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Infrastructure of audiovisual services – Communication procedures

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Gateway control protocol: ITU-T H.248 Stream grouping and aggregation

Recommendation ITU-T H.248.96

ITU-T

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Recommendation ITU-T H.248.96

Gateway control protocol:
ITU-T H.248 Stream grouping and aggregation

Summary

Recommendation ITU-T H.248.96 discusses how ITU-T H.248 Streams may be grouped according to a particular semantic and how they are aggregated or deaggregated internally in the Context for the execution of ITU-T H.248 control actions. It defines an ITU-T H.248 package that allows an explicit grouping semantic to be assigned to a group of streams. It also introduces the concept and support for a new type of ITU-T H.248 Stream, the "aggregation stream", the "deaggregation stream" and the "component stream", to be used only in combination with stream grouping.

The ability to group streams and to provide an explicit semantic allows the media gateway controller (MGC) to control the processing of multiple streams. The concept of aggregation allows Signals, Events, Statistics and Topology to be applied to an aggregation stream with benefits including, for example: the ability to report cumulative Statistics rather than multiple individual Statistics or report a single Event rather multiple Events on the component streams. The concept of deaggregation allows a better handling of multiple streams that share the same transport, for example, with regard to the different time dynamics of the transport layer and the upper layer streams.

History

Edition	Recommendation	Approval	Study Group	Unique ID[*]
1.0	ITU-T H.248.96	2015-11-29	16	11.1002/1000/12638

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FOREWORD

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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

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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, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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1 Scope

As described by the ITU-T H.248 connection model (clause 6 of [ITU-T H.248.1]) a Termination sources and/or sinks one or more streams. In a multimedia conference, a Termination can be multimedia that sources or sinks multiple media streams. The ITU-T H.248 protocol uses the stream concept to model individual media flows. That is, typically, there is one media (and optional control flow) per ITU-T H.248 Stream. The characteristics of each stream are described through the use of the LocalControl, Local Descriptor (LD) and Remote Descriptors (RDs). Each Termination contains a group of streams. ITU-T H.248 makes no assumptions as to the relationship between the streams on a Termination other than indicating that streams exiting a Termination shall be synchronised with each other (clause 7.1.4 of [ITU-T H.248.1]).

Certain network technologies may require a media gateway (MG) to have knowledge of how two or more streams relate to each other beyond simply knowing that they shall be synchronised. Where there is a multiplicity of streams there may be a different relation among different sets of streams. For the purposes of this Recommendation, the relationship among streams is defined as the "grouping semantic". Depending on the grouping semantic the MG may be required to apply certain processing to the media related to the streams. For example: one semantic may indicate that the media is duplicated on separate streams, another semantic may indicate media is only sent on one of two streams at a time. Some grouping semantics require that media flows from multiple streams are aggregated into a single flow.

[ITU-T H.248.1] does not support a means to describe grouping semantics. This Recommendation defines the "media grouping package" that allows a media gateway controller (MGC) to group media from two or more ITU-T H.248 Streams according to a particular semantic and optionally to aggregate/deaggregate the media from the grouped streams according to the semantic.

The grouping framework in [IETF RFC 5888] can, in principle, be applied to any transport. It is the actual grouping stream semantics that imposes limitations, i.e., BUNDLE may only be applied to IP transports. As such, the "media grouping package" and the concept of an ITU-T H.248 aggregation stream can be, in principle, applied to any transport. The majority of defined stream semantics focus on IP-based transports. As such, this Recommendation describes the semantics with respect to IP. While some semantics may be used for any type of bearer technology the use of the semantics for these bearer technologies are not covered in this Recommendation.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T H.248.1] Recommendation ITU-T H.248.1 (2013), *Gateway control protocol: Version 3*.

[ITU-T H.248.7] Recommendation ITU-T H.248.7 (2004), *Gateway control protocol: Generic Announcement package*.

[ITU-T H.248.39]	Recommendation ITU-T H.248.39 (2014), *Gateway control protocol: ITU-T H.248 SDP parameter identification and wildcarding*.
[ITU-T H.248.47]	Recommendation ITU-T H.248.47 (2008), *Gateway control protocol: Statistic conditional reporting package*.
[ITU-T H.248.58]	Recommendation ITU-T H.248.58 (2008), *Gateway control protocol: Packages for application level H.248 statistics*.
[ITU-T H.248.61]	Recommendation ITU-T H.248.61 (2013), *Gateway control protocol: Packages for network level ITU-T H.248 statistics*.
[ITU-T H.248.65]	Recommendation ITU-T H.248.65 (2009), *Gateway control protocol: Support of the resource reservation protocol*.
[IETF RFC 3524]	IETF RFC 3524 (2003), *Mapping of Media Streams to Resource Reservation Flows*.
[IETF RFC 4566]	IETF RFC 4566 (2006), *SDP: Session Description Protocol*.
[IETF RFC 4588]	IETF RFC 4588 (2006), *RTP Retransmission Payload Format*.
[IETF RFC 5583]	IETF RFC 5583 (2009), *Signaling Media Decoding Dependency in the Session Description Protocol (SDP)*.
[IETF RFC 5888]	IETF RFC 5888 (2010), *The Session Description Protocol (SDP) Grouping Framework*.
[IETF RFC 5956]	IETF RFC 5956 (2010), *Forward Error Correction Grouping Semantics in the Session Description Protocol*.
[IETF RFC 7104]	IETF RFC 7104 (2014), *Duplication Grouping Semantics in the Session Description Protocol*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 media (section 2.1 of [b-IETF RFC 7656], [b-ITU-T H.248.95]): A sequence of *synthetic* or *physical Stimuli* (sound waves, photons, key-strokes), represented in digital form. *Synthesized media* is typically generated directly in the digital domain.

3.1.2 (ITU-T H.248 media) stream ([ITU-T H.248.1]): Bidirectional media or control flow received/sent by a media gateway as part of a call or conference.

3.1.3 RTP stream (clause 2.1.10 of [b-IETF RFC 7656], [b-ITU-T H.248.95]**)**: A *stream* of RTP packets containing *media data*, *source* or *redundant*. The *RTP stream* is identified by an SSRC belonging to a particular *RTP session*.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 aggregation: The MG internal process of combining two or more component streams on entering the ITU-T H.248 Context in the MG into one single stream, called the aggregation stream. The way the component streams are combined is dependent on the stream grouping semantics defined for the component streams. It may consist of selecting one of the component streams, applying a reparation procedure to one of the component streams based on the information from another component stream, etc. In the reverse direction it may consist on delivering media to only one of them at a time, providing a replica, generating repairing or redundancy information, etc.

3.2.2 aggregation stream: A stream that sources media to two or more component streams and/ or sinks media from two or more component streams which are related to each other with a certain stream grouping semantics. The aggregation stream exists only in the interior of the Context whereas the component streams represent external streams. Within one Context a stream may be defined as an aggregation stream in one Termination and as a normal stream in another Termination.

3.2.3 component stream: A stream that acts as a source or sink to an aggregation or deaggregation stream.

3.2.4 deaggregation: The MG internal process of splitting a stream (called the deaggregation stream) on entering the ITU-T H.248 Context in the MG into multiple component streams. The way component streams are generated from a deaggregation stream is dependent of the stream grouping semantics. It may consist of stripping off lower layer information, de-multiplexing upper layer media and distributing it to different streams. In the reverse direction it may consist of sending multiple component streams over the same deaggregation stream.

3.2.5 deaggregation stream: A stream acting as a media sink to two or more component streams and/ or acting as a media source to two or more component streams that are related to each other with a certain stream grouping semantics. The component streams exist on the interior of the Context whereas a deaggregation stream represents an external stream. Within one Context, a stream may be defined as a component stream in one Termination and as a normal stream in another Termination.

3.2.6 group (or stream group): Streams that share the same stream grouping semantic are part of the same group. A stream may be part of several groups. An aggregation stream always requires a stream group but a stream group may exist without an aggregation stream. Depending on the stream grouping semantic the use of aggregation may be advantageous or even necessary to model the connectivity and the stream handling in the Context. Primarily [IETF RFC 5888] is utilised to group the streams and to provide the semantics.

3.2.7 multiplexed stream: Multiple media streams are combined into a lower layer protocol.

3.2.8 (RFC 5888 media) stream: The traffic description given by a particular SDP media description, which is unambiguously identifiable within the overall SDP session description. The SDP *media stream identification* attribute ("`a=mid:`") provides a media stream identifier at the protocol level.

3.2.9 stream semantics: The purpose for which the media streams are grouped (definition adapted from [IETF RFC 5888]).

NOTE – The notion of media stream in the definition is RFC-context specific; see clause 3.2.8.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AMR	Adaptive Multi-Rate
ANAT	Alternative Network Address Types
B2BRE	Back-to-Back RTP End system
CLUE	Controlling multiple streams for telepresence
CS	Circuit-Switched (network)
DDP	Decoding Dependency
DTLS	Datagram Transport Layer Security
DUP	Duplication

FEC	Forward Error Correction
FEC-FR	Forward Error Correction Flow Repair
FID	Flow Identifier
GoS	Grade of Service
GTT	Global Text Telephony (3GPP)
ID	Identity
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
IWF	Interworking Function
LD	Local Descriptor
LS	Lip Synchronization
MG	Media Gateway
MGC	Media Gateway Controller
NAT	Network Address Translation
PCM	Pulse Code Modulation
PES	PSTN Emulation Subsystem
PSTN	Public Switched Telephony Network
PT	Payload Type
RD	Remote Descriptor
RSVP	Resource Reservation Protocol
RTCP	RTP Control Protocol
RTP	Real-time Transport Protocol
RTP/AVP	RTP Audio Video Profile
RTPMT	RTP Media Translator
RTT	Real Time Text
SCTP	Stream Control Transmission Protocol
SDP	Session Description Protocol
SEP	(ITU-T H.248) Stream Endpoint
SEPP	(ITU-T H.248) Stream Endpoint Pair
SG	Stream Group
SIP	Session Initiation Protocol
SRF	Single Reservation Flow
SRTP	Secure Real-time Transport Protocol
SSRC	Synchronization Source
TCP	Transmission Control Protocol

ToIP	Text over IP
UDP	User Datagram Protocol
UE	User Equipment
VBD	VoiceBand Data
VBDoIP	VoiceBand Data over IP
VoIP	Voice over IP
WB	Wide Band
WEBRTC	Real-Time Communication in WEB-browsers

5 Conventions

5.1 General

Elements of the ITU-T H.248 protocol model, e.g., Context, Termination, Stream, Event are represented using the first letter capitalized. Property, Event, Signal and Parameter identities are given in *italics*.

The suffix ".req" added to an ITU-T H.248 command name stands for a command request, while the suffix ".rep" stands for a command reply. For example, "Notify.req" represents a Notify request.

5.2 Terminology relationships related to grouping

This Recommendation uses the terms "grouping", "aggregation", "deaggregation" and "multiplexing". As per the following definitions:

– grouping describes the process using ITU-T H.248 to group streams together that share a common stream semantic;

– aggregation describes the process of using ITU-T H.248 to indicate that the media of several streams is aggregated in a single stream;

– deaggregation describes the process of using ITU-T H.248 to indicate that the media of a single stream is deaggregated in multiple streams;

– multiplexing is the process used to carry multiple streams over the same lower layer protocol (see also clause 3.1 of [b-ITU-T H.Sup.13]).

5.3 Terminology relationships related to the semantic of "stream"

The notions of "*media stream*" and "*stream*" are equivalent in the context of this Recommendation because the original and real-time transport protocol (RTP)-specific meaning of *media* (see clause 3.1.1) is used in the general sense (e.g., IP application data information).

There is usually a 1:1 mapping between

1) *RTP traffic: an RTP stream and an ITU-T H.248 Stream; and*

2) *general: an RFC 5888 stream and an ITU-T H.248 Stream*,

especially in the case of ITU-T H.248 stream grouping models that limit the scope of an *ITU-T H.248 Stream* to a single *RTP stream* or *RFC 5888 stream*.

However, the ITU-T H.248 protocol architectures also supports in principle N:1 mapping models for the above stream types.

6 ITU-T H.248.1 defined stream grouping, aggregation and multiplexing

This clause describes the existing [ITU-T H.248.1] mechanisms related to stream grouping, aggregation and multiplexing.

6.1 ReserveGroup attribute

Within a single stream, [ITU-T H.248.1] allows multiple sets of local and/or remote parameters to be specified. This is accomplished through the use of the ReserveGroup attribute (clause 7.1.7.1.2 of [ITU-T H.248.1]). This allows an MGC to request that an MG reserve resources for functions described in each group. Media packets may be sent or received according to any of the groups although only a single alternative may be active at any time. The ReserveGroup concept does not describe any grouping semantic other than an implicit semantic indicating that the different groups may only be sent one at a time. As such, the ReserveGroup concept does not lead to aggregated streams. The use of aggregation on streams related to each other by ReserveGroup is not possible unless they are also grouped with other grouping semantics. Clause 8.6.3 describes several grouping semantics where the ReserveGroup concept may be used.

6.2 Stream multiplexing using transport address information

Typically, a single media stream is assigned to a single ITU-T H.248 Stream endpoint by specifying a unique address/port combination in the Local Descriptor (LD) per ITU-T H.248 Stream on a Termination along with the associated media properties. In general, to indicate the use of a multiplexed media stream where multiple streams are sent using the same transport address, the MGC requests the same address/port in the LD for all ITU-T H.248 Streams that are to make up the multiplexed media stream.

As such when the same transport address/port is used for several streams there is an implicit grouping semantic which effectively multiplexes several streams over the same transport.

For text-based ITU-T H.248, session description protocol (SDP) is used for each LD. In order to request to the same address/port the following conditions must be must:

– the value of the "c=" line must be the same for each LD; and

– the value of "m=" line [IETF RFC 4566] <port> field is the same for each LD.

An MGC may fully specify the address/port information for multiple ITU-T H.248 Streams in a single Termination in an Add.req command. However, in many cases the MGC will wildcard "choose" this information, in order for the MG to provide the address/port. In the case where wildcarding is used the MGC can:

a) request the address/port information for one of the ITU-T H.248 Streams involved in the multiplex and then use the same address/port information in subsequent Modify.req(s) for additional ITU-T H.248 Streams; or

b) request address/port information for all the ITU-T H.248 Streams involved in the multiplex and then select the address/port from one of the ITU-T H.248 Streams and then send a subsequent Modify.req to modify the address/port information. This has the disadvantage over option a) that some resources may have been allocated to the previous address/port and these allocations would have to be changed.

The scope of the above multiplexing scheme affects the *local connection endpoint* (see clause 5.2 of [ITU-T H.248.1]) only (due to ITU-T H.248 Local Descriptor scope).

The use case of multiplexing multiple *RTP streams* on a single IP transport address is demonstrated using a dual-media call based on audio and video streams. There are two media type specific *RTP* *sources* (with separate synchronization source (SSRC) value assignments) at sender side.[1] The two *RTP sources* generate two *RTP streams* which share a single *(RTP) media transport*.[2]

Figure 1 shows example syntax for a Termination (T1) utilising the two RTP media transports and Termination (T2) utilising one RTP media transport for the two RTP streams and their two ITU-T H.248 Streams (due to the applied 1:1 mapping between RTP streams and ITU-T H.248 Streams here).

Two ITU-T H.248 Streams, two RTP streams, two IP transport connections	**Two ITU-T H.248 Streams, two RTP streams, one IP transport connections**

MEGACO/3 [123.123.123.4]:55555
Transaction = 10003 {
Context = 1 {
Add = T1 {
Media {
Stream = 1 {
Local {
v=0
c=IN IP4 124.124.124.222
m=audio 2222 RTP/AVP 4
}
}
Stream = 2 {
Local {
v=0
c=IN IP4 124.124.124.222
m=video 2223 RTP/AVP 34
}
}
}
}
}
}
	MEGACO/3 [123.123.123.4]:55555
	Transaction = 10004 {
	Context = 1 {
	Add = T2 {
	Media {
	Stream = 1 {
	Local {
	v=0
	c=IN IP4 124.124.124.222
	m=audio 2222 RTP/AVP 4
	}
	}
	Stream = 2 {
	Local {
	v=0
	c=IN IP4 124.124.124.222
	m=video 2222 RTP/AVP 34
	}
	}
	}
	}
	}
	}

Figure 1 – Example single and multiplexed RTP media transport

Note that the above example only illustrates *RTP media multiplexing* (see [b-IETF RTPMUX]) because there are no explicit syntactical elements indicated related to RTP control protocol (RTCP) port allocation. This leads to the assumption that additional *RTP transport multiplexing* is not used due to default behaviour according to [b-ITU-T H.248.57] and [b-ITU-T H.248.95].

On reception of an Add, Modify or Move request command with several Local Descriptors from the same Termination containing the same address/port information the MG shall treat the associated ITU-T H.248 Streams as a multiplexed media stream (in case of RTP based services). Multiplexing is applied according to the type or RTP profile of the stream. For example: in the case where the RTP profile *RTP/AVP* is given, RTP multiplexing is applied. Each media stream of the overall multiplexed RTP traffic is coded according to the information Local Descriptor/ITU-T H.248 Stream for that particular media.

[1] In more detail: the two *RTP sources* are physically assigned to the IP *local source* connection endpoint, but the multiplexing scheme affects essentially the IP *local destination* connection endpoint where the correspondent *RTP sinks* are located. However, an SSRC identifies only the RTP source side. So what's the actual multiplexing effect from the ITU-T H.248 MG perspective? Answer: the MG will receive two *RTP streams*, which share a single IP *local destination transport address*. The two *received RTP streams* are separated and assigned to its *RTP sink* functions based on individual SSRC values, which are used by the correspondent *remote RTP source* entities.

