in the point of attachment of a mobile device changes the transit time, the new transit time should be reported before the change occurs.

Measures such as forward error correction or retransmission may be implemented in the higher layers, although they increase the transit time. The probability of corruption should be low enough that they are unnecessary for most applications.

9.4 Slots and allocations

Each physical link shall be formatted into “allocation periods” which recur at an interval which shall be (0,999 68 ± 0,000 1) ms or an integer multiple or submultiple thereof.

NOTE 1 The specified interval can be regarded as a nominal 1 ms with a tolerance of 100 ppm in the reference and a further margin to accommodate media streams whose reference clocks are up to 220 ppm faster than nominal.

Each allocation period shall contain a fixed sequence of “slots”, each able to carry one AV packet.

NOTE 2 ISO/IEC TR 29181-3:2013, 6.2.2.2 and 6.2.2.3 envisage the provision of a wide range of slot sizes and packet sizes; however, subsequent experimentation and prototyping has shown that a fixed slot size is preferable.