Forward Link Only Media Adaptation Layer Specification

ARIB STANDARD

ARIB STD-B49 Version 1.0

Version 1.0 November 5, 2010

Association of Radio Industries and Businesses

Forward

1. Introduction

With participation of radio communication equipment manufacturers, broadcasting equipment manufacturers, telecommunication operators, broadcasters and general equipment users, Association of Radio Industries and Businesses (ARIB) defines basic technical requirements for standard specifications of radio equipment, etc. as an "ARIB STANDARD" in the field of various radio systems.

In conjunction with national technical standards which are intended for effective spectrum utilization and avoidance of interference with other spectrum users, an ARIB STANDARD is intended as a standard for use by a private sector compiling various voluntary standards regarding the adequate quality of radio and broadcasting service, compatibility issues, etc., and aims to enhance conveniences for radio equipment manufacturers, telecommunication operators, broadcasting equipment manufacturers, broadcasters and general users.

An ARIB STANDARD herein is published as "Forward Link Only Media Adaptation Layer Specification." In order to ensure fairness and transparency in the defining stage, the standard was set by consensus of the standard council with participation of interested parties including radio equipment manufacturers, telecommunication operators, broadcasters, testing organizations, general users, etc. with impartiality.

It is our sincere hope that the standard would be widely used by radio equipment manufacturers, testing organizations, general users, etc.

2. Scope

This standard applies to the multimedia broadcasting defined in Section 2 of Chapter 3-2, Ordinance No.26 of the Ministry of Internal Affairs and Communications, 2003.

3. Standard References for Forward Link Only

The following list identifies the current version of the standards in the FLO family of standards.

Standard#	Title
STD-B47	Forward Link Only Air Interface Specification for Terrestrial Mobile Multimedia Multicast
STD-B48	Forward Link Only Transport Specification
STD-B49	Forward Link Only Media Adaptation Layer Specification
STD-B50	Forward Link Only Open Conditional Access (OpenCA) Specification
STD-B51	Forward Link Only System Information Specification
STD-B52	Forward Link Only Messaging Transport Specification
STD-B32	Video Coding, Audio Coding and Multiplexing Specifications for Digital Broadcasting*

*NOTE: The original document of this standard is Japanese version. Part 3 of this standard is not applicable to Forward Link Only system.

4. Industrial Property Rights

This standard does not describe industrial property rights mandatory to this standard. However, the right proprietor of the industrial property rights has expressed that "Industrial property rights related to this standard, listed in the annexed table below, are possessed by the applicator shown in the list. However, execution of the right listed in the annexed table below is permitted indiscriminately, without exclusion, under appropriate condition, to the user of this standard. In the case when the user of this standard possesses the mandatory industrial property rights for all or part of the contents specified in this standard, and when he asserts his rights, it is not applied."

Annexed Table (Selection of Option 2)

Patent Applicant/Holder	Name of Patent	Registration No./ Application No.	Remarks
QUALCOMM Inc.	A comprehensive confirmation form has been submitted with regard to ARIB STD-B49 Ver.1.0.		
JVC KENWOOD Holdings, Inc.	A comprehensive confirmation form has been submitted with regard to ARIB STD-B49 Ver.1.0.		

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FOREWORD

(This foreword is not part of this Specification.)

This document is the first version of this specification. It does not cancel or replace any other document either in whole or in part.

This Specification is intended for use in TM3 networks using ARIB STD-B47[19] and ARIB STD-B48 [20]. This Specification makes use of certain standards and recommendations defined by TIA and other bodies as listed in subclause 2.5.

The following Annexes to this Specification are normative: Annex A.

The following Annexes to this Specification are informative: None

No Text

1 INTRODUCTION AND SCOPE

This document specifies the Media Adaptation Layer for TM3 systems using the air interfaces specified in ARIB STD-B47 [19] and the Transport Layer specified in ARIB STD-B48 [20]. The document specifies the formats and procedures for delivering realtime, non-realtime and IP application data.

1.1 Document Organization

This document is organized into the following clauses:

Clause 1: An informative clause describing the scope and the organization of the document.

Clause 2: A normative clause defining compliance terminology, acronyms, definitions of terms, conventions for specifying data types, and references.

Clause 3: An informative clause providing an overview of the services provided by this Specification, the reference model assumed by this specification, and an overview of the protocol hierarchy.

Clause 4: A normative clause defining the protocols for synchronizing transport of real-time services and associated signaling.

Clause 5: A normative clause defining the protocols for file delivery for non-real-time services.

Clause 6: A normative clause defining the procedures for adapting the Transport Layer to support the IP Datacast Service.

Annex A is a normative Annex specifying configurable system parameters required for operation of the Media Adaptation Layer by the Device.

2 APPARATUS

2.1 Compliance Terminology

The key words “shall”, “shall not”, “should”, “should not”, “may”, “need not”, “can” and “cannot”, when used in this Specification, are to be interpreted as specified in the TIA Style Manual [18].

2.2 Symbols and Abbreviations

The following symbols and abbreviations are used in this Specification:

3GPP: 3rd Generation Partnership Project

DNS: Domain Name System

ESG: Electronic Services Guide

FASB: Fragmentation Across Superframe Boundaries

FDCP: File Delivery Control Protocol

FDCM: File Delivery Control Message

FDP: File Delivery Protocol

FDM: File Delivery Message

HE-AAC: High Efficiency Advanced Audio Coding

IANA: Internet Assigned Numbers Authority

IETF: Internet Engineering Task Force

IP: Internet Protocol

IPv4: Internet Protocol version 4

IPv6: Internet Protocol version 6

ISO: International Organization for Standardization

kbps: kilobits per second

LSB: Least Sigificant Bit

MIME: Multipurpose Internet Mail Extensions

MPEG: Moving Pictures Expert Group

MSB: Most Sigificant Bit

PSS: Packet-switched Streaming Service

PTS: Presentation Time Stamp

RAP: Random Access Point

RFC: Request For Comment

SAF: Simple Aggregation Format

TIA: Telecommunications Industry Association

TM3: Terrestrial Mobile Multicast Multimedia

UDP: User Datagram Protocol

UINT: Unsigned INTeger

2.3 Message Description Rules

The formats of messages specified in this document are defined as binary structures. The conventions for specifying binary structures are specified in subclause 2.3.1.

2.3.1 Binary Message Specifications

This subclause specifies the atomic data types used in this document and describes the general message formatting guidelines and ordering rules.

2.3.1.1 Message Specification Tables

A message is an ordered collection of fields. Messages are specified in tables. An example is shown in Table 1.

Table 1: Example Message Specification

Field Name	Field Type	Field Presence	Subclause Reference
FIELD_A	**UINT(8)**	**MANDATORY**	**[Field A subclause]**
FIELD_B	**BIT(1)**	**MANDATORY**	**[Field B subclause]**
FIELD_C	**FIELD_C_TYPE**	**CONDITIONAL**	**[Field C subclause]**

In the above example, the message has three fields, FIELD_A, FIELD_B and FIELD_C. The second column in the table defines the type of the field. For example, FIELD_A is of type UINT(8) and FIELD_B is a bit field of size 1 bit. UINT(8) and BIT(N) are basic types. The list of basic types is defined in subclause 2.3.1.3.

FIELD_C is of type FIELD_C_TYPE. FIELD_C_TYPE is a composite data type which is defined elsewhere by a similar table specifying its sub-fields.

The third column of the table specifies the rules for the presence of a field. Fields can be MANDATORY, CONDITIONAL or OPTIONAL.

The fourth column of the table identifies the subclause of this document where the field is specified.

2.3.1.2 Field Presence Classes

The possible Field Presence classes are specified in the following subclauses.

2.3.1.2.1 MANDATORY field

A MANDATORY field shall occur in every instance of the message.