[2] Assumption of address symmetry between local source and local destination endpoint.

RTP multiplexing as such (with its three variants) is described by [b-IETF RTPMUX].

This multiplexed media stream may contain more than one media type.

Multiple multiplexed media streams are also possible on a Termination.

Individual components of the media multiplex can be modified by changing the Local and/or Remote Descriptors (RDs) of the related ITU-T H.248 Stream. If the address/port information of an ITU-T H.248 Stream is changed to be different from the other components of the multiplexed media stream then the media defined by the ITU-T H.248 Stream will no longer be part of the multiplex and it will be its own media stream.

Clause 8.6.3 describes several grouping semantics where the use of transport address for multiplexing may be used.

7 Further issues with existing ITU-T H.248 stream grouping mechanisms

This clause describes issues associated with the stream grouping described in clause 6.

7.1 Scope of Signals/Events and Statistics

Signals, Events and Statistics may be set at either a Termination or stream level. Generally when set at a Termination level the scope of these elements applies to all of the ITU-T H.248 Streams on the Termination. For example: the octets sent statistic would be the sum of octets sent by each ITU-T H.248 Stream and by corollary each media stream.

When these elements are set at a stream level the scope of the element is given by the StreamID. In the case of the octets sent statistic it would contain only the octets sent by the ITU-T H.248 Stream given by the StreamID.

When applying grouping to media streams the above behaviour should be considered. The grouped streams may constitute a sub-set of the total ITU-T H.248 Streams in a Termination. For example: StreamID(1) could be a single stream, StreamIDs(2, 3) could be grouped media streams. This leads to complications regarding the scope of how Signals, Events and Statistics are applied. For example: A Termination level octets sent Statistic would correctly give the number of octets sent by the Termination, however there is no way to request an octets sent Statistic related to the grouped media streams. The MGC would have to request a statistic for StreamID(2) and another statistic for StreamID(3) and add them together.

This issue is also applicable to Signals and Events. This is no way to indicate that a Signal or Event is only applicable to those grouped streams

The media grouping package defined in this Recommendation introduces an aggregation stream concept that allows Signals, Events and Statistics to be set against an aggregation stream. What effect these elements have is based on the semantics associated with the aggregation.

7.2 Scope of Topology

For some of the media grouping semantics an MG may be required to interconnect a group of media streams at one interface with a single stream or a group of a different number of streams at another interface. This type of connectivity cannot be described with the existing Topology Descriptor.

The media grouping package defined in this Recommendation introduces an aggregation stream concept. This allows an MGC to indicate a topology for the aggregation Stream.

8 Media Grouping package

Package name: Media Grouping

Package ID: *mgroup* (0x011f)

Description: This package provides a general way for the MGC to instruct the MG to group media streams defined in different Stream Descriptors within the same Media Descriptor. It also introduces the "aggregation" and "deaggregation" ITU-T H.248 Stream concept and provides properties to indicate these types of ITU-T H.248 Streams.

Version: 1

Extends: None

8.1 Properties

8.1.1 Group Semantics

Property name: Group Semantics

Property ID: *groupse* (0x0001)

Description: This property allows an MGC to indicate which media streams to group, and for which purpose they are grouped. This allows the MG to allocate resources accordingly. For example, providing a common address/port in response to a wildcarded request from the MGC in case multiplexing is supported.

In addition, the optional "Direction" element allows indicating whether the grouping is applicable in both directions or in one particular direction. When not included a default of "bothway" is assumed.

Several sets of grouped streams are allowed per Termination.

Type: Sub-list of string

Possible values: Each element of the sub-list follows the group-attribute syntax in [IETF RCF 5888], represented here using type "`Group`":

```
Group = Semantics 1*WSP StreamIDList[1*WSP Direction] ;
(NOTE 1)
WSP = SP/HTAB
StreamIDList = StreamID *(WSP StreamID)
StreamID   = UINT16
Semantics = token
token-char = %x21 / %x23-27 / %x2A-2B / %x2D-2E / %x30-
39/ %x41-5A / %x5E-7E
token = 1*(token-char)
Direction = Bothtoken / Sendtoken / Receivetoken
Bothtoken = "B"
Sendtoken = "S"
Receivetoken = "R"
(NOTE 2)
```

NOTE 1 – The syntax functionally duplicates the grouping attribute syntax from [IETF RFC 5888] with the optional addition of a direction parameter.

NOTE 2 – This syntax definition allows for a StreamID list containing one single value. This case is only allowed in a reply to an AuditCapabilities command, where the StreamID shall be set to 0.

Default: None

Defined in: TerminationState

Characteristics: Read/Write

8.1.2 Stream Aggregation

Property name:	Stream Aggregation
Property ID:	*stragg* (0x0002)
Description:	This property indicates that the stream that this property is set on is an aggregation of the component streams specified in the property. The component streams must be grouped according to the grouping semantics indicated by the *groupse* property.
Type:	Sub-list of integer
Possible values:	Each value in the list is a StreamID
Default:	None
Defined in:	LocalControl
Characteristics:	Read/Write

8.1.3 Stream deaggregation

Property name:	Stream deaggregation
Property ID:	*strdeagg* (0x0003)
Description:	This property indicates that the data from the stream that this property is set on is deaggregated to the component streams specified in the property. The component streams must be grouped according to the grouping semantics indicated by the *groupse* property.
Type:	Sub-list of integer
Possible values:	Each value in the list is a StreamID.
Default:	None
Defined in:	LocalControl
Characteristics:	Read/Write

8.2 Events

None.

8.3 Signals

None.

8.4 Statistics

None.

8.5 Error codes

8.5.1 Invalid aggregation and/or deaggregation

Error code #:	489
Name:	Invalid aggregation and/or deaggregation
Definition:	The media stream components received in the stream aggregation and/or stream deaggregation results in an invalid configuration on the Termination.

Error text in the Error descriptor: None

Comments: None

8.6 Procedures

8.6.1 Support of media grouping

Usage and support of media grouping may be pre-agreed in a profile specification or may be discovered via auditing.

An MGC may audit the Packages Descriptor to determine if an MG supports media grouping. If the response contains the "media grouping package" (*mgroup*) it can assume that the MG supports media grouping. The MGC may perform an ITU-T H.248 AuditCapability.req on the *groupse* property to determine which semantics are supported by the MG. In this case, the MG shall respond with the supported semantic tags and the StreamID set to 0.

An MGC controlling an MG that supports the media grouping package can instruct the MG to group two or more sent and/or received media streams. Each media stream (including the sent and received directions) is described in its own Stream Descriptor and all are included in the same Media Descriptor.

The MGC can indicate to the MG:

– which sent media streams to group;

– which received media streams to group;

– for which purpose the media streams are grouped.

The *mgroup* package defines three properties, which may be used in various combinations. Table 1 indicates valid combinations.

Table 1 – Profile guidelines: package property combinations

H.248 Context level:	H.248 **mgroup** package: single or tandem usage combinations of properties		
	A)	B)	C)
Termination:	**groupse**	**groupse**	**groupse**
Stream:		**stragg**	**strdeagg**
Primary use case:	self-contained usage of stream grouping	characteristic of aggregation	characteristic of deaggregation

NOTE – The notion of "self-contained" means that the ITU-T H.248 Media Descriptor contains only the *groupse* property, without property *stragg* or *strdeagg*.

The *groupse* property can be used in a self-contained manner, i.e., in a particular ITU-T H.248 Termination without the stream-level properties *stragg* or *strdeagg*. The stream-level properties *stragg* and *strdeagg* are always used in conjunction with the *groupse* property, i.e., there are (grouping semantic specific) tandems of {*groupse*|*stragg*} or {*groupse*|*strdeagg*} in the description of a particular ITU-T H.248 Termination.

In general the *mgroup* properties can be used together with the ITU-T H.248 ReservedGroup concept (see clause 7.1.7 of [ITU-T H.248.1] as the *ReserveGroup* property applies to alternatives related to a particular ITU-T H.248 Stream. The *mgroup* package relates multiple ITU-T H.248 Streams. If ReserveGroup is used with the *mgroup* package properties, the MGC should ensure that any semantic is applicable to each of reserved groups on the applicable stream.

8.6.2 Mapping of SDP from call control signalling to ITU-T H.248 Stream Descriptors

8.6.2.1 Mapping of SDP group attributes in ITU-T H.248

An MGC that sends or receives SDP media grouping related attributes in an SDP offer/answer dialogue should map those attributes as follows when sending the command to the MG:

– each m-block is mapped into one Stream Descriptor;

– the "a=mid" attribute of each m-block is not used in the Local/Remote Descriptor of the corresponding Stream Descriptor, instead the StreamID, is used for the index in the group;

– the "a=group" attribute is mapped to the *mgroup/groupse* property and included in the TerminationState Descriptor. The content of the property, a sub-list of string, should be follow a copy of the "a=group" attribute. The semantic is retained and the "a=mid' value is replaced with the corresponding StreamID.

Example:

An MGC sends an SDP offer with the following media description (see Table 2).

Table 2 – Example command encoding– (SIP) SDP offer

Session initiation protocol (SIP) SDP encoding	Comments

`v=0`
`o=Alice 289083124 2890844526 IN IP4 124.124.124.222`
`c=IN IP4 124.124.124.222`
`a=group:LS 1 2`
`m=audio 30002 RTP/AVP 97`
`a=mid 1`
`a=rtpmap:97 AMR/8000`
`a=fmtp:97 mode-set=0,2,5,7; mode-change-period=2; \`
`    mode-change-neighbor = 1; mode-change-`
`capability=2; max-red=0`
`m=video 52738 RTP/AVP 99`
`a=mid 2`
`b=TIAS:256000`
`b=AS:270`
`a=rtpmap:99 H264/90000`
`a=fmtp:99 profile-level-id=428014;`
`     a=sendrecv`
	It describes a session containing one video stream and one audio stream. They use the " lip synchronization (LS)" [IETF RFC 5888] grouping semantics to indicate that the playout of both media must be synchronized.

The MGC maps this description into the media description in Table 3.

Table 3 – Example command encoding – MGC request

ITU-T H.248 encoding (shortened command)	Comments

`Media {`
`  TerminationState { mgroup/groupse = ["LS 1 2"]},`
`  Stream = 1 {`
`     Remote {`
`c=IN IP4 124.124.124.222`
`m=audio 30002 RTP/AVP 97`
`a=rtpmap:97 AMR/8000`
`a=fmtp:97 mode-set=0,2,5,7; mode-change-period=2; \`
`mode-change-neighbor = 1; mode-change-capability=2;`
`max-red=0`
`     }`
`  },`
`  Stream = 2 {`
`     Remote {`
`c=IN IP4 124.124.124.222`
`m=video 52738 RTP/AVP 99`
`b=TIAS:256000`
`b=AS:270`
`a=rtpmap:99 H264/90000`
`a=fmtp:99 profile-level-id=428014;`
`a=sendrecv`
`     }`
`  }`
`}`
	NOTE - A similar mapping would apply to the Local Descriptor. The Local Descriptor is not shown but it is also part of the Media Descriptor and will be sent to the MG.

8.6.2.2 General mapping of SDP to ITU-T H.248 aggregation/deaggregation streams

The call-level (SIP) SDP media description block covers a protocol stack segment (i.e., multiple protocol layers) in the IP user plane. Depending on the stack, the use of a deaggregation stream may be needed. In such a case the stack segments may be partitioned and mapped on ITU-T H.248 component stream(s) resulting in multiple ITU-T H.248 Streams (deaggregation and component) for on SDP media description block. The deaggregation stream may contain:

a) a complete "media description" in which case it may be unnecessary to provide further media description in the component streams;

b) a partial (or empty) media description in which case the component streams should be provided with sufficient information to complete the media description.

The media description split should normally reflect the protocol stack segment partition.

The call-level (SIP) SDP may contain multiple media description blocks that require multiple media streams be aggregated into a single stream. In this case the SDP media description blocks would be mapped to ITU-T H.248 component stream. The component streams would in general contain a complete "media description".

Any mapping of SDP media descriptions from SIP to ITU-T H.248 Streams needs to be unambiguous and any redundancy should be avoided.

8.6.3 MG behaviour

The behaviour of the MG with respect to the grouping is largely dependent on the semantic associated with the grouping, e.g., the value of semantic in the *mgroup/groupse* properties.

The SDP parameter IANA registry (http://www.iana.org/assignments/sdp-parameters/) contains a list of defined SDP group semantics. In general the MG should adopt the behaviour defined by the RFC (or other standard) that defines the semantic taking into consideration ITU-T H.248 protocol behaviour. The following sub-clauses discuss several semantics.

8.6.3.1 Lip synchronization

The "lip synchronization" semantic is defined in [IETF RFC 5888]. As per section 7 of [IETF RFC 5888], the MG must synchronise the playout of ITU-T H.248 Streams listed together in the same "LS" marked group.

8.6.3.1.1 Directionality

In most scenarios where LS is used both the video and audio would be bi-directional. However, there are some scenarios such as synchronization of source audio and simultaneous translation, where lip sync may only be applied in one direction. [IETF RFC 5888] does not define an SDP mechanism to negotiate a unidirectional use of the LS semantics between peers other than the one implicitly given by defining one of the streams as unidirectional. The *mgroup/groupse* property allows for defining a unidirectional use of the LS semantics also if the grouped streams are all bi-directional. However, as this use does not have an SDP counterpart between SDP peers, it is discouraged.

8.6.3.2 Flow identifier

The "flow identifier (FID)" semantic is defined in [IETF RFC 5888]. The use of the flow identifier with ITU-T H.248 is in some cases redundant due to the ITU-T H.248 connection model and ITU-T H.248 usage of SDP. ITU-T H.248 has the StreamID identifier which uniquely identifies media flows. Each ITU-T H.248 Stream may utilise the ReserveGroup/ReserveValue (see clause 7.1.8.2.3 of [ITU-T H.248.1]) construct which enables multiple configurations to be set for an ITU-T H.248 Stream. This allows a single ITU-T H.248 Stream to have multiple sets of characteristics of which one set is active at a particular point in time.

The following example described in section 8.4.1 of [IETF RFC 5888] can be emulated with the use of the ReserveGroup mechanism:

Example 1

Two audio streams are negotiated between two peers with different audio codecs. Only one is active at a time while the other one is muted. The peers indicate the same IP address for receiving both streams but different ports.

The following example also described in section 8.4.1 of [IETF RFC 5888] cannot be emulated with the use of the ReserveGroup/ReserveValue constructs and therefore requires the use of the ITU-T H.248 *mgroup/groupse* property:

Example 2

Three audio streams are negotiated between two peers. The first two are bi-directional and use different audio codecs. Only one of these is active at a time while the other one is muted. The third is unidirectional and has two payload types (PTs), one corresponding to each of the codecs used by the other two streams. This third stream always carries a copy of the active stream, either of the first or the second stream. Both active streams are received at the same IP address at different ports. The third stream is received at a different IP address.

NOTE – ReserveGroup/ReserveValue can apply to alternatives using the same or different IP addresses or ports.

Another example use of the FID semantics that cannot be emulated with the ReserveGroup/Reserve Value constructs is the one described in section 8.7 of [IETF RFC 4588]:

Example 3

Two SDP peers negotiate one audio and one video stream. In addition, they negotiate another audio and another video stream used for retransmission. The audio source and retransmission streams are grouped with the FID semantics and the video source and retransmission streams are grouped with the FID semantics.

8.6.3.2.1 Directionality

[IETF RFC 5888] does not define a mechanism to negotiate a unidirectional use of the FID semantics between peers other than the one implicitly given by defining one of the streams as unidirectional. The *mgroup/groupse* property allows for defining a unidirectional use of the FID semantics also if all the grouped streams are bi-directional. However, as this use does not have an SDP counterpart between SDP peers, it is discouraged.

8.6.3.3 Single reservation flow

The "single reservation flow (SRF)" semantic is defined in [IETF RFC 3524]. It indicates that media (described by m=lines) should be mapped to the same resource reservation flow. [ITU-T H.248.65] defines a package for the support of resource reservation protocol (RSVP). The initiation of a resource reservation request is typically explicitly requested through the use of an ITU-T H.248 Signal. Any identification of flow is part of the parameters to the Signal.

If the wanted behaviour is the allocation and subsequent policy enforcement of a predefined total bandwidth for a number of combined streams, the use of the SRF semantics is required as opposed to allocating individual bandwidths for each stream. The use of [ITU-T H.248.65] may also be applicable in combination with the *mgroup* package. In that case, sent or received RSVP messages will refer to all grouped media combined. For that reason, Signals and Events of the *rsvp* package should be sent or activated in the aggregation stream when they are conveying RSVP messages related to a grouped media streams (see clauses 8.6.5.1 and 8.6.5.2).

8.6.3.3.1 Directionality

[IETF RFC 3524] does not define a mechanism to negotiate a unidirectional use of the SRF semantics between peers other than the one implicitly given by defining one of the streams as unidirectional. Thus, it must be assumed that the negotiation of multiple streams grouped with the SRF semantics between peers is bi-directional if the grouped streams are also bidirectional.

However, this semantic is commonly associated with RSVP to reserve the required bandwidth. RSVP is unidirectional in nature. Thus, the SRF semantics may require two RSVP sessions. The use of RSVP in an MG requires [ITU-T H.248.65], which has the inherent mechanisms to determine the applicable direction, e.g., sending of an RSVP Path message with the ITU-T H.248 *rsvp/path* Signal is related to the outgoing stream while sending an RSVP Resv message with the ITU-T H.248 *rsvp/resv* Signal is related to the incoming stream.

If the *mgroup/groupse* property is used with the direction parameter together with the SRF semantics, the sent or received RSVP messages should apply or not to all grouped streams depending on the direction. For example, if the MGC sends *mgroup/groupse* = "SRF 1 2 R" to the MG, an RSVP Resv message sent by that Termination will refer to both Streams 1 and 2 combined, and the MGC should set the *rsvp/resv* Signal in the aggregation stream; however, an RSVP Path message will refer only to the individual stream where the Signal *rsvp/path* is set.

8.6.3.4 Alternative Network Address Types

The "Alternative Network Address Types (ANAT)" semantic is defined in [b-IETF RFC 4091]. The ANAT semantic allows an SDP offer to indicate that multiple network address types may be used for a single logical media stream. This semantic is redundant in ITU-T H.248 as it offers multiple methods for indicating or requesting address types. An MGC may use "over specification" (see clause 7.1.8.2.2 of [ITU-T H.248.1) to provide a list of network address types for a particular ITU-T H.248 Stream. An MG will then choose an appropriate network address type.

An MGC that wants to initiate at call control level an SDP offer with the ANAT semantics can reserve resources for both transport types using two ITU-T H.248 media groups (called "property groups" in ASN.1), using the LocalControl property "ReserveGroup" (see clause 7.1.7.1.2 of [ITU-T H.248.1]). Both property groups will contain the same information except for the IP address information (e.g., the SDP connection attribute) which will be partially wildcarded, and will request an Internet protocol version 4 (IPv4) address in one of the groups and an Internet protocol version 6 (IPv6) address in the other group. The MGC will set ReserveGroup to true. Thereafter it will send the SDP offer.

The MGC that receives the SDP offer with the ANAT semantics may be able to determine by itself which of the transport types to use, e.g., by certain call or traffic distribution criteria. In which case it will only indicate one address type when adding the Termination in the MG. The MGC may also delegate that decision to the MG. In which case it will send two property groups, like the initiating MGC, but in this case, it will set ReserveGroup to false. The MG will only allocate resources for one of the transport types and indicate the chosen one to the MGC in the ADD reply.

The initiating MGC, when receiving the SDP answer which contains the chosen transport type, may send an ITU-T H.248 Modify command to the MG, this time excluding the property group with the transport type that was not chosen.

8.6.3.5 Forward crror correction

The "forward error correction (FEC)" semantic is defined in [IETF RFC 5956]. The use of "FEC" has been deprecated and should not be used with ITU-T H.248.

8.6.3.6 Forward error correction flow repair

The "forward error correction flow repair (FEC-FR)" semantic is defined in [IETF RFC 5956]. This is used to associate source and repair flows for the purposes of FEC. If this semantic is received the MG should utilize the source and repairs ITU-T H.248 Streams listed together in the same "FEC-FR" marked group for the purposes of FEC.

The MGC should indicate whether a flow is a source or repair flow through the use of coding related parameters (i.e., "a=rtpmap:111 1d-interleaved-parityfec/90000" and "a=fmtp:111 L=10; D=10; repair-window=400000").

If the session consists of only one source stream and one repair stream, the MG can unambiguously identify, by means of the above attribute, which is the source and which is the corresponding repair stream. The *mgroup/groupse* property may be omitted in this case. However, if there are multiple source streams and/or multiple repair streams, it may not be possible to unambiguously identify to which source each repair stream corresponds. Furthermore, the FEC mechanism allows for different types of correction schemes: n repair streams may be related to m source streams. In all these cases the SRF semantics is required to indicate the association between repair and source streams.

8.6.3.6.1 Directionality

[IETF RFC 5956] does not define a mechanism to negotiate a unidirectional use of the FEC-FR semantics between peers other than the one implicitly given by defining one of the streams as unidirectional. The *mgroup/groupse* property allows for defining a unidirectional use of the FEC-FR semantics also if all the grouped streams are bi-directional. However, as this use does not have an SDP counterpart between SDP peers, it is discouraged.

Thus, the preferred method to specify the use of FEC only in one direction is with the use of StreamMode (SendOnly or RecvOnly) or the SDP direction attribute (a=sendonly or a=recvonly) in the repair stream(s).

8.6.3.7 Decoding dependency

The "decoding dependency (DDP)" semantic is defined in [IETF RFC 5583]. This semantic may be used with ITU-T H.248 as well as other SDP attributes (e.g., a=depend) to describe decoding dependencies for layered codings.

[IETF RFC 5583] does not define a mechanism to negotiate a unidirectional use of the DDP semantics between peers other than the one implicitly given by defining one of the streams as unidirectional. The *mgroup/groupse* property allows for defining a unidirectional use of the DDP semantics also if all the grouped streams are bi-directional. However, as this use does not have an SDP counterpart between SDP peers, it is discouraged.

8.6.3.8 Multiplexing negotiation using session description protocol (BUNDLE)

The "BUNDLE" semantic is defined in [b-IETF BUNDLE]. It is used to describe how two or more RTP streams use a single 5-tuple (i.e., multiplex multiple RTP streams onto a single 5-tuple). Because [b-IETF BUNDLE] only describes the use of BUNDLE for IP transports, it shall not be used with streams using non-IP transports.

As described in clause 7, it is possible to request that an MG use a multiplexed RTP stream, however there are a number of deficiencies.

Firstly, the MGC is unaware if the MG supports RTP multiplexing. In order to determine if the MG supports RTP multiplexing the MGC may audit the media grouping package to determine if the "BUNDLE" semantic is supported (see clause 8.6.1).

Secondly, there is no way to wildcard “choose” the address/port information from several ITU-T H.248 Streams and request that a single transport connection (i.e., multiplexed RTP stream) be used. The media grouping package contains the "group semantics" property that, when including the BUNDLE semantic allows the MGC to indicate that two or more ITU-T H.248 Streams are multiplexed together. MGs that support the media grouping package should check the "group semantics" property when processing wildcarding requests for multiple ITU-T H.248 Streams. If the ITU-T H.248 Streams match the association given by this property then the same value should be returned for those ITU-T H.248 Streams.

8.6.3.8.1 Directionality

BUNDLE is symmetric in nature. If it is used, it applies to source and destination.

In practice, however, the required behaviour from the MG specific to this semantic is related to the Local Descriptor, i.e., to the received media. The use of the same address and port for multiple streams in the Remote Descriptor is usually not problematic in the MG, or when BUNDLE is not used.

Therefore, the use of the direction parameter in the *mgroup/groupse* property is superfluous in case of the BUNDLE semantics.

8.6.3.8.2 Handling of the "bundle-only" SDP attribute

Section 6 of [b-IETF BUNDLE], defines the SDP attribute "a=bundle-only". The SDP element is only used in SIP-level SDP offer/answer negotiations, but not required for [ITU-T H.248.96]-based stream grouping control in context of BUNDLE. An MG not supporting bundling will reject an ITU-T H.248 command including the "BUNDLE" grouping semantics, due to the inherent master-slave nature of ITU-T H.248. Thus "bundle-only" is superfluous in ITU-T H.248 and the MGC shall consequently not insert this SDP attribute in ITU-T H.248 signalling, with or without ITU-T H.248 Stream grouping.

8.6.3.9 Duplication

The " duplication (DUP)" semantic is defined in [IETF RFC 7104]. It indicates that the MG should duplicate packets and send them in separate redundant streams. The RFC allows the "DUP" semantic to be used within a single m-line where multiple redundant streams use the same IP destination address. For an example see section 4.1 of [IETF RFC 7104]). For this usage an MGC can use the SDP to indicating the grouping rather than using the *mgroup* package.

The RFC also allows the "DUP" semantic to be used across m-lines where the redundant streams have different destination addresses. For an example, see section 4.2 of [IETF RFC 7104]. For this usage, the MGC shall use the *mgroup/groupse* to assign the DUP semantic to the relevant streams. Where a gateway is required to interwork between a redundant and non-redundant media stream the MGC shall use an aggregation stream to aggregate/deaggregate the main and redundant streams.

8.6.3.9.1 Directionality

The "DUP" semantic implicitly describes sending behaviour. Thus, the DUP semantic is associated with the sending direction. It is possible that while a Termination sends redundant media streams it receives a single stream in return. It is likely that these redundant streams would have a stream mode of send only, so setting the DUP semantic with "both" direction would have no effect given the overriding stream mode. Even if the main stream was set with the DUP semantic with a "both" direction and the stream mode was send/receive there would be no effect on the incoming stream, due to the DUP semantics.

8.6.4 Error handling

In the following error cases, the MG should return an error code 473 "conflicting property values":

– if any of the stream identities included in the *groupse* property do not exist in the Termination;

– if the *stragg* property is set without a value in the *groupse* property indicating the semantic associated with the aggregation stream, i.e., a value in the *groupse* property with the same StreamID list as in the aggregation;

– *If the strdeagg* property is set without a value in the *groupse* property indicating the semantic associated with the aggregation stream, i.e., a value in the *groupse* property with the same StreamID list as in the aggregation;

– depending on the grouping semantics if there is a mismatch between the *mgroup/groupse* property and the Local or Remote Descriptor.

For example: An error may be generated if the MGC uses the BUNDLE media grouping and specifies a StreamID of an ITU-T H.248 Stream whose Local Descriptor does not have the same address/port as the other ITU-T H.248 Streams in the group (and is not updated in the current command). Another example is if an error may be generated if MGC uses the "LS" semantic and specifies the StreamIDs of ITU-T H.248 Streams where the MG cannot maintain lip sync. A more specific error code may be returned if available. The underlying reasons for generating an error may depend on the semantic associated with the group.

8.6.5 Usage of stream aggregation

In some grouping scenarios, multiple media streams may be aggregated when they enter the Context into one media stream and, in the other direction, may result from the reverse operation of splitting one media stream into several media streams. Clause 6.2 of [ITU-T H.248.1] describes the multiplexing of Terminations through the use of a multiplex Termination. However, it does not support multiplexing of streams within a Termination.

The *mgroup* package defines the concept of an Aggregation Stream. By setting the *stragg* property on an aggregation stream indicating the component streams it allows stream aggregation to be modelled internally in the MG. Media is then aggregated to/from the component streams to the aggregation stream according to the applicable grouping semantics.

Figure 2 illustrates this concept.

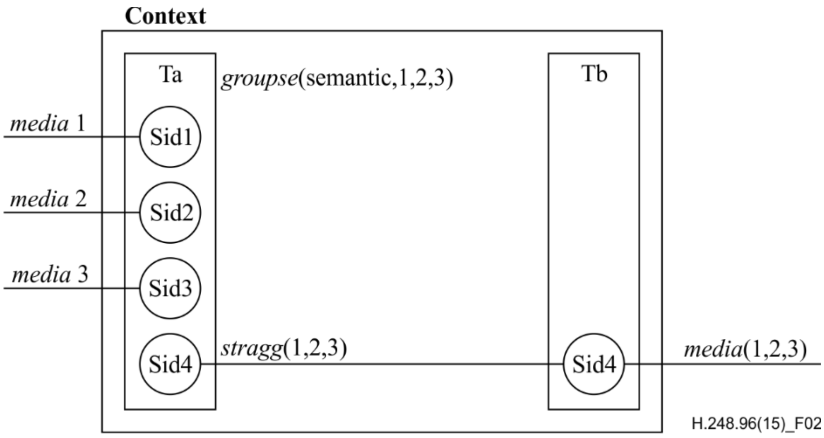


Figure 2 – Aggregation Stream

In Figure 2 media streams labelled *media* 1, 2, and 3 received as described by the Stream Descriptors Sid1, Sid2, Sid3 will be aggregated according to the *groupse* semantic for those streams. This aggregation will be sent via stream Sid4 to Termination Tb. It is then sent externally from the media gateway (MG) as described by the Stream Descriptor for stream Sid4 on Termination Tb. The MG may apply any interworking/adaptation etc., functions that would normally apply when the same media stream is set on two Terminations. The aggregation stream may also remain isolated to one Termination in a Context.

The component streams are external streams and their sending and receiving behaviour is characterized by the LocalControl, Local and Remote Descriptor, as per a normal stream.

The media flow between the component streams and the aggregation stream is further regulated by the grouping semantics, which may, for example, indicate that the aggregation stream sources media to only one of the component streams at a certain time (FID semantics).

Thus, the behaviour of the aggregation stream is well determined by the grouping semantics and the Media Descriptors of the corresponding component streams minimising the need to set properties in the LocalControl, Local and Remote Descriptors. If set the values of the properties should be compatible with those defined in the component streams and should not override any value set in those streams. Clause 8.6.8 provides further details on stream level interactions.

An MGC may apply Signals, Events, Statistics and Topology to the aggregation stream as per normal streams. The behaviour is discussed in more detail in the clauses below.

8.6.5.1 Signals and aggregation streams

A Signal applied to the aggregation stream will have the effect of being played out on one or more component streams. Which component streams the Signal is played out over depends on the grouping semantic associated with the aggregation. Signals may still be specified to be played on the individual component streams. In this case, the playout is isolated to that particular component stream.

Figure 3 illustrates an example scenario using the flow identification semantic.

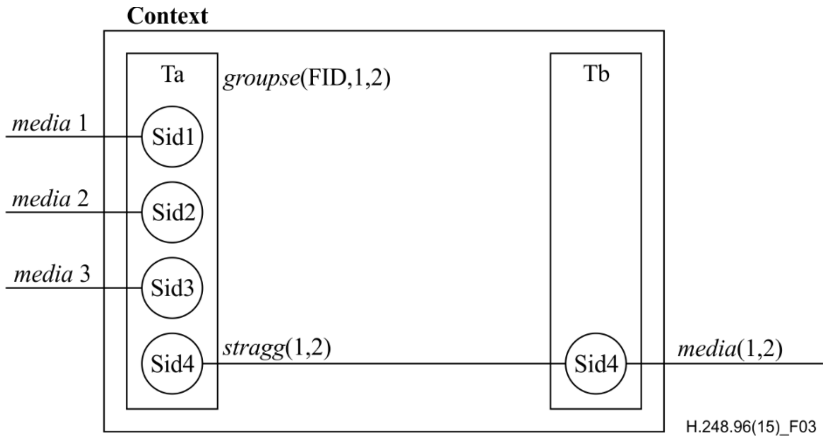


Figure 3 – Signals on an aggregation stream with FID semantic

Example 1

Termination Ta has four streams, including an aggregation stream. It has two audio streams with identities 1 and 2 that use the same codec. They are grouped with the FID semantics [IETF RFC 5888]. Thus, they carry identical content. One is a replica of the other, usually sent to a different destination address. The Termination has, in addition, another media stream with identity 3, which is not part of the media group. Termination Ta has an aggregation stream with streams 1 and 2 as the components. Requesting an *an/apv* [ITU-T H.248.7] Signal on stream 4 to play an audio announcement should result in the announcement being sent synchronously to streams 1 and 2.

Example 2

Termination Ta has four streams, including an aggregation stream. It has two audio streams with identities 1 and 2 that use different codecs. They are grouped with the FID semantics [IETF RFC 5888]. At a time, only one of the streams carries data in each direction while the other one is muted in that direction. This is dependent on the codec which is chosen dynamically by the end-user equipment. Termination Ta has an aggregation stream 4 with streams 1 and 2 as the components. Requesting an *an/apv* [ITU-T H.248.7] Signal on stream 4 to play an audio announcement should result in the announcement being sent in the stream (1 or 2) which carries media at that moment.

Example 3

A Termination Ta has one video stream and two audio streams with identities 1, 2 and 3 grouped with the SRF semantics [IETF RFC 3524]. Thus, resource reservation using RSVP and policy enforcement is applied to the complete group. The MGC defines an aggregation stream 4. In order to send RSVP messages related to all grouped streams, the MGC should set the Signals of the *rsvp* package [ITU-T H.248.65], e.g., *rsvp/path* on the aggregation stream 4.

NOTE – RSVP sessions are normally defined by the triplet destination address, protocol ID, destination port. For the identification of the session related to grouped media, see [IETF RFC 3524].

8.6.5.2 Events and aggregation streams

An Event applied to the aggregation stream will have the effect of detecting Events on the component streams as a result of stimulus usually from outside the Context. How the Event is reported is based on the grouping semantic associated with the aggregation stream. Events may still be specified on the component streams. In this case, detection is isolated to that particular component stream.

Where an Event is set at the Termination level on a Termination that has an aggregation stream the effect will be that it is only set against the aggregation streams and streams not involved in an aggregation.

Example 1

Figure 4 shows an example where a Context has a Termination Ta with one video stream and two audio streams with identities 1, 2 and 3 grouped with the SRF semantics [IETF RFC 3524]. Thus, resource reservation using RSVP and policy enforcement is applied to the complete group. The MGC has defined an aggregation stream with stream identity 4 (Sid4). In order to receive RSVP messages related to all grouped streams, the MGC should request the Events of the *rsvp* package [ITU-T H.248.65], e.g., *rsvp/pathr* Event on stream 4. The detection of a RSVP path message related to stream 1, 2 and 3 results in the notification of a single ObservedEvent from the aggregation stream.

NOTE – RSVP sessions are normally defined by the triplet destination address, protocol ID, destination port. For the identification of the session related to grouped media, see [IETF RFC 3524].