2.3.1.2.2 CONDITIONAL field

The presence of a CONDITIONAL field is conditioned on the value of another field. The conditions under which the field is present are be specified in the subclause where the field is described.

2.3.1.2.3 OPTIONAL field

An OPTIONAL field may occur in an instance of the message, according to the requirements of the message source.

2.3.1.3 Basic Data Types

The following basic data types are used in this document.

2.3.1.3.1 UINT(n)

This is an n-bit unsigned integer. The possible range of values is 0 to $2^n - 1$. A field of this type may be restricted to a subset of these values.

2.3.1.3.2 BIT(n)

This is an n-bit pattern type.

2.3.1.3.3 INT(n)

This is an n-bit signed integer. Twos complement representation is used. The possible range of values is $-2^{(n-1)}$ to $2^{(n-1)} - 1$. A field of this type may be further restricted to a subset of this range.

2.3.1.4 Ordering Rules

Message fields are arranged in “little endian” order unless specifically stated otherwise. Bits are numbered from 1 to 8 in a byte, where bit 1 is the least significant bit. Bytes are numbered from 1 to N, where byte 1 is the least significant byte of an N-byte quantity.

For example, the ordering of the bits and bytes of a field of type UINT(32) is shown in Table 2. The least significant bit of the field is bit 1 of byte 1. The most significant bit is bit 8 of byte 4.

Table 2: Bit and Byte Order of UINT(32) Values

8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
							LSB	**1**
								2, 3
MSB								**4**

A more complex field type with two sub-fields is shown in Table 3.

Table 3: Example Complex Field Type

Field Name	Field Type	Field Presence
VALUE	**UINT(5)**	**MANDATORY**
INDEX	**UINT(5)**	**MANDATORY**

In this example, the bits are arranged as shown in Table 4. The VALUE field is listed in the table before the INDEX field. The bits of the VALUE field appear in the least significant bits of byte 1. The least significant bit of INDEX appears at bit 6 of byte 1 and the most significant bit appears in bit 2 of byte 2.

Table 4: Bit and Byte Order of Complex Field Type Example

8	7	6	5	4	3	2	1	
		LSB of INDEX	MSB of VALUE				LSB of VALUE	1
OTHER BITS…						MSB of INDEX		2

2.3.1.5 Byte Alignment

All messages shall contain an integer number of bytes. Padding bits shall be added to the last byte at the most significant end, if necessary.

Byte alignment of individual fields, if required, is specified on a case-by-case basis.

2.4 Definitions

The following definitions apply to capitalized terms used in this document:

Term	Definition
Base Layer Modulation Component	A set of modulation symbols reserved to transmit data for any Flow in a waveform conformant to **ARIB STD-B47** [19].
Device	Customer Equipment that can be activated to access Service in a Network.
Enhanced Layer Modulation Component	A set of modulation symbols reserved to transmit data for certain Flows in a waveform conformant to **ARIB STD-B47** [19] in addition to the Base Layer Modulation Component.
Flow	Logical stream within a Multiplex, typically used to deliver a single Media component of a Realtime Presentation, or a file containing a Non Real Time Presentation, or IP-based Messages.
Increment	Addition of 1.
IP Datacast	Content delivered using IPv4 [9] or IPv6 [17] to a defined IP multicast address.
IP Datacast Presentation	A Presentation consisting of IP Datacast content.
IP Datacast Service	A Service delivering IP Datacast Presentations.
Media	Formats for representing information, such as moving or still images, sound, or text, possibly associated with metadata used to assist in interpretation of the media content.
Media Frame	A logical unit of Media data which is presented in a defined interval of time.
Media Adaptation Layer	The protocols responsible for delivering Media of a specified type using the services of the Transport Layer.
Message Coding	A scalable method to combat packet loss while efficiently and reliably delivering files to Devices in a mobile multicast environment.
MIME Type	A media type delivered in a Non Real Time or IP Datacast Presentation and the associated metadata identifying it according to the conventions of RFCs 2045 – 2049 ([12] - [16]).
Multiplex	A set of Flows available in a given signal conformant to **ARIB STD-B47** [19] and **ARIB STD-B48** [20]. The signal may contain more than one Multiplex.

Term	Definition
Network	A wireless multicast network using **ARIB STD-B47** [19] and **ARIB STD-B48** [20].
Non Real Time Service	A Service delivering file-based content.
Presentation	A set of media segments which may be presented to the user concurrently and/or consecutively.
Real Time Presentation	A Presentation consisting of Media that is presented to the user as it is received and processed, and which need not be stored for later retrieval.
Real Time Service	A Service delivering content consisting entirely of Real Time Presentations.
Service	A service is an aggregation of one or more Flows and offers a sequence of Presentations.
Superframe	The portion of a signal conformant to **ARIB STD-B47** [19] for a specific second.
Transport Layer	The protocol layers specified in ARIB STD-B48 [20].
Transport Layer Service Packet	The unit of data provided to the Transport Layer for transport over the Network and delivery to a process on the Device as an integral unit.

2.5 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this Specification. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Specification are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. ANSI and TIA maintain registers of currently valid national standards published by them.

[1] 3GPP[1] TS 26.245. *Transparent end-to-end packet switched streaming service (PSS): timed text format (Release 6)*, 2004.

[2] ITU-T Recommendation H.264 | ISO/IEC 14496-10. *Information technology -- Coding of audio-visual objects -- Part 10: Advanced Video Coding*, 2005.

[3] ISO/IEC 14496-3. *Information technology -- Coding of audio-visual objects -- Part 3: Audio*, 2001.

[4] ISO/IEC 14496-20. *Information technology -- Coding of audio-visual objects -- Part 20: Lightweight Application Scene representation (LASeR) and Simple Aggregation Format (SAF)*, 2006

[5] RFC[2] 3452[3]. Luby, Michael; Vicisano, Lorenzo; Gemmell, Jim; Rizzo, Luigi; Handley, Mark; Crowcroft, Jon., *Forward Error Correction (FEC) Building Block*, 2002.

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[1] 3GPP specifications are issued by the Third Generation Partnership Program (3GPP). The address of 3GPP is: ETSI Mobile Competence Centre, 650, route des Lucioles, 06921 Sophia-Antipolis Cedex, France.

[2] RFCs are issued by the Internet Engineering Task Force (IETF). The address of the IETF is: IETF Secretariat, c/o Corporation for National Research Initiatives, 1895 Preston White Drive, Suite 100, Reston, VA 20191-5434, USA.

[6] RFC 3695. Luby, Michael; Vicisano, Lorenzo., *Compact Forward Error Correction (FEC) Schemes*, 2004.

[7] RFC 3926. Paila, Toni; Luby, Michael; Lehtonen, Rami; Roca, Vincent; Walsh, Rod., *FLUTE – File Delivery over Unidirectional Transport,* 2004.

[8] RFC 768. Postel, Jon B., *User datagram protocol*, 1980.

[9] RFC 791. Postel, Jon B., *Internet protocol*, 1981.

[10] RFC 1035. Mockapetris, Paul V., *Domain names – implementation and specification*, 1987.

[11] RFC 1112. Deering, Stephen E., *Host extensions for IP multicasting*, 1989.

[12] RFC 2045. Freed, Ned; Borenstein, Nathaniel S., *Multipurpose internet mail extensions (MIME) part one: Format of message bodies*, 1996.

[13] RFC 2046. Freed, Ned; Borenstein, Nathaniel S., *Multipurpose internet mail extensions (MIME) part two: Media types*, 1996.

[14] RFC 2047. Moore, Keith, *MIME (multipurpose internet mail extensions) part three: Message header extensions for non-ASCII text*, 1996.

[15] RFC 2048. Freed, Ned; Borenstein, Nathaniel S.; Postel, Jon D., *MIME (multipurpose internet mail extensions) part four: Registration procedures*, 1996.

[16] RFC 2049. Freed, Ned; Borenstein, Nathaniel S., *MIME (multipurpose internet mail extensions) part five: Conformance criteria and examples*, 1996.

[17] RFC 2450. Deering, Stephen E.; Hinden, Robert M., *Internet protocol, version 6 (IPv6) specification*, 1998.

[18] TIA[4] Engineering Committee Recommendation. *TIA style manual (Internet Version),* 1992.

[19] ARIB STD-B47 , *Forward Link Only Air Interface Specification for Terrestrial Mobile Multimedia Multicast*.

[20] ARIB STD-B48 , *Forward Link Only Transport specification*.

[21] Ordinance No.26 of the Ministry of Internal Affairs and Communications, 2003.

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[3] The internet draft, draft-ietf-rmt-fec-bb-revised-07 has been approved to supersede RFC 3452.

[4] TIA Standards and recommendations are issued by the Telecommunications Industry Association (TIA). The address of the TIA is: Telecommunications Industry Association, 2500 Wilson Blvd., Suite 300, Arlington, VA 22201 USA

3 MEDIA ADAPTATION LAYER OVERVIEW

3.1 Introduction

TM3 Networks efficiently distribute broadband multimedia content over multicast wireless networks to mobile devices supporting large numbers of subscribers. This document specifies the protocols for delivering content in TM3 Networks conforming to ARIB STD-B47 [19] and ARIB STD-B48 [20].

3.2 Types of Service

There are three types of Service supported by TM3 Networks conforming to ARIB STD-B47 [19] and ARIB STD-B48 [20]:

– Real-Time Service

– Non Real-Time Service

– IP Datacast Service

3.2.1 Real-Time Service

The Real-Time Service delivers streaming content to the Device which is presented to the user in real-time as it is received. A typical real-time service provides streaming video and audio, possibly associated with timed text such as closed captioning. The end-user can “tune-in” to a Real-Time Service at any time and receive current content. The user will typically need to subscribe to a Real-Time Service before gaining access.

3.2.2 Non Real-Time Service

The Non Real-Time Service delivers content to the Device in files. These typically contain media clips, consisting of audio and video, but may contain any other type of data. Once the user has subscribed to the Service, the content is delivered to the user’s mobile Device in the background, transparently to the user. The media is stored on the Device for later retrieval.

3.2.3 IP Datacast Service

The IP Datacast Service multicasts a stream of IP datagrams over the wireless interface. It may be used to support a wide range of applications. This service type allows the Network operator and/or third-parties to deliver multicast content using IETF protocols over the Network. As with Real-Time and Non Real-Time Services, the user will typically need to subscribe to an IP Datacast Service before gaining access.

3.3 Reference Model

The reference model for the Media Adaptation Layer is shown in Figure 1. The Network delivers content to the Devices as a sequence of application service packets over the Transport Layer specified in ARIB STD-B48 [20].

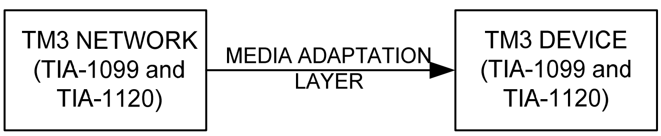

Figure 1: Media Adaptation Layer Reference Architecture

This document specifies protocols for unidirectional delivery of content between two components of a TM3 system over the air interface specified in ARIB STD-B47 [19] and the Transport Layer specified in ARIB STD-B48 [20]:

– The Device

– The Network

3.3.1 The Device

The Device is any device capable of receiving and interpreting content delivered over the Network using an air interface conformant to ARIB STD-B47 [19] and a transport layer conforming to ARIB STD-B48 [20]. Typically, it has an integrated receiver that allows it to detect and acquire the waveform, and to process the content transmitted over it to deliver it in a form intelligible to the user (e.g. as video or audio).

3.3.2 The Network

The Network transmits content to the Devices.

The tasks performed by the Network in support of Media Adaptation include:

– Delivery of content to the Transport Layer specified in ARIB STD-B48 [20].

– Encryption within the Transport Layer to support Conditional Access.

– Formation and transmission of a waveform conformant to ARIB STD-B47 [19] for reception by the Device.

3.4 Media Adaptation Protocol Architecture

Media Adaptation is provided by a suite of protocols and procedures. There is a separate protocol for each identified class of content: Real-time, Non Real-time and IP Datacast. Media Adaptation is conducted by messages sent by the Network to the Device over the Transport Layer. The primary purpose of the Media Adaptation layer is to adapt different classes of service data to the common Transport Layer.

The layering architecture of the Media Adaptation Protocol stack is shown in Figure 2. The Media Adaptation protocols are those implementing the layers highlighted between the dark solid lines. The Media Adaptation protocols use the services provided by the Transport Layer [20]. The application layers use the services of the Media Adaptation protocol appropriate to the class of content appropriate to the particular application. The organization of the application layers shown in Figure 2 is representative of a Device or Network supporting all three classes of service, where files delivered over the File Delivery Layer may contain clips of streaming media content.

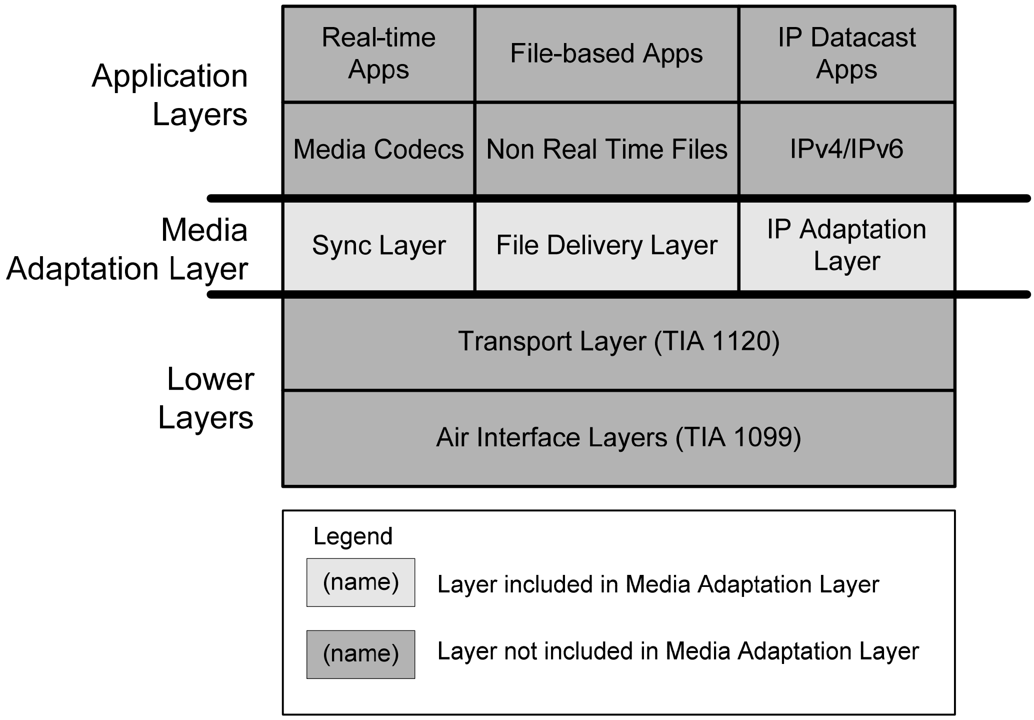

Figure 2: Media Adaptation Protocol Layer Architecture

Networks based on ARIB STD-B47 [19] and ARIB STD-B48 [20] may implement the Media Adaptation protocols specified in this document, as appropriate to their requirements.