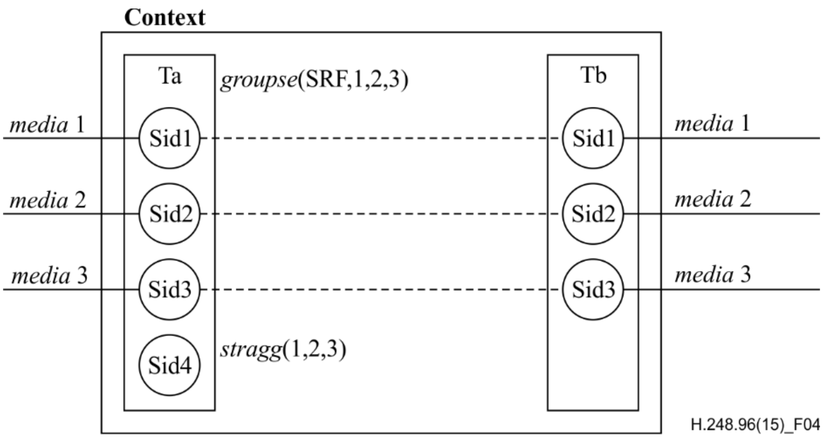


Figure 4 – Events on an aggregation stream with SRF semantic

Example 2

Figure 5 shows an example where a Context has a Termination Ta. It has two audio streams which use different codecs (media streams 1 and 2). They are grouped with the FID semantics [IETF RFC 5888]. Thus, at any time, only one of them carries data while the other one is muted. The Termination has in addition another media stream with identity 3, not part of the stream group at Ta. The MGC has defined an aggregation stream 4. The MGC requests the MG to collect data volume related statistics on the aggregation stream. The MGC uses also the conditional reporting functionality [ITU-T H.248.47] and therefore activates the *scr/cr* Event on the aggregation stream and refers to the relevant Statistics in the *si* parameter.

Termination Tb contains two stream endpoints: Sid3 for video traffic (= H.248 media stream 3) and Sid4 for the aggregated audio streams.

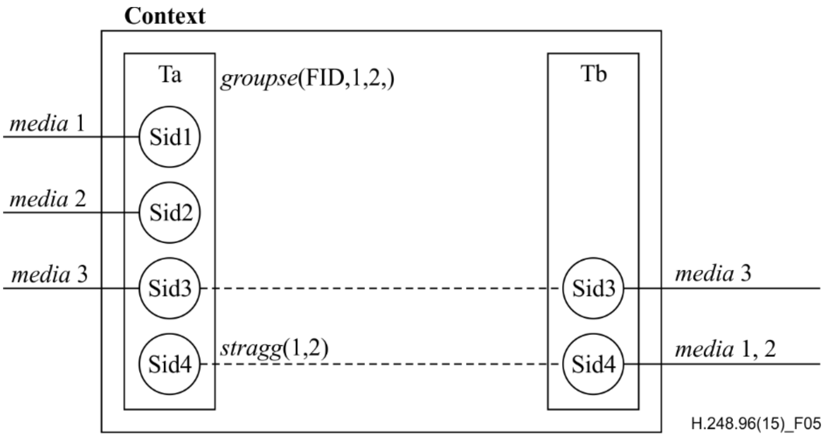


Figure 5 – Events on an aggregation stream with FID semantic

8.6.5.3 Statistics and aggregation streams

When Statistics are set against an aggregation stream, the Statistics are collected as if they had been set against all the component streams. For example, if the *rtp/pr* "RTP packets received" Statistic is set on an aggregation stream it will count the sum of RTP packets received from all the component streams.

When Statistics are set at the Termination level on a Termination that has an aggregation stream the effect will be that it is only set against the aggregation stream and streams not involved in an aggregation.

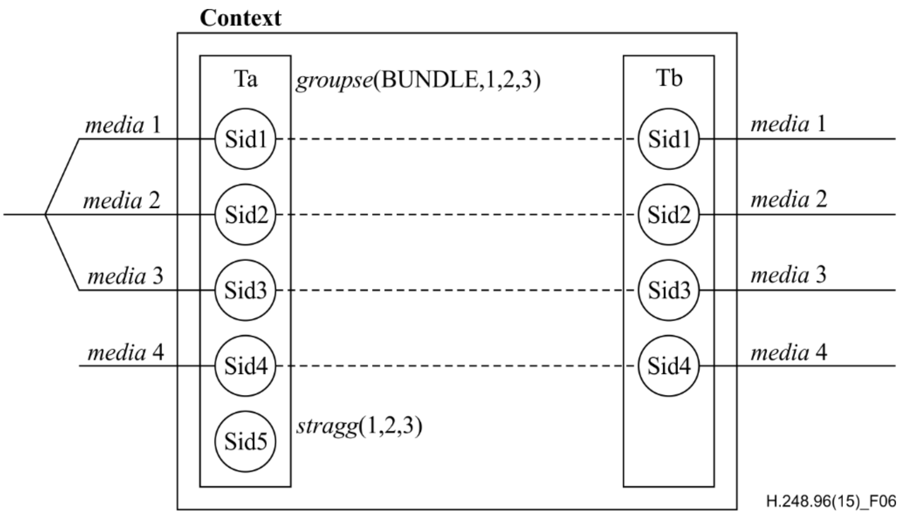


Figure 6 – Statistics on an aggregation stream with BUNDLE semantic

Example

Figure 6 shows an example where a Context has a Termination Ta that handles three audio streams with identities 1, 2 and 3 grouped with the BUNDLE semantic. The Termination has in addition another media stream with identity 4, not part of the media group. The MGC has defined an aggregation stream with identity 5. The MGC wishes to collect statistics on the data volumes sent and received in the bundled group at different levels (network, transport, application). It uses the Network Package *os* and *or* [ITU-T H.248.1], the IP Layer Octets Counts Statistics Package *ipos, ipor, ipps* and *ippr* [ITU-T H.248.61] and the RTP Application Data Package *payloados* and *payloador* [ITU-T H.248.58] statistics. It requests these statistics by including them in the Statistics Descriptor of the Stream Descriptor of stream 5. The MG should collect statistics in each of the three component streams and sum up the values.

8.6.5.4 Topology and aggregation streams

An aggregation stream allows the MG to transfer the media from/to several component media streams into/from one single stream or a different set of component media streams.

The requested behaviour from the MG depends on the grouping semantics, but it will usually involve some dynamic switching of the connectivity between the Terminations included in the Topology command based on external conditions. This dynamic switching will not be controlled by the MGC.

Example 1

Figure 7 illustrates a scenario where a Context connects two Terminations. One of them has three audio streams: stream with identity 1 (sendrecv) uses pulse code modulation (PCM) A-law, stream with identity 2 (sendrecv) uses adaptive multi rate (AMR) and stream with identity 3 (sendonly) uses PCM A-law. The three streams are grouped with the FID [IETF RFC 5888] semantics. The other Termination has one single stream with two payload types, PCM A-law and AMR.

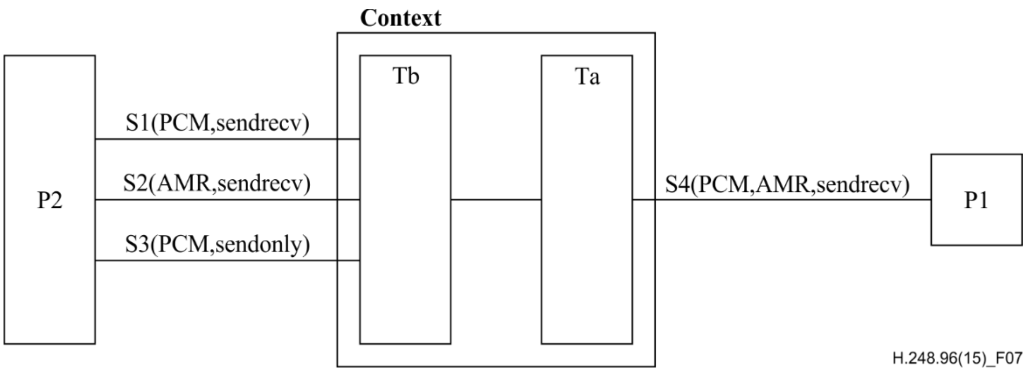
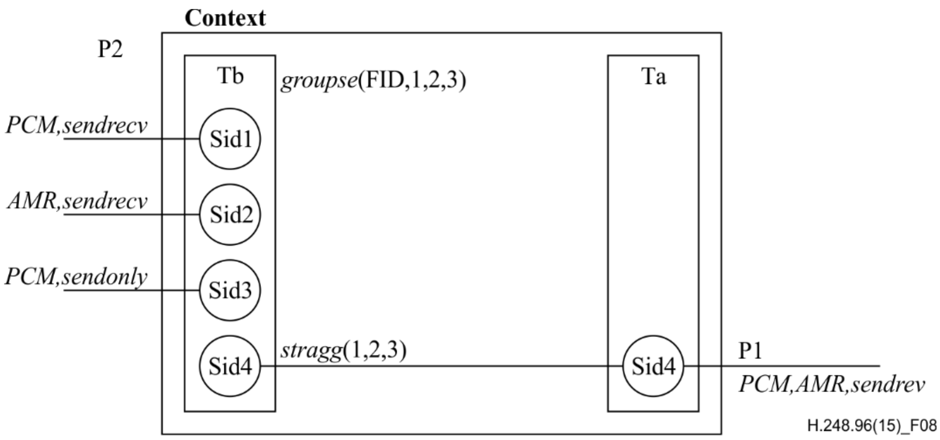


Figure 7 – Interworking between grouped streams and single stream

In order to connect the set of streams at Ta with the single stream at Tb, the MGC defines stream identity 4 as an aggregation stream on Termination Ta. It then sets stream identity 4 on Termination Tb. Terminations Ta and Tb are then by default bothway connected through stream 4 (Figure 8).



NOTE – The direction attributes shown correspond to the MG Terminations' views.

Figure 8 – Example of a multiple stream aggregation into a single stream

P1 (Figure 7) can change the codec dynamically to send data. According to the FID semantics, when PCM encoded audio is received externally in Ta, Tb forwards it to P2 in stream 1 and also sends a replica in stream 3. It may be with a different IP destination address if specified like that in the Remote Descriptor. Stream 2 remains muted. When AMR encoded audio is received in Ta, Tb forwards it to P2 in stream 2 while stream 1 and stream 3 remain muted.

When PCM encoded audio is received externally in Tb in stream 1 it is forwarded to Ta via stream4. When AMR encoded audio is received externally in Tb stream 2 it is forwarded to Ta via stream 4.

It is possible for a stream to be connected to other Terminations directly of via an aggregation stream.

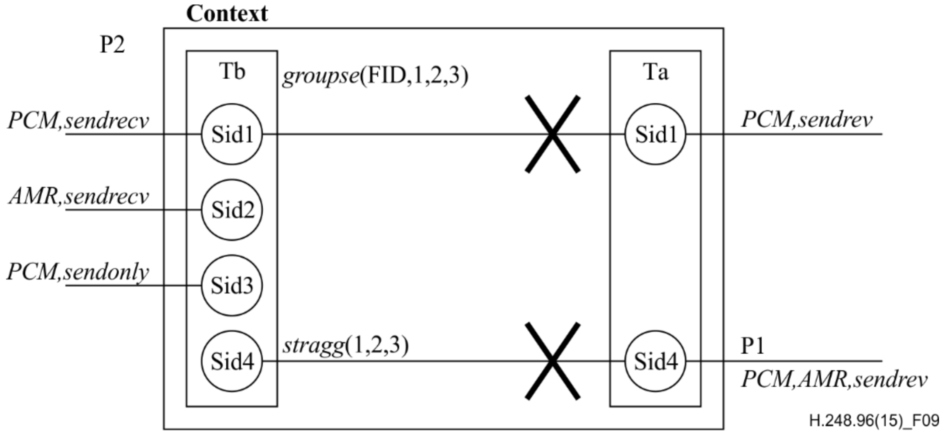


Figure 9 – Example of invalid direct stream and aggregation stream connection between two Terminations

It is not possible for a normal stream to be directly connected to other Terminations in a Context and be connected at the same time to the same Termination through an aggregation stream. Figure 9 shows an example of such a case where two Terminations are connected via a normal stream (stream identity 1) and an aggregation stream (stream identity 4).

There may be multiple aggregation streams on a Termination. A stream cannot be a component of more than one aggregation stream if the aggregation streams are connected between the same Terminations, i.e., it is not possible for a stream to be connected to another Termination through more than one aggregation stream. However, a component can be the source of multiple aggregation streams if at most one (either the component or one of the aggregation streams) is connected to another specific Termination. This can be the case e.g., with aggregation streams defined for statistics gathering, sending Signals or detecting Events, which can have an isolated Topology from other Terminations.

The MGC can modify Topology related to an aggregation stream by using its identity in a Topology Descriptor. For example using Figure 8 the Topology may be set to Topology(Ta, Tb, oneway, Sid4), Topology(Tb, Ta, oneway, Sid4), Topology(Ta, Tb, isolate, Sid4,) or Topology(Ta, Tb, bothway, Sid4).

8.6.6 Usage of stream deaggregation

In some grouping scenarios a single media stream on entering the Context may be deaggregated into multiple component media streams and, in the other direction, may result from the reverse operation of merging multiple component media streams into a single media stream.

The *mgroup* package defines the concept of a deaggregation stream. By setting the *mgroup/strdeagg* property on an ITU-T H.248 Stream indicating the component streams it allows stream deaggregation to be modelled internally in the MG. Media is then deaggregated to/from the deaggregation stream to the component streams according to the applicable grouping semantics.

The *mgroup/strdeagg* property may be set on multiple ITU-T H.248 Streams on a Termination. However the component ITU-T H.248 StreamIDs shall only be assigned to one deaggregation stream. If the MGC assigns a component ITU-T H.248 StreamID to more than one *mgroup/strdeagg* property on a Termination then error code 489 "invalid aggregation and/or deaggregation" shall be returned by the MG.

Figure 10 illustrates this concept.

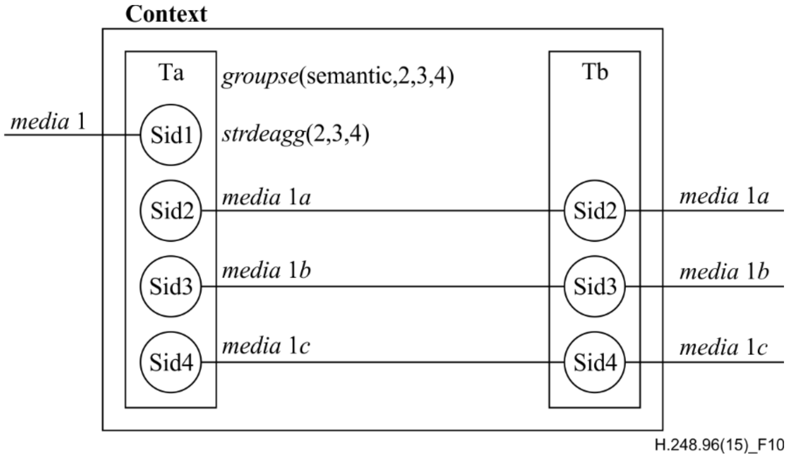


Figure 10 – Deaggregation stream

In Figure 10 media stream labelled *media* 1 described by Stream Descriptor Sid1 will be deaggregated into components 1a, 1b and 1c according to the *groupse* semantic for those streams. This deaggregation will be sent via streams Sid2, Sid3 and Sid4 to Termination Tb. Streams Sid2, Sid3 and Sid4 are the component streams. They are then sent externally from the MG as described by the Stream Descriptor for streams Sid2, Sid3 and Sid4 on Termination Tb. The MG may apply any interworking/adaptation etc., functions that would normally apply when the same media stream is set on two Terminations. The deaggregation stream may also remain isolated to one Termination in a Context.

The deaggregation stream is an external stream and its sending and receiving behaviour has to be characterized with the LocalControl, Local and Remote Descriptor, like with a normal stream.

The concept of deaggregation has been introduced in order to allow multiple component streams to share the same transport. The deaggregation stream represents the common transport while the component streams represent a particular user of the common transport, i.e., an instance of an upper layer. Thus, the deaggregation and the component streams represent different stacked layers.

This is different than the concept of aggregation, where the separation between aggregation and component streams is not related to different stacked layers.

Thus, in the case of deaggregation, component streams may be further characterized by LocalControl, Local and Remote Descriptors, with properties to describe upper layers not described in the deaggregation stream. However, properties related to the layers characterized by the deaggregation stream should be avoided in the component streams. If set, the values of these properties in the component streams should be compatible with those defined in the deaggregation stream and should not override any value set in the deaggregation stream. Clause 8.6.8 provides further details on stream level interactions.

An MGC may apply Signals, Events, Statistics and Topology to the deaggregation and component streams. This behaviour is discussed in more detail in the clauses below.

8.6.6.1 Signals and deaggregation streams

A Signal applied to a deaggregation stream will usually have the effect of being played out externally. Its effect is dependent on the semantic of the Signal. A Signal applied to the internal direction will have the effect of playing on each of the component streams.

A Signal applied to a component stream will usually have the effect of being played out externally on the deaggregation stream in the part that the component relates to.

8.6.6.2 Events and deaggregation streams

An Event applied to the component stream will have the effect of detecting Events as a result of stimulus usually from outside the Context only on the component of the deaggregation. How the Event is reported is based on the grouping semantic associated with the deaggregation stream. Events may be specified on the deaggregation streams. Detection is based on the deaggregation stream has a whole or any of the components of the stream.

Where an Event is set at the Termination level on a Termination that has a deaggregation stream the effect will be that it is only set against the deaggregation stream and streams not involved in a deaggregation.

8.6.6.3 Statistics and aggregation streams

When Statistics are set against a deaggregation stream, the Statistics are collected as if they had been set against all the component streams. If Statistics are set against a component stream, the Statistics are collected only for that component of the deaggregation stream.

When Statistics are set at the Termination level on a Termination that has a deaggregation stream the effect will be that it is only set against the deaggregation streams and streams not involved in a deaggregation.