3.4.1 Services Provided to the Media Adaptation Layer

The Media Adaptation protocols specified in this document assume the services supplied by the Transport Layer specified in ARIB STD-B48 [20]. The Transport Layer provides the Devices with access to a set of Flows. Each Flow transports the packets for a logical data stream delivered over the Transport Layer in the order presented by the Network for each Flow. The Transport Layer optionally groups packets for delivery on a second-by-second basis in a ARIB STD-B47 Superframe, and also provides optional error protection by CRC, and optional encryption and decryption services which may be used to support Conditional Access.

3.4.2 Services Provided by the Media Adaptation Layer

Media Adaptation protocols supply protocol adaptations that are specific to the class of content being transported. Accordingly, they are classified according to service Type.

The Sync Layer provides synchronization within and between real-time Flows such as video, audio and timed data when transmitted by the Network. The Sync Layer is specified in Clause 4.

The File Delivery Layer delivers files reliably over the Network. The File Delivery Layer is specified in Clause 5.

The IP Adaptation Layer manages the transport of IP packets over the Transport Layer and the mappings of IP Addresses to Flow IDs used to deliver IP Datacast Services over the Network. The IP Adaptation Layer is specified in Clause 6.

3.5 Media Adaptation Configurable System Parameters

In addition to specifying the protocols and message formats required to implement the Media Adaptation layer, this document identifies certain parameters related to the operation of Media Adaptation protocols by the Device. The parameters, the recommended values and the ranges of these parameters are specified in Annex A. The means by which these parameters are set are outside the scope of this Specification.

4 REAL-TIME SERVICE

4.1 Introduction

The Network delivers three types of content: Real-Time, Non Real-Time and IP Datacast. This clause specifies the Sync Layer, which is the Media Adaptation protocol for delivery of Real-Time Service.

4.1.1 Overview of Real-Time Service

The Network supports continuous realtime delivery of streaming content to the Device. Each content stream is delivered as a separate Flow. The Network additionally provides data allowing the Devices to synchronize the real time media streams with each other and with the presentation timing requirements of the content. The layer for combining media streams and synchronization data is known as the Sync Layer. The relationship between Sync Layer messages and real-time media streams output by the Device is shown in Figure 3.

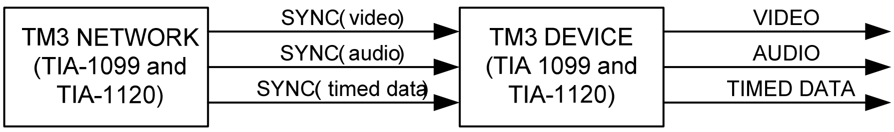

Figure 3: Real-Time Service Model

A Device required to access a Real-Time Service selects the appropriate Flows and plays the received streams. The timing and the synchronization of the presentation of these streams to the media codecs in the Device are controlled by the protocols specified in this clause.

4.1.2 Protocol Architecture

The protocol architecture of a Real-Time Service is shown in Figure 4.

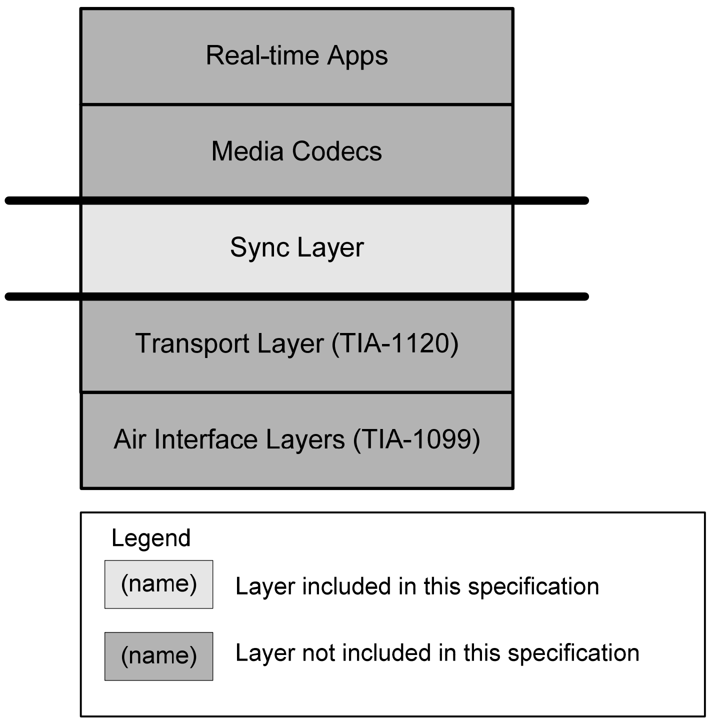

Figure 4: Real-Time Service Protocol Layers

A Real-Time application makes use of the services of two sub-layers: the Media Codec Layer and the Sync Layer.

The Media Codec Layer supports media-specific codecs, e.g. video and audio codecs. These are outside the scope of this specification. A Media Codec supplies a sequence of Media Frames to the Sync Layer in the Network. Each Media Frame is identified by a Presentation Time Stamp (PTS), which specifies the time at which the Media Frame is to be presented, and an associated Frame ID, which identifies the relative position of the Media Frame in the sequence of Frames within the Superframe. A video source codec may generate multiple Media Frames with the same PTS and Frame ID within a Superframe.

For certain media types, notably video, the Media Codec Layer in the Network may also supply content enhancements such as rich media or metadata to the Sync Layer. For example, the video media codec may supply a video sync layer directory which the Sync Layer in the Device may use to assist in acquiring and recovering the sequence of Media Frames to be delivered to the Media Codec Layer in the Device.

The Sync Layer is responsible for adapting the Media Frames as required according to media type, and for providing media synchronization and presentation timing. The Sync Layer transports a sequence of Sync Layer Packets. A Sync Layer Packet conveys either a Media Frame or a Sync Layer Adaptation Frame, as described below. A Sync Layer Packet conveying a Media Frame is formed by adding a Sync Header to the Media Frame. The Sync Header consists of a Media Type, a Media Common Header, and a Media Specific Header, as defined in subclause 4.5.

Additionally, the Sync Layer may convey content enhancements such as metadata specific to each media type. Metadata is conveyed in two ways. First, as noted, media-specific extensions may be included in the Sync Header of Sync Layer Packets. Second, Sync Layer Packets may be used to convey Sync Layer Adaptation Frames which are generated within the Sync Layer and interleaved between Sync Layer Packets conveying Media Frames in the same Flow. Sync Layer Adaptation Frames may also be used to convey enhanced content such as rich media. Different types of Sync Layer Adaptation Frames are identified by a Sync Layer Adaptation Type in the Sync Header for the Sync Layer Application Frame.

The relationship between Sync Layer Packets and the Media Frames is illustrated in Figure 5.

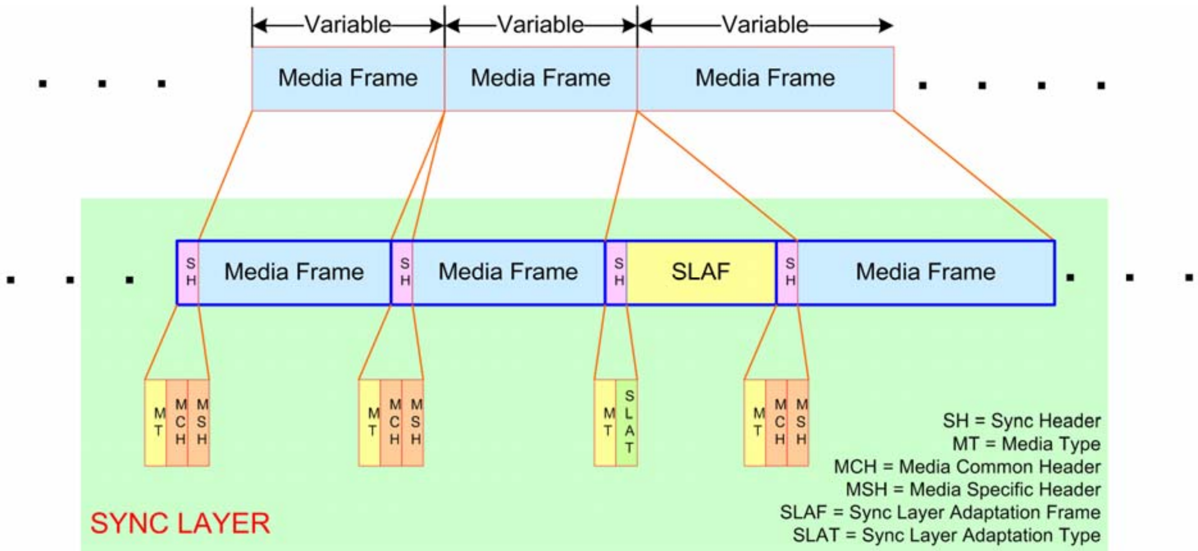

Figure 5: Relationship between Media Frames and Sync Layer Packets

4.2 Real Time Flow Configuration Options

For Flows providing Real Time data the Flow Configuration options of the FlowBLOB field specified in subclause 5.3.1 of the Transport Layer [20] shall be configured as follows:

– FASB_ALLOWED: not selected

– CHECKSUM_ACTIVE: configurable

– STREAM_ENCRYPTION_ACTIVE: configurable

4.3 Media Codec and Transport Layer Interfaces

A Real Time Service may consist of more than one type of streaming component, e.g. video, audio and text used for commentary or closed captioning, possibly in multiple language streams. Each streaming component shall be conveyed in a separate Flow.

Each type of content is encoded and formatted appropriately. Three types of streaming content are supported:

– Video, e.g. H.264 [2]

– Audio, e.g. HE-AAC version 2 [3].

– Timed Data, e.g. 3GPP PSS Timed Text [1].

Sync Layer Adaptation Frames conveying either metadata or other content enhancements associated with the Flow are considered as a fourth content type. A Flow may consist entirely of Sync Layer Adaptation Frames. Alternately, Sync Layer Adaptation Frames may be multiplexed within the Flows with which they are associated. The restrictions on transport of Sync Layer Adaptation Frames, if any, depend on the type of Sync Layer Adaptation Frame.

The Media Codec Interface in the Network supplies a sequence of Media Frames to the Sync Layer. In the Device, the Sync Layer supplies a sequence of Media Frames to the Media Codec. The Media Frames shall be aligned to byte boundaries when passed across the interface between the Sync Layer and the Media Codec Layer in both the Device and the Network.

The Sync Layer in the Network adds Sync Layer Headers to the Media Frames to create Sync Packets, interleaves them with Sync Packets delivering Sync Layer Adaptation Frames as appropriate for the type of Sync Layer Adaptation Frame, and delivers the resultant Sync Packets to the Transport Layer for transmission. Sync Packets may be transmitted in either the Base Layer modulation component or the Enhanced Layer modulation component of the Transport Layer, subject to any restrictions specified for a specific Media Codec Layer.

The Sync Layer in the Device delivers Media Frames to the Media Codec Layer in increasing order of Frame ID in each Superframe. The delivery order of video Media Frames is subject to certain additional constraints in the case where there is more than one video Media Frame with the same Frame ID, as defined in subclause 4.3.1.4.

The maximum size of a Media Frame shall not exceed P_{MAX_RT} bytes, where P_{MAX_RT} is a configurable system parameter. See Annex A for further details.

The following subclauses specify the adaptation of the Service Packets provided by the Media Codecs for transport over the Sync Layer for each Media Type, and the media-specific interactions of the Sync Layer with the Transport Layer.

4.3.1 Video Content

4.3.1.1 Network Media Codec Interface for Video Content

For each Superframe, the Media Codec Layer shall indicate to the Sync Layer the number of video Media Frames which it wishes to be presented to the user.

Video frames consist of an integral number of bytes. Therefore it is not necessary to provide byte alignment for a video Media Frame.

The Media Codec Layer shall present video frames to the Sync Layer in decode order. The Media Codec Layer shall provide the following metadata to the Sync Layer with each video frame:

– The PTS and Frame ID,

– Whether the frame is a Random Access Point (RAP), which the Device may use to acquire the video stream

– Whether the frame is a reference frame

– Whether the frame contains essential video information or additional video information. The criteria by which video information is determined to be essential or additional are determined by the Media Codec Layer.

– Whether the frame is intended for transmission in the Base Layer modulation component or the Enhanced Layer modulation component

The value of the Frame ID shall be set to zero for the first video frame in the Superframe. It shall either Increment or remain the same for each subsequent video frame presented to the Sync Layer, up to and including the number of Media Frames to be presented by the Device.

The delivery of frames with the same Frame ID across the interface is subject to the following restrictions:

– If the Media Codec Layer generates one or more frames with the RAP flag set ("RAP Frames") and one or more non-RAP Frames with the same Frame ID, it shall present the RAP Frame(s) to the Sync Layer before the non-RAP frames.

– If the Media Codec Layer generates two frames for the same Frame ID which differ only in the level of video information (see subclause 4.5.2.1.3), the frame containing essential information shall be transmitted in the Base Layer modulation component and the frame containing additional information shall be transmitted in the Enhanced Layer modulation component.

4.3.1.2 Network Transport Layer Interface for Video Content

The Sync Layer shall group the Sync Packets conveying video frames according to whether they are transmitted in the Base Layer or the Enhanced Layer modulation component. Each group shall be processed separately.

The Sync Layer shall provide the Sync Packets for each group to the Transport Layer in increasing order of Frame ID. Two Sync Packets with the same Frame ID in the same modulation component shall be provided to the Transport Layer in the order they were received from the Media Codec Layer.

4.3.1.3 Device Transport Layer Interface for Video Content

The Device shall recover Sync Packets transmitted in the Base Layer and the Enhanced Layer modulation components, and shall recover the order in which they are to be delivered across the Device Media Codec interface by processing them together.

4.3.1.4 Device Media Codec Interface for Video Content

The Sync Layer in the Device shall present video Media Frames to the Media Codec Layer in decode order, as determined from the Frame ID, subject to the following additional restrictions:

If the Sync Layer detects a RAP Frame and one or more non-RAP frame(s) with the same Frame ID, then:

– If the Sync Layer has not acquired the video stream, it shall deliver the RAP Frame across the Media Codec Interface, and shall discard the non-RAP Frame(s), as specified in subclause 4.3.4.

– Otherwise, the Sync Layer shall discard the RAP Frame and shall deliver the non-RAP Frame(s) across the Media Codec Interface, as appropriate.

If the Sync Layer detects two video Media Frames with identical Sync Layer Headers, it shall deliver the frame received in the Enhanced Layer modulation component to the Media Codec Layer and discard the Media Frame received in the Base Layer modulation component.

If the Sync Layer detects a video Media Frame with essential video information, and a second video Media Frame with the same Frame ID and additional video information, then:

– If the Media Codec Layer does not support processing of additional video information, the Sync Layer shall discard the additional video Media Frame and deliver the video Media Frame with essential video information to the Media Codec Layer

– Otherwise, the Sync Layer shall deliver both video Media Frames to the Media Codec Layer.

4.3.2 Audio Content

4.3.2.1 Network Media Codec Interface for Audio Content

Audio frames are generated at a fixed rate according to the type of audio codec in use. However, the audio frame rate may not be an integral multiple of the Superframe rate. Hence for each Superframe, the Media Codec Layer shall indicate to the Sync Layer the number of Media Frames which it wishes to be presented.

A Frame ID shall be associated with each audio frame presented to the Sync Layer. The Frame ID may be assigned by either the Media Codec Layer or the Sync Layer. The value of the Frame ID shall be set to zero for the first audio frame in the Superframe. The value shall Increment for each subsequent audio frame presented to the Sync Layer, up to and including the number of Media Frames to be presented by the Device.