8.6.6.4 Topology and deaggregation streams

As per clause 8.6.5.4.

8.6.6.5 Principle use cases of stream aggregation and deaggregation

Figure 11 illustrates the principle models for use case 1) Stream aggregation and 2) and Stream deaggregation.

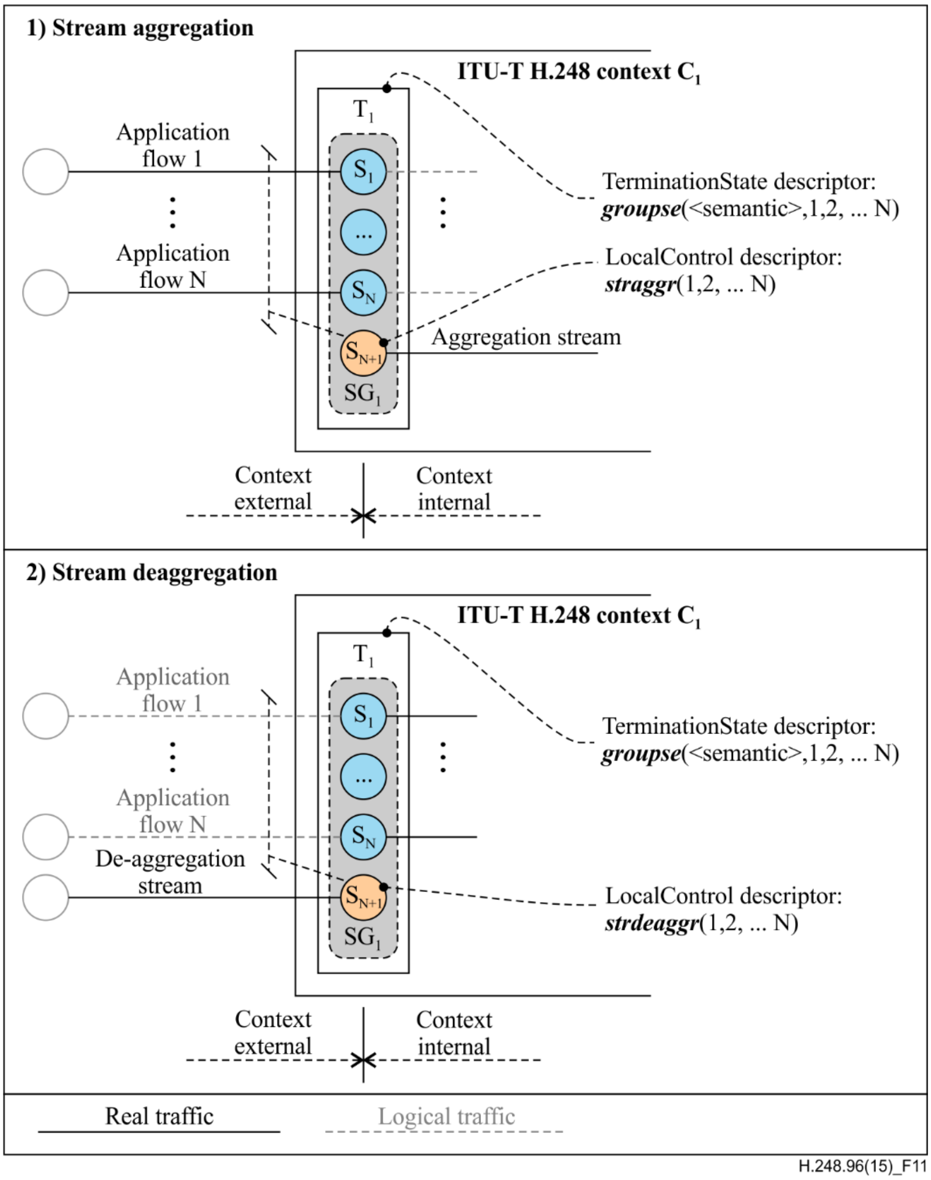


Figure 11 – Half context model – Principle use cases of 1) Stream aggregation and 2) Stream deaggregation

8.6.7 Interaction of "aggregation" and "deaggregation" streams

Appendix I discusses possible aggregation and deaggregation cascading and provides guidelines on its use.

8.6.8 Stream level interactions

ITU-T H.248 Stream properties may be sent against aggregation/deaggregation streams and/or their component streams. The setting of properties is independent. That is, the inclusion of a property in a LocalControl, Local or Remote Descriptor in an aggregation or deaggregation stream does not mean that this property is included in the component Stream Descriptors. As per clauses 8.6.5 and 8.6.6 an MGC should ensure that properties (and their values) set in aggregation and deaggregation stream should not conflict with their components streams.

Properties will be applied to the data stream dependent on the direction (e.g., external->internal->Context or Context->internal->external) and whether the stream is an aggregation/deaggregation stream or a component. The clauses below provide more detailed procedures.

NOTE – The use of StreamMode in the clauses below is to illustrate the applied principles. These principles can be applied to any stream property.

8.6.8.1 Deaggregation streams

Data received externally at the deaggregation stream is first processed using the deaggregation stream properties. As data is passed to the component streams it is processed according the relevant component stream's properties. The data is then passed into the Context.

Data received on a component stream from the Context is processed against the component's stream properties. The data is then passed to the deaggregation stream and then processed against the deaggregation stream properties before being sent externally.

Figure 12 below shows the procedures using the StreamMode property with a deaggregation stream as an example.

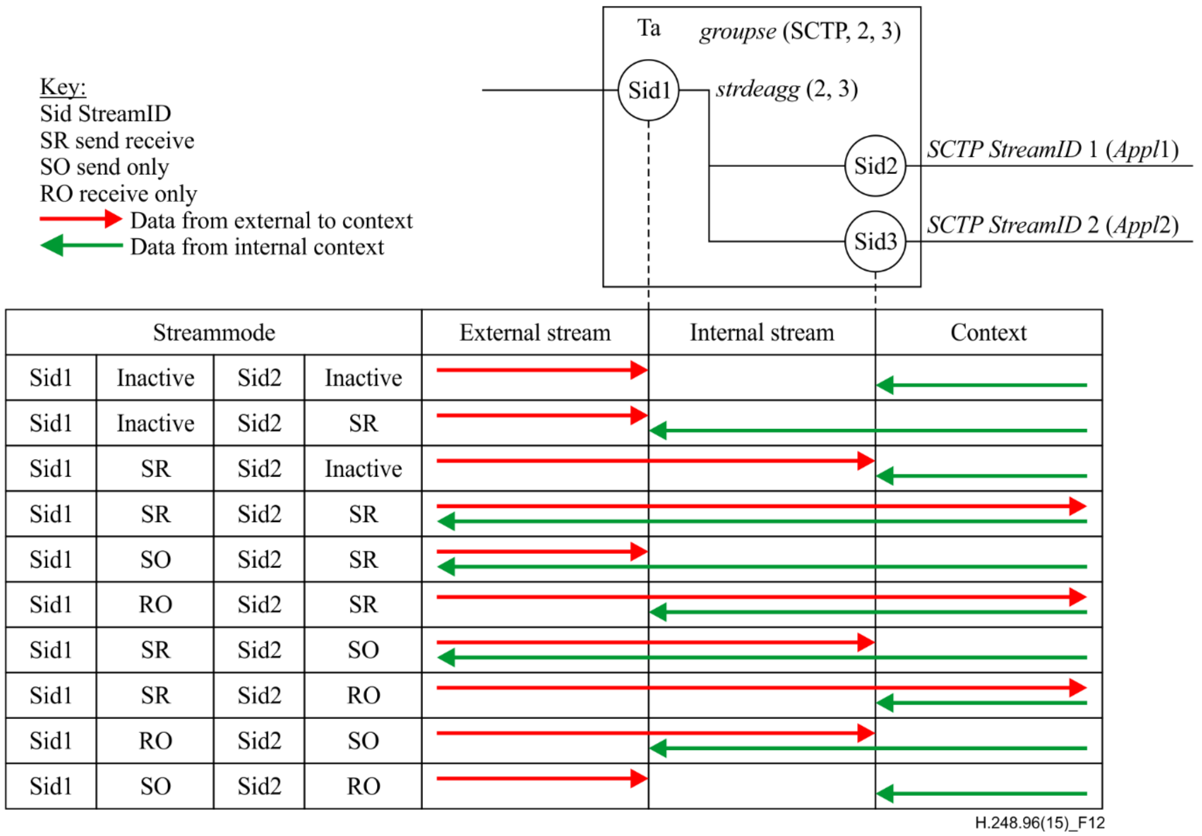


Figure 12 – Deaggregation stream property interaction: StreamMode

Figure 12 shows how the setting of the StreamMode property in a deaggregation stream and its component streams affect data flow into and out of the Context. For successful data flow from the external stream into the Context, the StreamMode must be set on both the deaggregation stream and the component stream to allow data flow in the desired direction/s across the both of them. Likewise, for successful data flow from the Context to the external data stream, the StreamMode must be set on both the deaggregation stream and the component to allow flow in the desired direction/s across both of them. Figure 12 shows how the setting of the StreamMode affects how far data is sent or received in the staged processing.

8.6.8.2 Aggregation streams

Data received externally at the component stream is first processed using the component streams' properties. As data is passed to the aggregation stream it is processed according to the aggregation stream's properties. The data is then passed into the Context.

Data received on an aggregation stream from the Context is processed against the aggregation streams' properties. The data is then passed to the relevant component stream and then processed against the component stream properties before being sent externally.

Figure 13 below shows the procedures using StreamMode with an aggregation stream as an example.

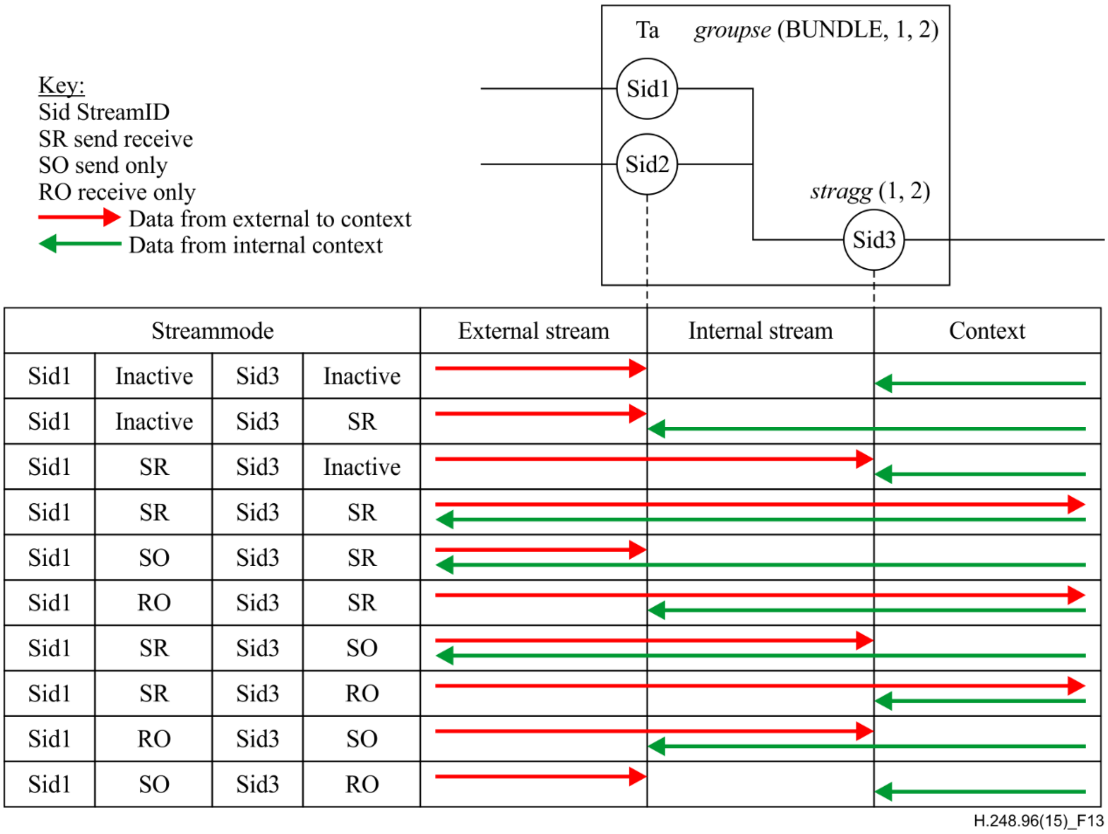


Figure 13 – Aggregation stream property interaction: StreamMode

Figure 13 shows how the setting of the StreamMode property in an aggregation stream and its component streams affect data flow into and out of the Context. For successful data flow from the external stream into the Context, the StreamMode must be set on both the aggregation stream and the component to allow data flow in the desired direction/s across both of them. Likewise, for successful data flow from the Context to the external data stream, the StreamMode must be set on both the aggregation stream and the component to allow data flow in the desired direction/s across both of them.

Annex A

Codepoints for parameter *Semantics* of ITU-T H.248 property *Group Semantics*

(This annex forms an integral part of this Recommendation.)

A.1 Introduction and purpose

Property *mgroup*/*groupse* (clause 8.1.1) defines a list of ITU-T H.248 StreamID values which are qualified by semantics according to the *Semantics* (SDP) parameter as defined by [IETF RFC 5888]. The purpose of this annex is to summarize IANA registered codepoints as well as proposed codepoints by IETF working documents and ITU-T defined codepoints. This information should be reviewed and updated for each release of this Recommendation.

A.2 IETF defined codepoints

IANA registered values for *Semantics* see [b-IANA group semantics]. Table A.1 provides a copy of this information, augmented with additional, yet unregistered, codepoint information.

Table A.1 – Codepoints – Semantics for the "group" SDP attribute (status: 10/2015)

Semantics	Token	Reference	IANA registered
Alternative network address types	ANAT	[b-IETF RFC 4091]	Yes
Bundling	BUNDLE	[b-IETF BUNDLE]	Not yet
Controlling multiple streams for telepresence (CLUE)	CLUE	[b-IETF CLUESIG]	Not yet
Composite session	CS	[b-IETF FLUTE]	Yes
Decoding dependency	DDP	[IETF RFC 5583]	Yes
Duplication	DUP	[IETF RFC 7104]	Yes
Flow identification	FID	[IETF RFC 5888]	Yes
Forward error correction (deprecated)	FEC	[IETF RFC 5956]	Yes
Forward error correction FR	FEC-FR	[IETF RFC 5956]	Yes
Lip synchronization	LS	[IETF RFC 5888]	Yes
Single reservation flow	SRF	[IETF RFC 3524]	Yes

A.3 ITU-T defined codepoints

Table A.2 summarizes codepoints which are specific to ITU-T H.248-based gateway control.

Table A.2 – Codepoints – Semantics for the "group" SDP attribute

Semantics	Token	Reference	IANA registered
Stream control transmission protocol (SCTP) stream deaggregation	SCTP	[b-ITU-T H.248.97]	No

Appendix I

Cascading of aggregation and deaggregation streams

(This appendix does not form an integral part of this Recommendation.)

I.1 General

There are four theoretically possible "cascading" combinations for aggregation and deaggregation streams:

1) deaggregation to deaggregation;
2) deaggregation to aggregation;
3) aggregation to deaggregation;
4) aggregation to aggregation.

This appendix analyses the various combinations and indicates which cascades are supported by version 1 of the *mgroup* package.

I.2 Deaggregation to deaggregation

In this combination an incoming data stream is essentially de-multiplexed multiple times as it enters the ITU-T H.248 Context. This is illustrated in Figure I.1 below.

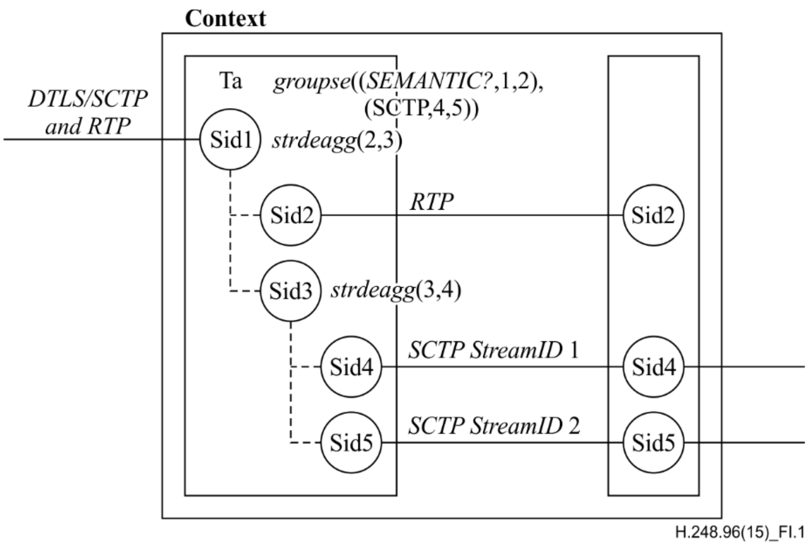


Figure I.1 – Deaggregation component to deaggregation stream cascade

A possible use case would be where datagram transport layer security (DTLS)/SCTP and secure real-time transport protocol (SRTP) are multiplexed over the same transport address/port. This use case is mandated by section 3.5 of [b-IETF WEBTRANS] for real-time communication in WEB-browsers (WebRTC) implementations, i.e.,

> *"WebRTC implementations MUST support multiplexing of DTLS and RTP over the same port pair, as described in the DTLS_SRTP specification [RFC5764], section 5.1.2. All application layer protocol payloads over this DTLS connection are SCTP packets."*

The first deaggregation could de-multiplex the external data stream into DTLS/SCTP and RTP component streams. In this case the external data stream could be modelled by two ITU-T H.248 Streams (i.e., one user datagram protocol (UDP)/transport layer security (TLS)/RTP/secure audiovisual profile with feedback (SAVPF)" and one with "UDP/DTLS/SCTP" utilising the same transport address/port). A BUNDLE semantic would be specified via the *groupse* property.

However, a deaggregation stream would not be needed because of the use of multiple ITU-T H.248 Streams. So while this first "de-mux" could be modelled via a deaggregation, in practice it would be defined via another method.

A deaggregation would be needed to de-multiplex the SCTP component stream representing the SCTP association into component streams representing the SCTP streams.

This is illustrated in Figure I.2 below.

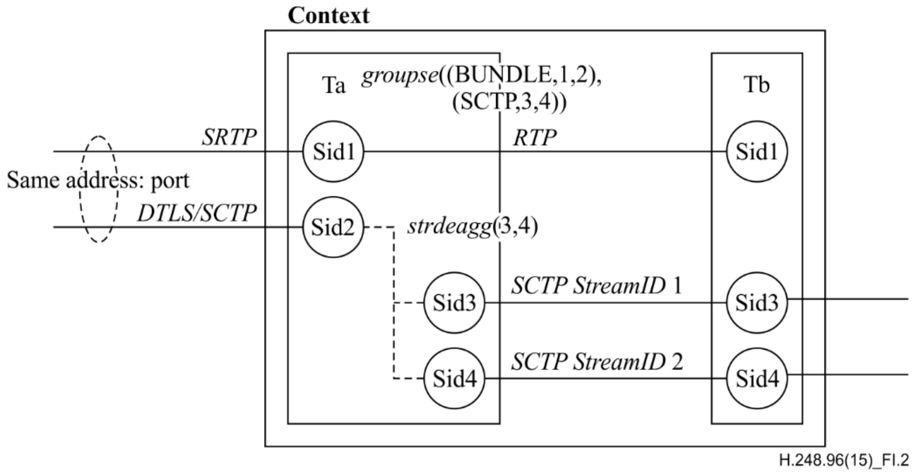


Figure I.2 – Multiple de-multiplexes one deaggregation

In considering other scenarios where BUNDLE is used it appears that these can also be handled in the above manner. Thus no practical use case is identified for the support of deaggregation to deaggregation cascading.

Conclusion: *While multiple deaggregations per Figure I.1 are theoretically possible, their use should be avoided via the use of a configuration such as that shown in Figure I.2. Therefore, for the current version of the mgroup package the configuration as illustrated in Figure I.1 is not supported. A future version could introduce this configuration.*

I.3 Deaggregation to aggregation

I.3.1 No cascade

This scenario builds on the scenario in clause I.1. An external data stream is de-multiplexed to several component streams. This could occur where the media from the deaggregation stream needs to be aggregated with other streams, for example as part of a FID semantic. Figure I.3 shows this scenario.

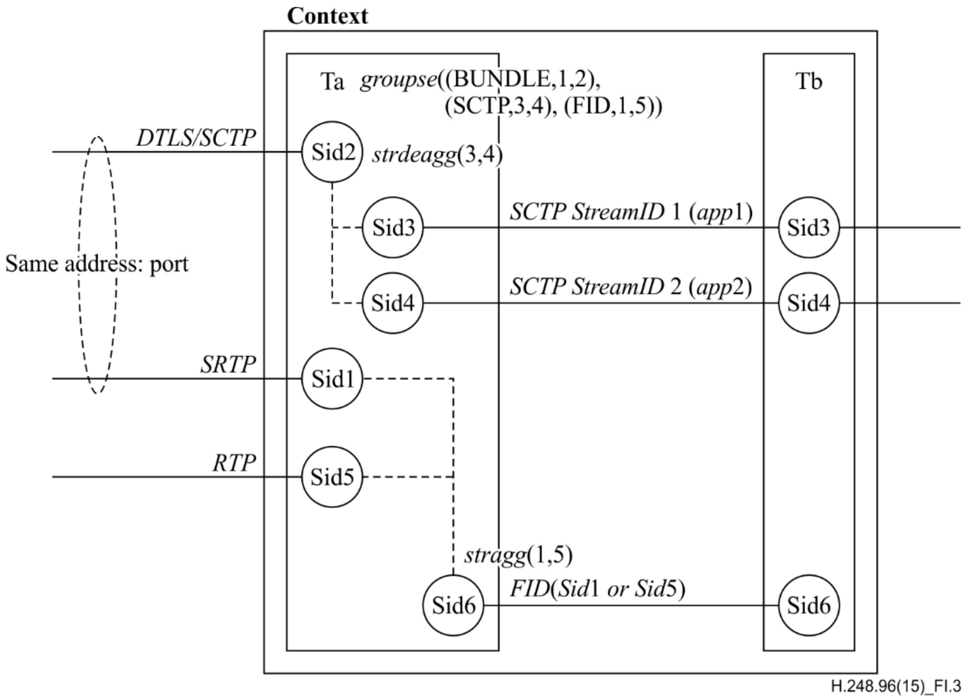


Figure I.3 – Deaggregation to aggregation no cascade

Figure I.3 shows that while deaggregation and aggregation are used, they are not cascaded.

Conclusion: *This is a valid configuration; however it is not cascaded.*

I.3.2 Component cascade

A slightly modified scenario is where one of the applications on an SCTP stream needs to be included in an aggregation before being forwarded to Termination Tb. This scenario is illustrated in Figure I.4.

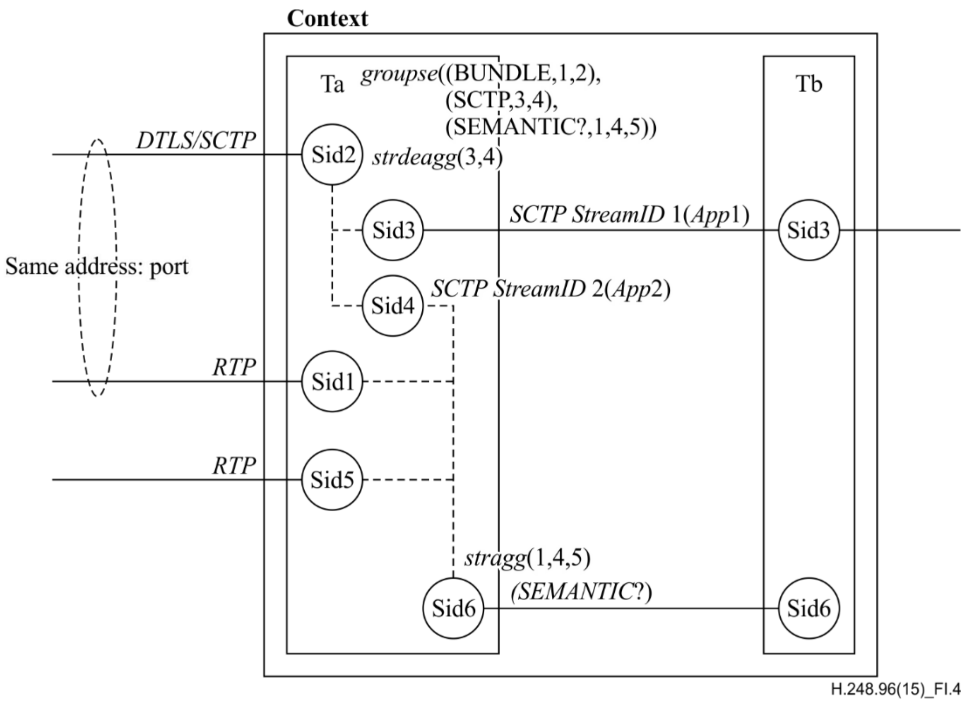


Figure I.4 – Deaggregation component to aggregation cascade

This is very similar to the previous scenario in Figure I.3 in that the same *strdeagg* and *stragg* properties are used. However, the difference is that the component stream from the deaggregation is used as part of the aggregation. While it is theoretically possible, no practical use case has been identified. The stream aggregation semantic could be FID meaning that Sid6 would source media from Sid1, Sid4 or Sid5 however, this usage is unlikely.

A more likely scenario is that the deaggregation component is processed according to a subsequent semantic on another Termination. Figure I.5 shows a scenario where a deaggregation component (Sid4) becomes part of a BUNDLE on Termination Tb.

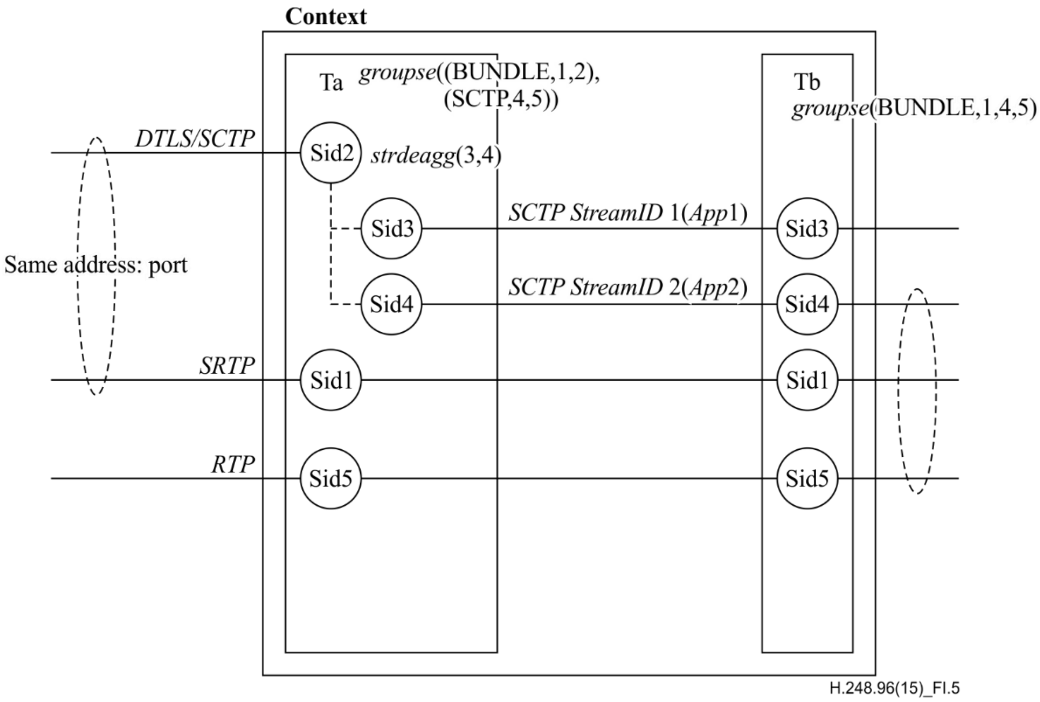


Figure I.5 – Deaggregation component to subsequent semantic

Conclusion: *While multiple deaggregations per Figure I.4 are theoretically possible, their use should be avoided via the use of configurations such as those shown in Figure I.5. Therefore, for the current version of the mgroup package this configuration is not supported. A future version could introduce this configuration and would need to indicate that an aggregation component may be an internal stream.*

I.3.3 Deaggregation stream cascade

In this scenario the deaggregation stream is used as an input to an aggregation stream. Figure I.6 illustrates the scenario.

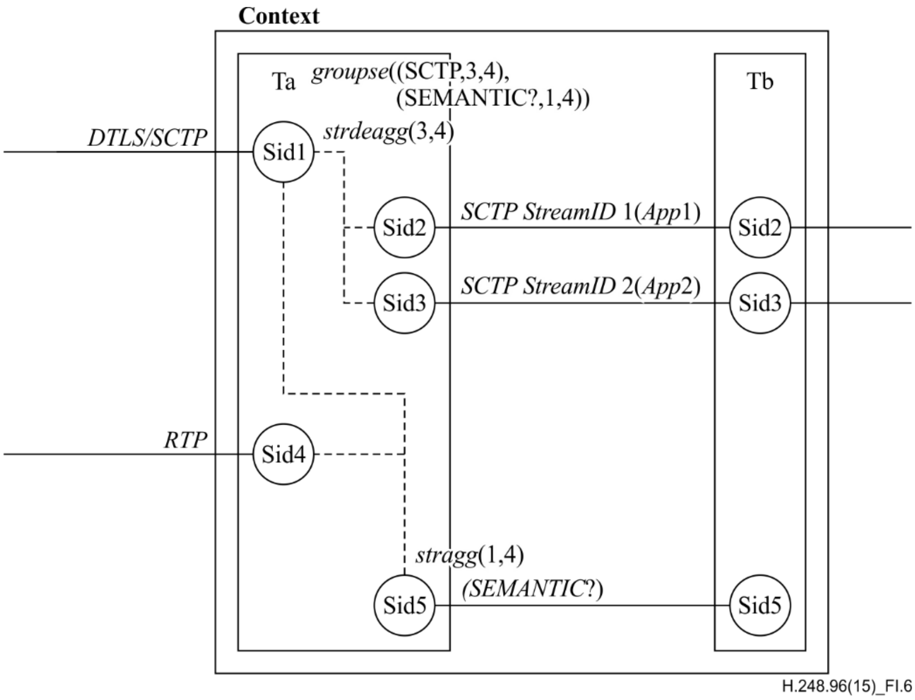


Figure I.6 – Deaggregation stream to aggregation cascade

Figure I.6 illustrates a scenario where the deaggregation stream Sid1 is used as a component to the aggregation stream Sid5. This is theoretically possible; however, none of the currently defined aggregation semantics (i.e., in clause 8.6.3) would result in such a configuration.

Conclusion: *A valid configuration however no semantics are currently defined that require this configuration. Therefore, for the current version of the mgroup package this configuration is not supported. A future version could introduce this configuration.*

I.4 Aggregation to deaggregation

In this scenario an aggregation stream also acts as a deaggregation stream. This is illustrated in Figure I.7.

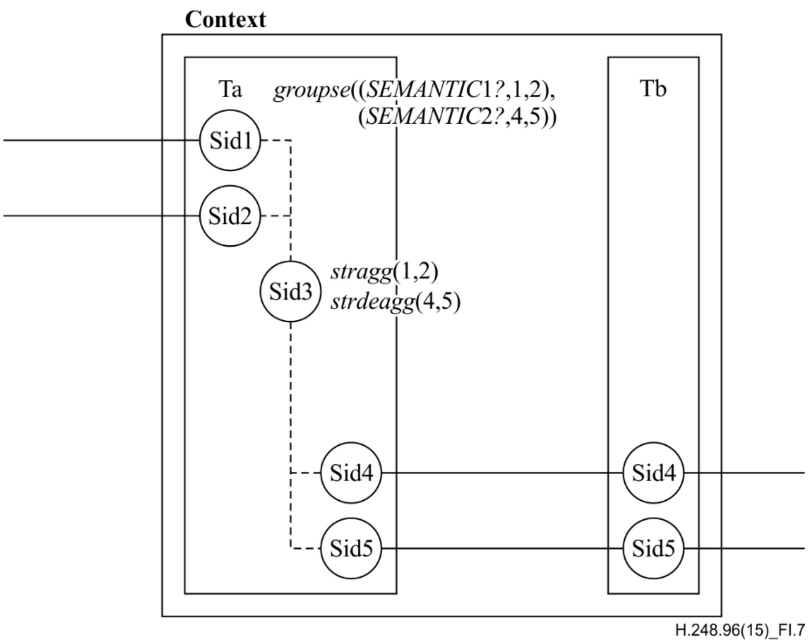


Figure I.7 – Aggregation to deaggregation cascade

Given the existing semantics no scenario is identified that could result in an aggregation stream being used as a deaggregation stream. The only currently defined deaggregation semantic is "SCTP". Therefore, any deaggregation stream must be SCTP related. The currently defined aggregation semantics (i.e., in clause 8.6.3) do not appear to relate to SCTP streams.

Conclusion: *If an MGC tries to set such a configuration the MG shall respond with an appropriate error code.*

I.5 Aggregation to aggregation

In this scenario the FID semantic is used to identify that one of two RTP streams (RTP1 or RTP2) will be sent at a particular time. Then either resultant stream or RTP3 is sent into the Context due to the second FID semantic. Figure I.8 shows the possible use of two aggregations to achieve this behaviour.

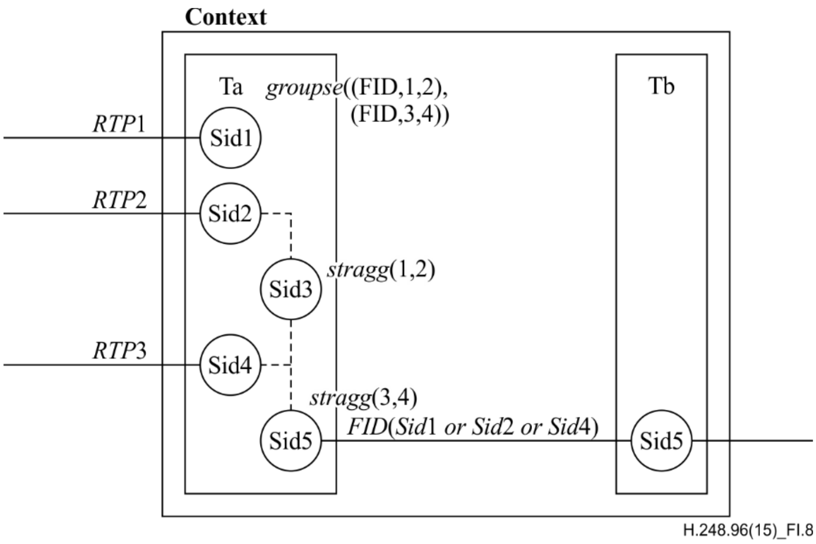


Figure I.8 – Aggregation stream as aggregation component

The resultant aggregation of ITU-T H.248 Stream Sid3 is used as a component stream to the aggregation for Sid5. However, this scenario could be more simply modelled via a single aggregation as shown in Figure I.9.