The Media Codec Layer in the Network shall present audio frames to the Sync Layer in the order they are generated.

An audio frame may consist of a non-integer number of bytes. The Media Codec Layer shall achieve byte-alignment according to the means specified for the type of audio codec in use.

The Media Codec Layer shall provide the following metadata to the Sync Layer in association with each audio frame:

– The Frame ID, if it is assigned by the Media Codec Layer

– Whether the frame is a RAP frame

– Whether the frame contains essential audio information or additional audio information. The criteria by which audio information is determined to be essential or additional are determined by the Media Codec Layer.

4.3.2.2 Network Transport Layer Interface for Audio Content

Sync Packets containing audio frames shall be transmitted in the modulation component directed by the Media Codec Layer. The audio frames received within each modulation component shall be presented to the Transport Layer in the order they are generated.

4.3.2.3 Device Transport Layer Interface for Audio Content

The Sync Layer in the Device shall process Sync Packets in the order they are received across the Transport Layer interface.

4.3.2.4 Device Media Codec Interface for Audio Content

The Sync Layer in the Device shall present audio frames to the Media Codec Layer in the order they are extracted from the Sync Packets.

4.3.3 Timed Data Content

4.3.3.1 Network Media Codec Interface for Timed Data Content

Timed Data frames are generated at a variable rate. Typically, but not necessarily, there is at most one Timed Data frame per Superframe in a Timed Data Flow.

A Frame ID shall be associated with each timed data frame presented to the Sync Layer. The Frame ID may be assigned by either the Media Codec Layer or the Sync Layer. The value of the Frame ID shall be set to zero for the first timed data frame in the Superframe. The value shall Increment for each subsequent timed data frame presented to the Sync Layer, up to and including the number of Media Frames to be presented by the Device.

The Media Codec Layer in the Network shall present Timed Data frames to the Sync Layer in the order they are generated.

Timed Data frames may consist of a non-integer number of bytes. Byte-alignment shall be achieved according to the means specified for the type of timed data in use.

The metadata provided by the Media Codec Layer to the Sync Layer in association with each timed data frame, if any, is dependent on type of data.

4.3.3.2 Network Transport Layer Interface for Timed Data Content

Sync Packets containing timed data frames shall be transmitted in the modulation component directed by the Media Codec Layer. The timed data frames received within each modulation component shall be presented to the Transport Layer in the order they are generated.

4.3.3.3 Device Transport Layer Interface for Timed Data Content

The Sync Layer in the Device shall process Sync Packets in the order they are received across the Transport Layer interface.

4.3.3.4 Device Media Codec Interface for Timed Data Content

The Sync Layer in the Device shall present timed data frames to the Media Codec Layer in the order they are extracted from the Sync Packets.

4.3.4 Sync Layer Adaptation Frame Content

4.3.4.1 Network Media Codec Interface for Sync Layer Adaptation Frame Content

Certain types of Sync Layer Adaptation Frame, such as the SAF Frame specified in subclause 4.6.2, may transport Media Frames. A Media Codec interface shall be supplied in the Network to support the delivery of such Sync Layer Adaptation Frames. The Media Codec delivers the

Media Frames to the Sync Layer in an order appropriate to the specific type of Sync Layer Adaptation Frame.

Other Sync Layer Adaptation Frames, such as the Video Sync Layer Directory Frame specified in subclause 4.6.1, are generated within the Sync Layer. These do not require the provision of a Media Codec Interface in the Network.

There is no Frame ID in a Sync Layer Adaptation Frame header. Therefore no Frame ID shall be associated with Media Frames presented to the Sync Layer intended for transport in a Sync Layer Adaptation Frame.

If a Media Frame intended for transport in a Sync Layer Adaptation Frame consists of a non-integer number of bytes, byte-alignment shall be achieved according to the means specified for the type of Media Frame.

The metadata provided by the Media Codec Layer to the Sync Layer in association with each Media Frame intended for transport in a Sync Layer Adaptation Frame, if any, is dependent on the type of Media Frame.

4.3.4.2 Network Transport Layer Interface for Sync Layer Adaptation Frame Content

Sync Layer Adaptation Frames which transport Media Frames shall be transmitted in the modulation component directed by the Media Codec Layer. Sync Layer Adaptation Frames which are generated within the Sync Layer shall be transmitted in the modulation component(s) specified for the specific type of Sync Layer Adaptation Frame. The Sync Layer Adaptation Frames received within each modulation component shall be presented to the Transport Layer in the order they are generated.

4.3.4.3 Device Transport Layer Interface for Sync Layer Adaptation Frame Content

The Sync Layer in the Device shall process Sync Packets in the order they are received across the Transport Layer interface.

4.3.4.4 Device Media Codec Interface for Sync Layer Adaptation Frame Content

The Sync Layer in the Device shall process Sync Layer Adaptation Frames which do not contain Media Frames as specified for each type of Sync Layer Adaptation Frame. Media Frames transported in Sync Layer Adaptation Frames shall be presented to the Media Codec Layer in the order they are extracted from the Sync Packets.

4.4 Sync Layer Acquisition

Figure 6 shows the state machine for processing the Sync Layer for an individual Flow in the Device.

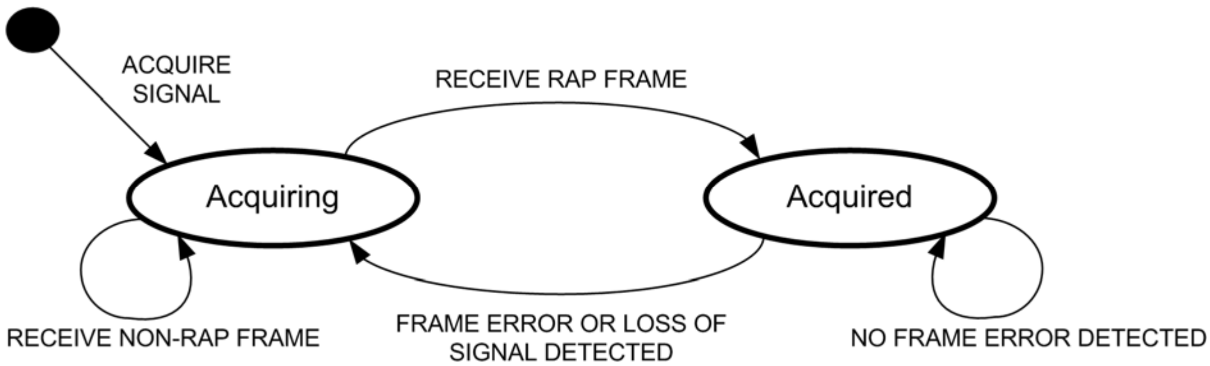

Figure 6: Sync Layer State Machine in Device

The following subclauses describe the transitions between each state and the processing undertaken in each state.

4.4.1 Acquiring State

The Device shall enter the Acquiring state in any of the following circumstances:

- Initial acquisition of the signal
- Loss of signal when in the Acquired State
- Detection of a Media Frame with errors while in the Acquired State

Errors may be signaled to the Sync Layer by the Transport Layer if they are detected at a lower layer or are detected by the CRC in the Transport Layer, if CRC processing is configured (see subclause 4.2). In the case of video, the Device may use information provided by the Video Sync Layer Directory (see subclause 4.6.1), if available, to determine the nature of the Media Frames affected by the error. The Device may be able to determine that error recovery procedures are possible without reentering the Acquiring State.

While in the Acquiring State, the Device shall process Media Frames provided by the Transport Layer. Media Frames which are not valid RAP Frames shall be discarded.

4.4.2 Acquired State

On receipt of a RAP Frame that is not in error, the Device shall enter the Acquired State.