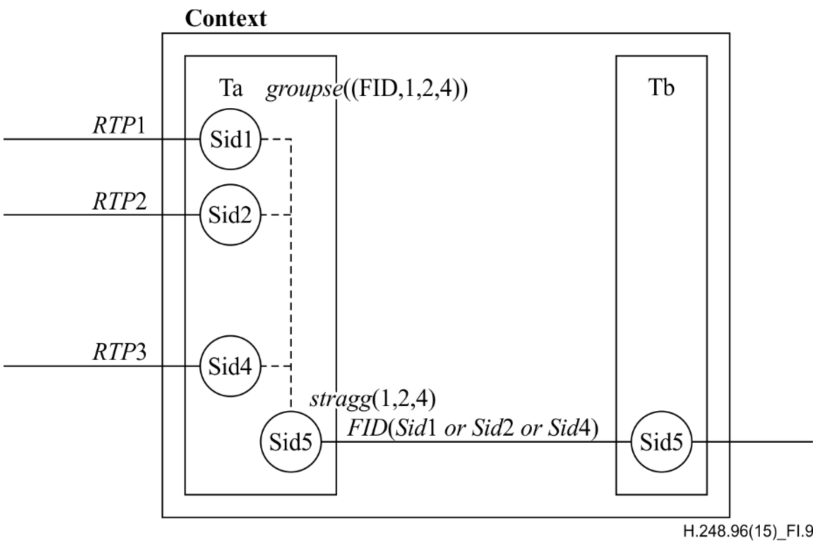


Figure I.9 – Single aggregation

Figure I.9 shows a simpler implementation using a single *stragg* property. There isn't a valid use case using existing semantics for aggregation to aggregation cascading.

Conclusion: *An MGC shall not use an aggregation to aggregation component configuration when the aggregations have the same semantics. An MGC may use such a configuration where the aggregations have different semantics; however, none of the existing semantics warrant such a configuration*.

Appendix II

Potential stream grouping use cases

(This appendix does not form an integral part of this Recommendation.)

II.1 Use case #1: alternate speech-text telephony

II.1.1 Use case #1.1: alternate speech-text telephony in IP-to-IP gateways (without RTP bundling)

II.1.1.1 High-level description of the gateway interworking service

The alternate speech-text telephony communication (e.g., [b-ITU-T F.703], [b-ITU-T F.790], [b-ITU-T F.791], [b-ETSI ETR 333], [b-ETSI EG 202 320]) is a regulated service, e.g., as defined for 3GPPs global text telephony (GTT) service ([b-ETSI TS 122 226], [b-ETSI TS 123 226]). This service has the peculiarities that at least one communication party is using audio and text quasi in parallel, but only one media format at a particular point in time and also only in a unidirectional manner (e.g., a mute-only person gets audio in receive only mode and text in send only mode, or a deaf-only person gets a vice versa configuration). Figure II.1 illustrates combinations of interest in this appendix, i.e., one Termination with audio and embedded text as voiceband data (using [b-ITU-T V.18] modem), and one Termination with separate stream endpoints for native voice over IP (VoIP) (audio) and Text over IP (ToIP) (text). Again, combinations when one communication party could use audio or text in bidirectional manner is out of scope of this Recommendation because it effectively leads to an audio-only or text-only call. The ITU-T H.248 Context model in scope has combinations with unidirectional audio and text (Figure II.1).

This use case is an example for demonstrating stream grouping with scope on:

1) stream aggregation: two unidirectional traffic flows (carried in bidirectional ITU-T H.248 media streams) are combined to a single bidirectional flow; and
2) non-applicability of the directionality token usage in property *groupse* (despite the mentioned fact of a unidirectional characteristic at traffic flow level);
3) RTP Topology related RTCP handling in the non-grouped and grouped stream model; and
4) the case of additional bundling (subject of use case #1.2 in clause II.1.2).

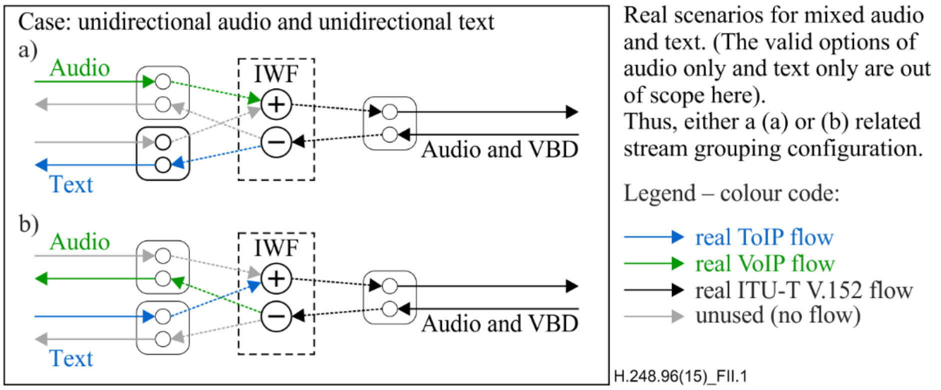


Figure II.1 – Use case #1.1: alternate speech-text telephony in IP-to-IP gateways – Traffic flow models

The basic question relates to the modelling of audio and text on the left hand side, e.g., whether both could be merged into a single ITU-T H.248 Stream? This is basically possible by usage of the ITU-T H.248 *ReserveGroup* property and the definition of two ITU-T H.248 media groups. There are deficiencies with this model, primarily that both media groups share all common stream endpoint characteristics such as traffic directionality configuration (StreamMode). Other constraints are stream-level statistics. Therefore, an enhanced Context model based on stream grouping is discussed.

The IP application protocol for ITU-T H.248 Stream endpoint $T_A(S_1)$ is [b-ITU-T V.152], which relates to a dual mode VoIP / voiceband data over IP (VBDoIP) configuration (with an *audio* mode and voiceband data *(VBD)* mode). The example media formats are:

– [b-ITU-T V.152] *audio mode*: ITU-T G.711 µ-law without silence suppression;

– [b-ITU-T V.152] *VBD mode*: ITU-T G.711 µ-law as VBD codec plus RTP packet redundancy in order to provide an assured transport service (see clause 6.3.2 of [b-ITU-T V.152]).

II.1.1.2 Selected stream grouping model

See Figure II.2 with the usage of stream grouping at Termination T_C (there are two ITU-T H.248 *components streams* ($T_C(S_2)$ and $T_C(S_3)$) are assigned to ITU-T H.248 aggregation stream $T_C(S_1)$).

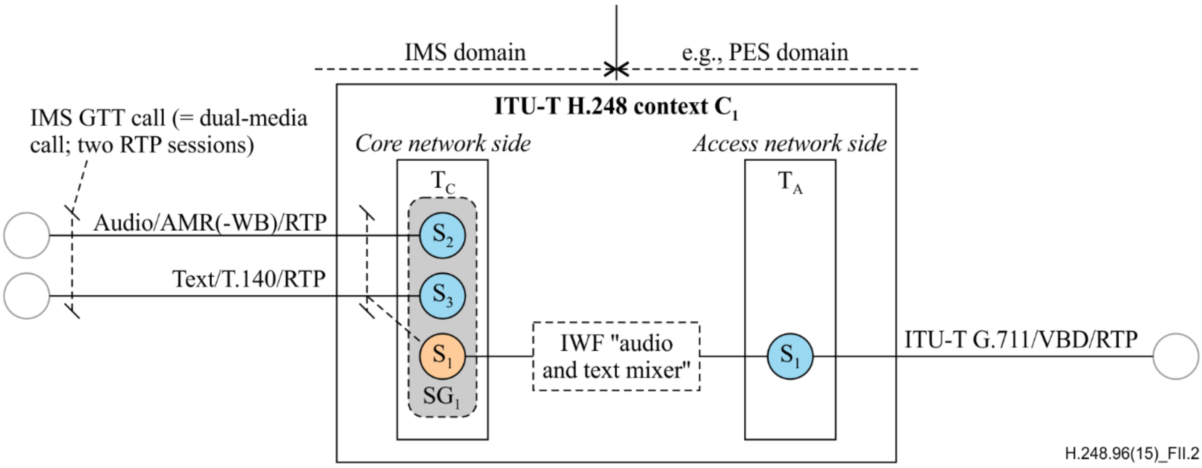


Figure II.2 – Use case #1.1: alternate speech-text telephony in IP-to-IP gateways – Context stream grouping model

One call leg is located in an IP multimedia subsystem (IMS) domain, and the other call leg in a public switched telephony network (PSTN) emulation subsystem (PES) domain.

Desired MG behaviour:

– if stream endpoint (SEP) $T_C(S_2)$ receives an AMR/RTP packet, then the AMR encoded voice sample is transcoded to a [b-ITU-T G.711] encoded voice sample that then SEP $T_A(S_1)$ transmits an RTP packet with RTP "PT = 0";

– if SEP $T_C(S_3)$ receives a [b-ITU-T T.140]/RTP packet, then the encoded text is transformed into a corresponding series of baudot tones, which is ITU-T G.711 encoded and packetized into a series of ITU-T G.711/VBD/RTP packets (based on [b-ITUT-T V.152], which then are transmitted by SEP $T_A(S_1)$ within [b-IETF RFC 2198] ("PT=102") RTP packets;

– if SEP $T_A(S_1)$ receives an ITU-T G.711/RTP packet with encoded voice sample, then this voice sample is AMR encoded and a corresponding AMR/RTP packet is transmitted by SEP $T_C(S_2)$. Such an interworking function (IWF) relates to "audio transcoding";

– if SEP $T_A(S_1)$ receives an [b-IETF RFC 2198] RTP packet ("PT=102"), then it extracts the contained "PT=98" VBD payloads, it then interprets the VBD payload as a fraction of the text part encoding baudot tone and tries to transform the baudot tone into the corresponding text characters (several VBD payloads may need to be concatenated before doing this), then it transforms these text characters into the corresponding ITU-T T.140 format, which is then encoded and packetized into ITU-T T.140/RTP packets as per [b-IETF RFC 4103], which then are transmitted by SEP $T_C(S_3)$. Such an IWF relates to "text transcoding".

Thus, Termination T_C would have to "know" whether to use its ITU-T H.248 Stream S_2 or S_3 for transmission of an RTP packet. This would depend on the payload type format of the RTP packet(s) $T_A(S_1)$ receives and on the payload type(s) which the IWF uses when generating RTP packets. Hence, the MG is expected to aggregate streams according to the "FID" semantic.

Furthermore, Termination T_A implies the usage of a single ITU-T H.248 Stream in "dual mode" usage, which is inherently satisfied by ITU-T V.152 (and its two state model of "audio mode" and "VBD mode").

II.1.1.3 Overall signalling scenario (PES-to-IMS call)

Note that the PES-to-IMS call establishment direction is difficult due to the uncertainty of additional text usage, leading to dynamic stream grouping aspects. On the contrary, the IMS-to-PES call establishment direction is straightforward from a stream grouping perspective due to the explicit capabilities indications already in the first SDP offer sent from the IMS user equipment (UE).

The following message sequence diagram (Figure II.3) shows the messages and message numbering scheme which is used by all example message flows in this use case, which are related to the PES network domain being the communication session originator.

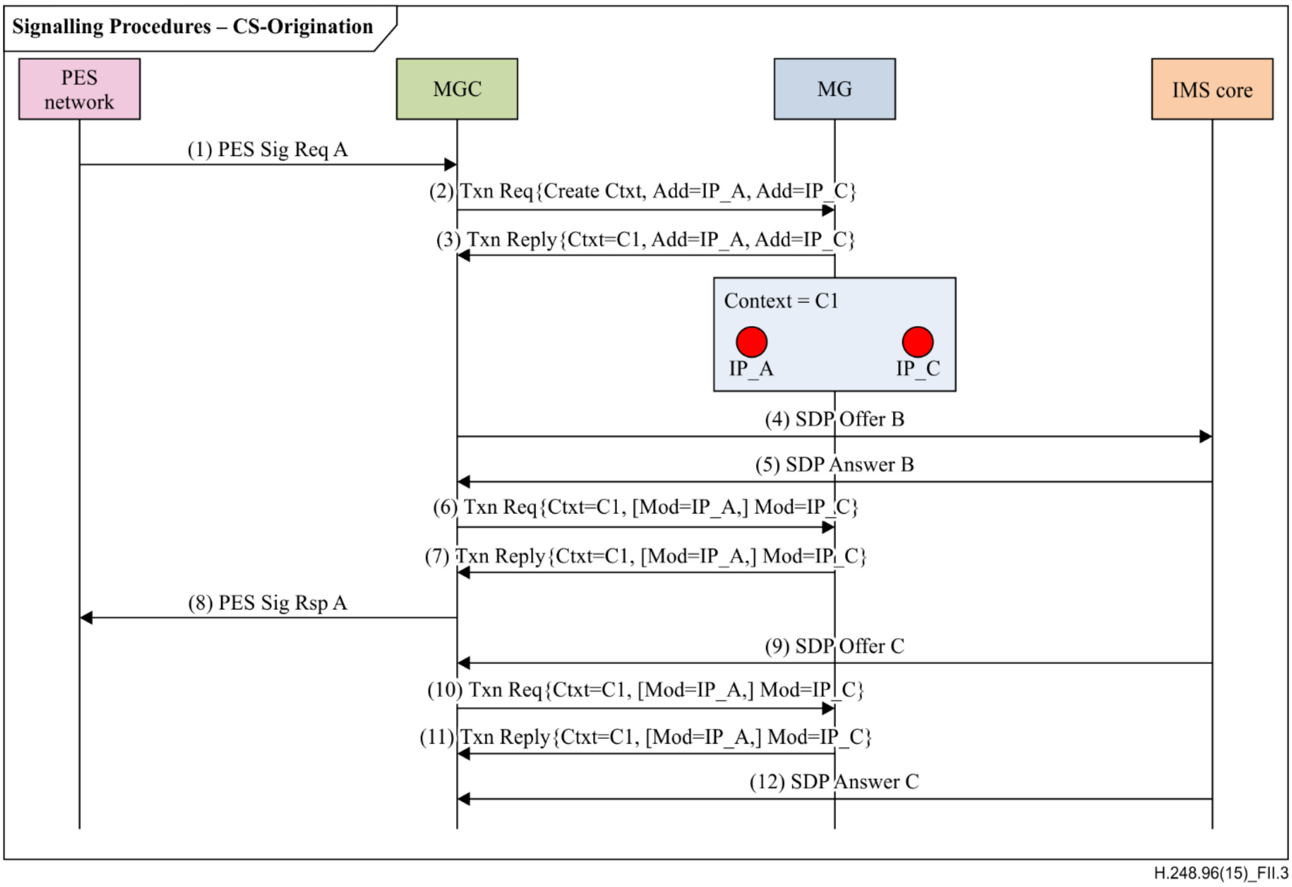


Figure II.3 – Overall message sequence diagram for a call in PES-to-IMS direction

There is call control signalling between the PES domain and the MGC (1, 8), and the IMS domain and the MGC (4, 5, 9, 12). Such call control signalling would be SIP-based, but the specific call control protocol syntax is out of scope of this Recommendation.

The basic assumption in the above scenario is that the Context C1 is initially created and prepared for audio-only, and extended for additional text support after a correspondent update from the IMS side. The rationale behind this is the expected distribution between "audio-only" and "audio and text" calls (e.g., an estimated probability of 99.99 per cent of type "audio-only").

II.1.1.4 Signalling steps

Notes:

– Some GTT independent SDP attributes are not shown in the following example messages. Such additional SDP attributes would typically be present in Local and Remote Descriptors. Also, some GTT independent LocalControl Descriptor properties are deliberately not shown.

– Events and Signals Descriptors, which would potentially be used in some cases, are also not shown.

Step 1: PES call control signalling (e.g., based on SIP-I)

– request for a "speech" call

Steps 2 and 3: ITU-T H.248 transaction request/reply {Create Context, Add Terminations "IP_A" and "IP_C"}

See Table II.1

Table II.1 – Example ITU-T H.248 signalling for Steps 2 and 3 ("audio-only configuration")

H.248/SDP encoding (shortened H.248 Media Descriptor)	Comments:

Transaction = 1 {
  Context = $ {
    Add = ip/$/$/$ {   ; **"PES Termination"**
      Media {
        Stream = 1 {
          LocalControl {
            Mode = SendReceive,
            ReservedValue = ON ; (Note 1)
          },
          Local {
           rtpt/rtptopo = PP ; B2BRE topo enforced
          ; start of SDP-defined H.248 media group
            v=0
            c=IN IP4 $
            m=audio $ RTP/AVP 0 98 102
            a=rtpmap:98 PCMU/8000
            a=gpmd:98 **vbd=yes**
            a=rtpmap:102 red/8000 ; packet redun.
            a=fmtp:102 98/98/98/98
            a=…
          },
          Remote {
           rtpt/rtptopo = PP ; B2BRE topo enforced
            v=0
            c=IN IP4 <PES_IP_addr_audio>
            m=audio <PES_port_audio> 0 98
            a=rtpmap:98 PCMU/8000
            a=gpmd:98 **vbd=yes**
            a=rtpmap:102 red/8000 ; packet redun.
            a=fmtp:102 98/98/98/98
            a=…
    }}}},
    Add = ip/$/$/$ {   ; **"IMS Termination"**
      Media {
        Stream = 1 {
          LocalControl {
            Mode = SendReceive,
	Initial speech only configuration with media formats AMR at IMS side and ITU-T G.711 µ-law at PES side. Hence, the MG is requested for an IWF "audio transcoding".
	The PES Termination is additional enabled for potential VBD, i.e., an
	– audio configuration 'PCMU' and
	– VBDoIP configuration with 'PCMU' as VBD codec.