While in the Acquired State, the Device shall process Media Frames provided by the Transport Layer. Valid Media Frames shall be delivered to the Media Codec Layer. See subclauses 4.3.1.4, 4.3.2.4,4.3.3.4 and 4.3.4.4 for further detail.

4.5 Sync Header

The general format of the Sync Header is shown in Table 5.

Table 5: General Format of Sync Layer Header

Field Name	Field Type	Field Presence	Subclause Reference
MEDIA_TYPE	UINT(2)	MANDATORY	4.5.1
Additional Fields	Variable	MANDATORY	4.5.2

The Sync Header consists of a Media Type field followed by additional fields whose format depends on the value of the Media Type field.

4.5.1 MEDIA_TYPE

The MEDIA_TYPE field identifies the type of Media Frame carried by the Sync Layer Packet, or that the Sync Layer Packet is carrying an Adaptation Frame. The defined values for MEDIA_TYPE are listed in Table 6:

Table 6: Defined values for MEDIA_TYPE

Name	Value	Subclause Reference
VIDEO	00	4.5.2.2.1
AUDIO	01	4.5.2.2.2
TIMED_DATA	10	4.5.2.2.3
ADAPTATION	11	4.6

4.5.2 Additional Fields

The format of the additional fields depends on the value of the Media Type field.

The general format of header fields for Sync Packets transporting video, audio or timed data Media Frames is shown in Table 7.

Table 7: General Format of Additional Fields for Sync Layer Header for Media Frames

Field Name	Field Type	Field Presence	Subclause Reference
Common Media Header	BIT(22)	MANDATORY	4.5.2.1
Media-Specific Header	Variable	CONDITIONAL	4.5.2.2

The general format of header fields for Sync Packets transporting Adaptation Frames is shown in Table 8.

Table 8: General Format of Additional Fields for Sync Layer Header for Sync Layer Adaptation Frames

Field Name	Field Type	Field Presence	Subclause Reference
SL_ADAPTATION_TYPE	UINT(6)	MANDATORY	4.5.2.3

4.5.2.1 Common Media Header

This subclause specifies the format of the Common Media Header for Sync Layer Packets carrying Media Frames.

The Common Media Header provides the following information:

- Time stamp and media Frame ID information.
- Information level indicator.
- Random Access Points in the continuous stream of data. This supports rapid acquisition of Audio, Video and Timed Text streams.

The format of the Common Media Header is shown in Table 9.

Table 9: Format of the Common Media Header

Field Name	Field Type	Field Presence	Subclause Reference
PTS	UINT(14)	MANDATORY	4.5.2.1.1
FRAME_ID	UINT (6)	MANDATORY	4.5.2.1.2
INFORMATION_LEVEL_FLAG	BIT(1)	MANDATORY	4.5.2.1.3
RAP_FLAG	BIT(1)	MANDATORY	4.5.2.1.4

The individual fields of the Common Media Header are defined in the following subclauses.

4.5.2.1.1 PTS

The PTS field is the Presentation Time Stamp of the Media Frame. This field is specified in units of milliseconds. The PTS field is added to the Superframe Time to get the actual time at which the Media Frame is to be presented.

4.5.2.1.2 FRAME_ID

The FRAME_ID is the number of the Media Frame within the Superframe. The number is set to 0 for the first Media Frame within the Superframe and Incremented for each subsequent Media Frame which has a different value for PTS from that of the preceding Media Frame in the Superframe.

4.5.2.1.3 INFORMATION_LEVEL_FLAG

The INFORMATION_LEVEL_FLAG is a bit that indicates whether the Media Frame conveys essential information for the Media Frame or additional information that may be combined with essential information.

If the Media Frame conveys essential information, the INFORMATION_LEVEL_FLAG shall be set to 0.

If the Media Frame conveys additional information, the INFORMATION_LEVEL_FLAG shall be set to 1.

The definition of essential and additional information is codec-dependent. If the media codec does not support an additional information level, the INFORMATION_LEVEL_FLAG shall be set to 0 and the field shall be ignored by the Device.

4.5.2.1.4 RAP_FLAG

The RAP_FLAG signals whether the Media Frame is a random access point. The Device may use the RAP_FLAG during reacquisition or channel switching to determine whether it can begin to access the media stream with this Media Frame.

If the MEDIA_TYPE is set to VIDEO or AUDIO, and if the Media Frame is a random access point, the RAP_FLAG shall be set to 1.

If the MEDIA_TYPE is set to VIDEO or AUDIO, and if the Media Frame is not a random access point, the RAP_FLAG shall be set to 0.

If the MEDIA_TYPE is set to TIMED_DATA, the RAP_FLAG shall be set to 1 on all Media Frames.

4.5.2.2 Media-Specific Headers

This subclause specifies the formats of the Media-Specific Header for Sync Layer Packets carrying Media Frames, according to Media Type.

4.5.2.2.1 Video Media Header

The Media-Specific Header for Sync Layer Packets carrying video media frames is the Video Media Header. The format of the Video Media Header is specified in Table 10.

Table 10: Video Media Header

Field Name	Field Type	Field Presence	Subclause Reference
RESERVED	UINT(3)	MANDATORY	4.5.2.2.1.2
UNREFERENCED_FRAME_FLAG	BIT(1)	MANDATORY	4.5.2.2.1.1
RESERVED	UINT(4)	MANDATORY	4.5.2.2.1.2

The individual fields of the Video Media Header are defined in the following subclauses.

4.5.2.2.1.1 UNREFERENCED_FRAME_FLAG

The UNREFERENCED_FRAME_FLAG is a bit that indicates whether the Media Frame is used as a reference in the reconstruction of other Media Frames. The bit allows Media Frames to be dropped without processing in certain circumstances (e.g. Fast Forward).

If the Media Frame is a reference frame, the UNREFERENCED_FRAME_FLAG shall be set to 0.

If the Media Frame is not a reference frame, the UNREFERENCED_FRAME_FLAG shall be set to 1.

4.5.2.2.1.2 RESERVED

The value of all RESERVED bits should be set to 0.

4.5.2.2.2 Audio Media Header

There is no Media-Specific Header for Sync Layer Packets carrying audio media frames.

4.5.2.2.3 Timed Data Media Header

The Media-Specific Header for Sync Layer Packets carrying timed data media frames is the Timed Data Media Header. The format of the Timed Data Media Header is specified in Table 11.

Table 11: Format of the Timed Data Media Header

Field Name	Field Type	Field Presence	Subclause Reference
TIMED_DATA_TYPE	UINT(8)	MANDATORY	4.5.2.2.3.1

4.5.2.2.3.1 TIMED_DATA_TYPE

The TIMED_DATA_TYPE field identifies the specific type of data in the TIMED_DATA Media Frame. The defined values for TIMED_DATA_TYPE are given in Table 12.

Table 12: Defined Values for TIMED_DATA_TYPE

Name	Value
CHARACTER_TEXT	0
The values 1 through 255 are reserved.	

4.5.2.3 SL_ADAPTATION_TYPE

The SL_ADAPTATION_TYPE field specifies the type of Sync Layer Adaptation Data in the Sync Layer Adaptation Frame. The defined values of the SL_ADAPTATION_TYPE field are specified in Table 13.

Table 13: Defined values for SL_ADAPTATION_TYPE

Name	Value
VIDEO_SYNC_LAYER_DIRECTORY	1
SAF_FRAME	2
Reserved for Future Use	3-46
Not Available for Use	47-63

4.6 Sync Layer Adaptation Frames

The structure of the body of the Sync Layer Adaptation Frame is dependent on the Sync Layer Adaptation Type. The following subclauses specify the body of the Adaptation Frame from each Sync Layer Adaptation Type specified in Table 13.