Table II.1 – Example ITU-T H.248 signalling for Steps 2 and 3 ("audio-only configuration")

H.248/SDP encoding (shortened H.248 Media Descriptor)	Comments:

`ReservedValue = ON ;(Note 2)`
`},`
`Local {`
`rtpt/rtptopo = PP` `; B2BRE topo enforced`
`v=0`
`c=IN IP6 $`
`m=audio $ RTP/AVP 103 0 13 100`
`a=rtpmap:100 telephone-event/8000`
`a=fmtp:100 0-15`
`a=rtpmap:103 AMR/8000/1`
`a=fmtp:103 mode-set=0,2,5,7`
`a=ptime:20`
`a=silenceSupp:on - - - -`
`}}}}}}`	

`Reply = 1 {` **`…}`**	positive acknowledgement
NOTE 1 – The ITU-T V.152 dual mode configuration implies a ReserveValue 'true' setting. NOTE 2 – The setting ReserveValue 'true' leads to an additional reservation of audio codec types "0" and "13", which could actually result in a transcoding-less Context configuration of "PCMU-to-PCMU" interworking. The setting ReserveValue 'false' would enforce an audio transcoder "AMR-to-PCMU".	

Steps 4 and 5: SIP call control signalling – SDP offer/answer cycle

– request for a "audio-only" call with AMR as codec which is confirmed by IMS UE

Steps 6 and 7: ITU-T H.248 transaction request/reply for completion of the initial audio-only Context configuration

Step 8: PES call control signalling – positive response

The IMS terminal decides (e.g., based on configuration data) to change from audio-only to parallel usage of audio and text, leading to a SIP UPDATE or re-INVITE request (Step 9).

Step 9: SIP call control signalling – SDP offer

– with an additional media description for a media type 'text'

Steps 10 and 11: ITU-T H.248 transaction request/reply {modification of Termination "IP_C"}

See Table II.2.

Table II.2 – Example ITU-T H.248 signalling for Steps 10 and 11

H.248/SDP encoding (shortened H.248 Media Descriptor)	Comments:

`Transaction = 3 {`
`Context = <C1> {`
`Modify = <IP_C> { ; NOTE 1`
`TerminationState {`
`mgroup/groupse = ["FID 2 3"]`
`},`
`Media {`
`Stream = 1` `{`
`LocalControl {`
`mgroup/stragg = [2, 3],`
`ReservedValue = ON`
`},`
`Local {},`
`Remote {}`
	MGC adds TerminationState Descriptor containing the *mgroup/groupse* property in order to request the MG to group the two new SEPs 2 and 3 with semantic "FID" as per [IETF RFC 5888].
	
	Stream S1:
	MGC changes this SEP to the aggregating SEP. This allows keeping SEP <IP_A>.S1 without

Table II.2 – Example ITU-T H.248 signalling for Steps 10 and 11

<table>
<tr><th>H.248/SDP encoding (shortened H.248 Media Descriptor)</th><th>Comments:</th></tr>
<tr><td><pre>
        },
        Stream = 2 {
          LocalControl {
            Mode = SendReceive,
            ReservedValue = ON
          },
          Local {
           rtpt/rtptopo = PP ; B2BRE topo enforced
            v=0
            c=IN IP6 $
            m=audio $ RTP/AVP 0 103 100
            a=rtpmap:103 AMR/8000/1
            a=rtpmap:100 telephone-event/8000
            a=fmtp:103 mode-set=0,2,5,7; max-red=0
            a=ptime:20
            a=maxptime:30
            a=silenceSupp:off - - - -
          },
          Remote {
           rtpt/rtptopo = PP ; B2BRE topo enforced
            v=0
            c=IN IP6 <IMS_IP_addr_audio>
            m=audio <IMS_port_audio> RTP/AVP 0 110
100
            a=rtpmap:110 AMR/8000/1
            a=rtpmap:100 telephone-event/8000
            a=fmtp:110 mode-set=0,2,5,7
            a=ptime:20
            a=maxptime:30
            a=silenceSupp:off - - - -
          }
        },
        Stream = 3 {
          LocalControl {
            Mode = SendReceive,
            ReservedValue = OFF
          },
          Local {
           rtpt/rtptopo = PP ; B2BRE topo enforced
            v=0
            c=IN IP6 $
            m=text $ RTP/AVP 120 121
            a=rtpmap:120 red/1000/1
            a=fmtp:120 121/121/121 ; NOTE 2
            a=rtpmap:121 t140/1000/1
          },
          Remote {
           rtpt/rtptopo = PP ; B2BRE topo enforced
            v=0
            c=IN IP6 <IMS_IP_addr_text>
            m=text <IMS_port_text> 120 121
            a=rtpmap:120 red/1000/1
            a=fmtp:120 121/121/121 ; NOTE 2
            a=rtpmap:121 t140/1000/1
          }
}}}}}
</pre></td><td>any modifications.
MGC sets ReserveValue = ON in order to avoid SEP 1 being deleted.
MGC replaces Local and Remote with empty Descriptors, as the aggregation SEP does not need any own Local or Remote Descriptor content and especially does not have an own externally visible transport address.
Stream S2:
MGC creates SEP 2 which takes over the previous role of <IP_C>'s SEP 1 (audio media towards IMS). However, new SEP 2 is created with choose wildcards in the Local Descriptor, as the MG does not support moving SEP 1's transport address to SEP 2.
Stream S3:
New SEP 3 for the new text media component towards IMS.</td></tr>
</table>

Table II.2 – Example ITU-T H.248 signalling for Steps 10 and 11

H.248/SDP encoding (shortened H.248 Media Descriptor)	Comments:
NOTE 1 – In Step (10) the MGC does not modify the PES side Termination <IP_A>. Thus its SEP 1 remains PCMU-based for audio and VBD Signals. But due to the modification of <IP_C>'s SEP 1 to an SEP aggregating the new SEPs 2 and 3, and due to the new SEPs 2 and 3 describe audio and real time text (RTT) text-based media components, respectively, the MG now knows that it needs to insert an IWF into the internal data path between <IP_A>'s SEP 1 on the one hand side and <IP_C>'s SEPs 2 and 3 on the other hand side. The IWF provides: 1. audio transcoding between AMR and PCMU; 2. text transcoding between [b-IETF RFC 4103] based RTT to text/baudot/PCMU/VBD; and 3. "mixing" of the two internal PCMU-based streams to PCMU/RTP/UDP/IP packets in PES direction. NOTE 2 – The example shows packet redundancy levels of two at SEP $T_C(S_3)$ for native text-over-RTP and of three at SEP $T_A(S_1)$ for text in VBD encoding (see Table II.1.1.). The higher redundancy might be justified by the different encoding schemes or/and different grade of service (GoS) conditions in the two IP domains.	
`Reply = 3 {` `…}`	positive acknowledgement

Step 12: SIP call control signalling – SDP answer

– completion of call establishment.

II.1.1.5 Observations

Figure II.4 summarizes the transition from the initial audio-only Context to additional text support.

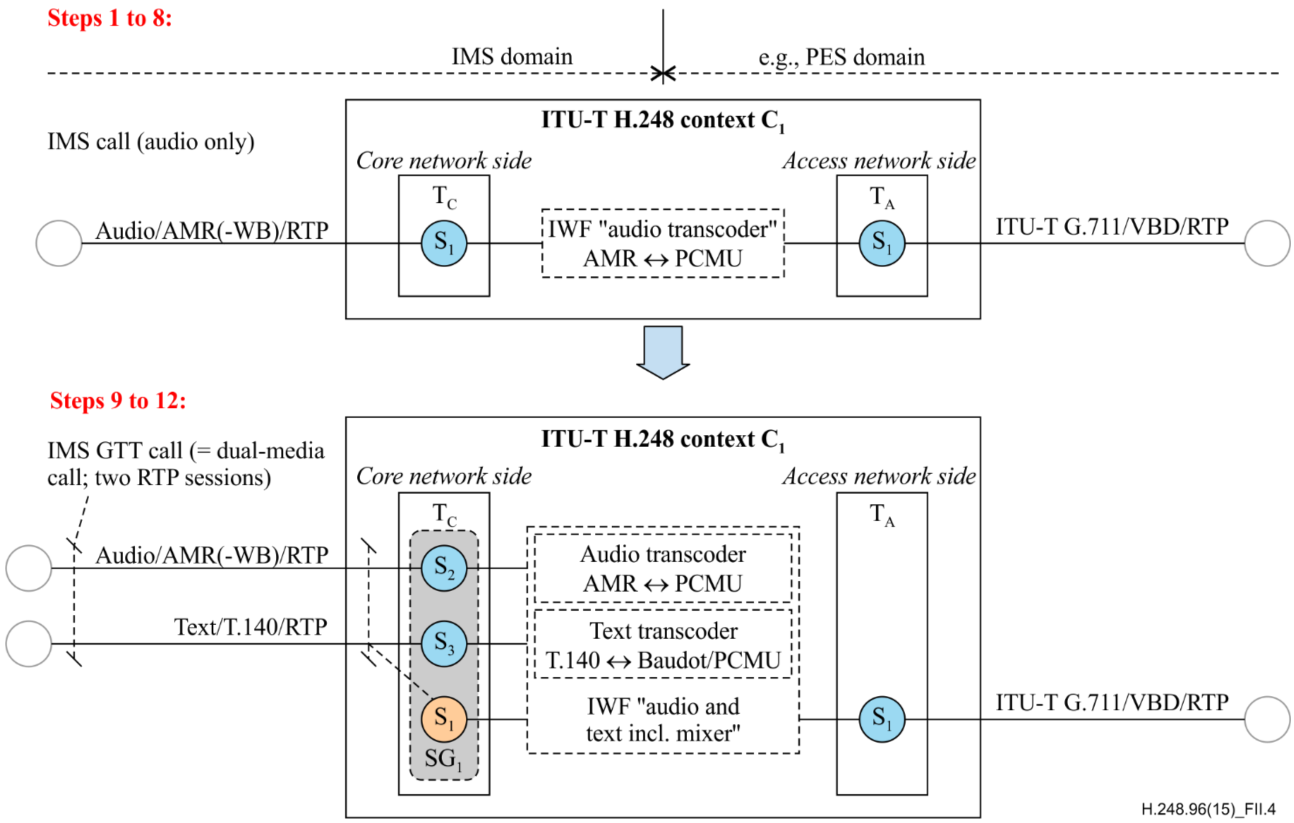


Figure II.4 – Use case #1.1: summary of the example evolution of the considered Context stream grouping model

Steps 9 to 12 are only executed for the rare cases of additional text support. The ITU-T H.248 "PES" Termination would then not be affected by a "Context reconfiguration".

The aspect of "RTP Topology" [b-ITU-T H.248.88] should be carefully considered:

– Phase 1 "audio-only" (Steps 1 to 8):
  - either back-to-back RTP end system (B2BRE) or RTP media translator (RTPMT) Topology (due to enforced audio transcoding).
– Phase 2 "additional text" (Steps 9 to 12):
  - the RTP Topology among the three external ITU-T H.248 media streams looks like an "RTP mixer", but the overall communication topology relates still to an two-party call only, underlined by the fact that there are only two ITU-T H.248 Terminations and the ITU-T H.248 Topology Descriptor is not used;
  - the ultimate requirement for RTCP is the isolation of RTCP control flows to their RTP session legs only (from an end-to-end perspective). Thus, any incoming RTCP report needs to be fully terminated in its ITU-T H.248 SEP. Such behaviour is only guaranteed by a B2BRE Topology configuration, which is therefore explicitly enforced on each stream and each traffic direction.
– The RTP Topology (in the ITU-T H.248 MG) should not change by a transition from phase 1 to phase 2 from an end-to-end communication perspective. That's the reason why the B2BRE Topology was already explicitly enforced in both phases.

NOTE – The *rtpt/rtptopo* property is located at LD-/RD-level (and not at LocalControl Descriptor level) (see [b-ITU-T H.248.88]). This might result in a conflict with the media description SDP lines in the LD and/or RD.

II.1.2 Use case #1.2: alternate speech-text telephony in IP-to-IP gateways with RTP bundling

Use case #1.2 provides RTP bundling in the IMS domain in addition to use case #1.1.

II.1.3 Use case #1.3: additional performance monitoring

The transition from initial audio-only mode to GTT mode could demand correspondent performance monitoring support (e.g., due to a regulated service).

In order to minimize cost, the number of ITU-T H.248 statistics might be reduced by consideration of media stream specific characteristics. For instance, by support of stream-level statistics:

– number of ITU-T H.248 statistics: at least one performance metric is selected per media type (audio and text) in order to characterize the performance of the media stream;
– type of ITU-T H.248 statistic: *RTP packet loss* for audio in order to get feedback about GoS, and *RTP payload traffic volume* in octets for text as a measure for "characters". Furthermore, a performance metric such as information loss isn't really helpful for media type "text" due to enabled packet redundancy mode.

Hence, in order to reduce the cost of performance monitoring to the absolute minimum, following stream-level statistics might be considered ("the Statistics Descriptors would be inserted in the ITU-T H.248 transaction request in Step 10"):

```
Statistics{  ; Stream 2 = audio
 rtp/pl,     ; "RFC3550 packet loss" ingress
 recrtcp/rpl ; "RFC3550 packet loss" egress
}

Statistics{  ; Stream 3 = text
 rtpad/payloados, ; "T.140 text" octets sent
 rtpad/payloador  ; "T.140 text" octets recv.
}
```

Bibliography

[b-ITU-T F.703] Recommendation ITU-T F.703 (2000), *Multimedia conversational services*.

[b-ITU-T F.790] Recommendation ITU-T F.790 (2007), *Telecommunications accessibility guidelines for older persons and persons with disabilities*.

[b-ITU-T F.791] Recommendation ITU-T F.791 (2015), *Accessibility terms and definitions*.

[b-ITU-T G.711] Recommendation ITU-T G.711 (1988), *Pulse code modulation (PCM) of voice frequencies*.

[b-ITU-T H.248.57] Recommendation ITU-T H.248.57 (2014), *Gateway control protocol: RTP control protocol package*.

[b-ITU-T H.248.88] Recommendation ITU-T H.248.88 (2014), *Gateway control protocol: RTP topology dependent RTCP handling by ITU-T H.248 media gateways with IP terminations*.

[b-ITU-T H.248.95] Recommendation ITU-T H.248.95 (2015), *Gateway control protocol: H.248 Support for RTP multiplexing*.

[b-ITU-T H.248.97] Recommendation ITU-T H.248.97 (2015), *Gateway Control Protocol: H.248 support for control of SCTP bearer connections.*

[b-ITU-T H.Sup.13] Supplement ITU-T H.Suppl.13 (2015), *Gateway control protocol: Common ITU-T H.248 terminology – Release 2*.

[b-ITU-T T.140] Recommendation ITU-T T.140 (1988), *Protocol for multimedia application text conversation*.

[b-ITU-T V.18] Recommendation ITU-T V.18 (2000), *Operational and interworking requirements for DCEs operating in the text telephone mode*.

[b-ITU-T V.152] Recommendation ITU-T V.152 (2010), *Procedures for supporting voice-band data over IP networks*.

[b-ETSI EG 202 320] ETSI EG 202 320 Version 1.2.1 (2005), *Human Factors (HF); Duplex Universal Speech and Text (DUST) communications*.

[b-ETSI ETR 333] ETSI ETR 333 edition 2 (1998), *Human Factors (HF); Text Telephony; Basic user requirements and recommendations*.

[b-ETSI TS 122 226] ETSI TS 122 226 Version 9.0.0 (2010), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Global text telephony (GTT); Stage 1: Service description (3GPP TS 22.226 version 9.0.0 Release 9).*

[b-ETSI TS 123 226] ETSI TS 123 226 Version 9.0.0 (2010), *Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Global text telephony (GTT); Stage 2: Service description (3GPP TS 22.226 version 9.0.0 Release 9)*

[b-IANA group semantics] IANA registry for "Semantics for the "group" SDP Attribute". <http://www.iana.org/assignments/sdp-parameters/sdp-parameters.xhtml#sdp-parameters-13>

[b-IETF RFC 2198] IETF RFC 2198 (1997), *RTP Payload for Redundant Audio Data*.

[b-IETF RFC 4091] IETF RFC 4091 (2005), *The Alternative Network Address Types (ANAT) Semantics for the Session Description Protocol (SDP) Grouping Framework*.

[b-IETF RFC 4103] IETF RFC 4103 (2005), *RTP Payload for Text Conversation*.

[b-IETF RFC 7656] IETF RFC 7656 (2015), *A Taxonomy of Semantics and Mechanisms for Real-Time Transport Protocol (RTP) Sources*.

[b-IETF BUNDLE] IETF draft-ietf-mmusic-sdp-bundle-negotiation-23 (2015), *Negotiating Media Multiplexing Using the Session Description Protocol (SDP)*.

[b-IETF CLUESIG] IETF draft-ietf-clue-signaling-06 (2015), *CLUE Signaling*.

[b-IETF FLUTE] IETF draft-ietf-rmt-flute-sdp-03 (2012), *SDP Descriptors for FLUTE*.

[b-IETF RTPMUX] IETF draft-ietf-avtcore-rtp-multi-stream-09 (2015), *Sending Multiple Media Streams in a Single RTP Session*.

[b-IETF WEBTRANS] IETF draft-ietf-rtcweb-transports-10 (2015), *Transports for WebRTC*.

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