4.6.1 Video Sync Layer Directory

The Video Sync Layer Directory is an optional Sync Layer Adaptation Frame which may be used by the Sync Layer in the Device to assist the video codec in error recovery. For example, it may allow the Sync Layer to determine whether a lost or corrupt frame was intended to be a reference frame. This knowledge may permit the video codec to determine whether subsequent frames up to the next reference frame should be possessed or discarded.

The Video Sync Layer Directory, if present, shall be transported as a Sync Layer Adaptation Frame in the Base Layer Modulation component of the video Flow to which it applies. It shall be multiplexed with video Media Frames. It should be transmitted at least once per Superframe.

The format of the Video Sync Layer Directory is specified in Table 14.

Table 14: Video Sync Layer Directory

Field Name	Field Type	Field Presence	Subclause Reference
VSL_RECORDs	VSL_RECORD_TYPE	MANDATORY	4.6.1.1
RAP_FLAG_BITS	BIT(60)	MANDATORY	4.6.1.2
U_FRAME_FLAG_BITS	BIT(60)	MANDATORY	4.6.1.3
RESERVED	BIT(variable)	CONDITIONAL	4.6.1.4

4.6.1.1 VSL_RECORD

The Video Sync Layer Directory shall contain one or more VSL_RECORDs. The format of the VSL_RECORD is specified in Table 15.

Table 15: Format of a VSL_RECORD

Field Name	Field Type	Field Presence	Subclause Reference
MORE_VSL_RECORDS	BIT(1)	MANDATORY	4.6.1.1.1
RESERVED	UINT(3)	MANDATORY	4.6.1.1.2
NUM_FRAMES	UINT(6)	MANDATORY	4.6.1.1.3
FIRST_FRAME_PTS	UINT(14)	MANDATORY	4.6.1.1.4
LAST_FRAME_PTS	UINT(14)	MANDATORY	4.6.1.1.5

4.6.1.1.1 MORE_VSL_RECORDS

The MORE_VSL_RECORDS flag shall be set to 0 if the current VSL_RECORD is the last in the Video Sync Layer Directory.

The MORE_VSL_RECORDS flag shall be set to 1 if the current VSL_RECORD is not the last in the Video Sync Layer Directory.

The number of VSL_RECORDs in a Video Sync Layer Directory shall be determined by the Network according to operational criteria outside the scope of this specification.

4.6.1.1.2 RESERVED

The Network should set the RESERVED field to 0.

4.6.1.1.3 NUM_FRAMES

The NUM_FRAMES field indicates the number of video Media Frames with different Frame ID values in the block of consecutive video Media Frames starting at FIRST_FRAME_PTS and ending at LAST_FRAME_PTS within the Superframe.

4.6.1.1.4 FIRST_FRAME_PTS

The FIRST_FRAME_PTS is the PTS of the first video Media Frame of a block of NUM_FRAMES consecutive video Media Frames.

4.6.1.1.5 LAST_FRAME_PTS

The LAST_FRAME_PTS is the PTS of the last video Media Frame of the block of NUM_FRAMES consecutive video Media Frames starting at FIRST_FRAME_PTS.

4.6.1.2 RAP_FLAG_BITS

The Video Sync Layer Directory contains 60 RAP_FLAG_BITS, corresponding to a maximum of 60 video Media Frames in a Superframe. Each bit of the RAP_FLAG_BITS field corresponds to a particular video Media Frame, up to the number of distinct video Media Frames in the Superframe, as identified by Frame ID. The least significant bit corresponds to the first video Media Frame covered by the first VSL_RECORD. The RAP_FLAG_BITS covered by the first VSL_RECORD are followed by the RAP_FLAG_BITS covered by the second and subsequent VSL_RECORDs, if present, in order of transmission.

Each bit in the RAP_FLAGS_BIT field of the Video Sync Layer Directory shall be set to 1 if the corresponding video Media Frame is a random access point and is not accompanied by a non-RAP frame with the same Frame ID. Otherwise, the bit is set to 0. Bits following the bit in RAP_FLAG_BITS that correspond to the last transmitted video Media Frame in the Superframe shall be set to 0.

4.6.1.3 U_FRAME_FLAG_BITS

The message contains 60 U_FRAME_FLAG_BITS, corresponding to a maximum of 60 video Media Frames in a Superframe. Each bit of the U_FRAME_FLAG_BITS field corresponds to a particular video Media Frame, up to the number of distinct video Media Frames in the Superframe, identified by Frame ID. The least significant bit corresponds to the first video Media Frame covered by the first VSL_RECORD. The U_FRAME_FLAG_BITS covered by the first VSL_RECORD are followed by the U_FRAME_FLAG_BITS covered by the second and subsequent VSL_RECORDs, if present, in order of transmission.

Each bit in the U_FRAME_FLAG_BIT field of the Video Sync Layer Directory shall be set to 1 if the corresponding video frame is an unreferenced frame. Otherwise, the bit is set to 0. Bits following the bit in U_FRAME_FLAG_BITS that corresponds to the last transmitted frame in the Superframe shall be set to 0.

4.6.1.4 RESERVED

The last bit of the U_FRAME_FLAG_BIT field is followed by the minimum number of RESERVED bits necessary to align the final byte of the Video Sync Directory to a byte boundary. The Network shall set the RESERVED bits in the Video Sync Directory to 0.

4.6.2 SAF Frame

The SAF Frame is an optional Sync Layer Adaptation Frame which may be used to transport rich media enhancements. It may be multiplexed within a real time Flow transporting other content, or it may be transported in a dedicated Flow.

If the Flow on which the SAF Frame is transported has both a Base Layer and an Enhanced Layer modulation component, the SAF Frame may be transported as a Sync Layer Adaptation Frame in either modulation component.

The format of a SAF Frame is specified in clause 7 of ISO/IEC 14496-20 [4]. Note: the term SAF Frame as used in this document is synonymous with the term SAF Packet, and specifically, a SAF Frame comprises exactly one SAF packet per the nomenclature of [4].

5 NON REAL-TIME SERVICE

5.1 Introduction

This clause specifies the protocols and messages used to deliver a file in a Non Real-Time Service.

5.1.1 Reference Model

The entities involved in the Non Real-Time Service are shown in Figure 7. The Non Real-Time service is used to deliver files to the Device. The files may contain arbitrary content or they may contain a set of media objects and associated metadata.

The Network broadcasts files to Devices over the Transport Layer using Non Real-Time Services. The Network may support multiple Non Real-Time Services. Each Non Real-Time Service consists of two Flows. The first Flow is used to deliver the file data according to the File Delivery Protocol (FDP) specified in subclause 5.4. The second Flow is used to deliver control information related to the file delivery according to the File Delivery Control Protocol (FDCP) specified in subclause 5.5. FDP and FDCP are two closely-linked parts of the same system; both are required to complete the file delivery mechanism specified in this clause.

Each Device receives the files delivered on the Non Real-Time Services to which it subscribes and stores them locally for later access, as appropriate according to the nature of the file. For example, if the File contains a set of multimedia Presentations, the Device may extract the Presentations contained in the File, and store them locally so that they are available for later access by the user.

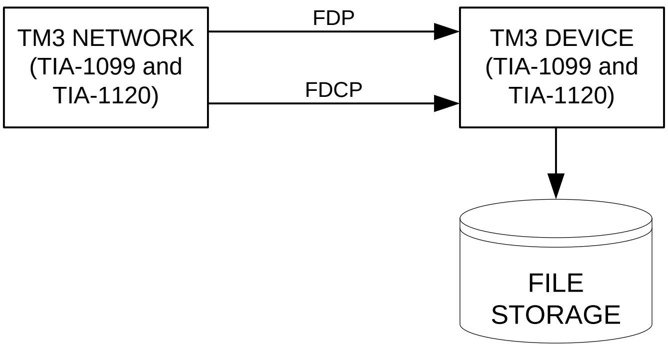

Figure 7: Data Flow for a Non Real-Time Service

The protocol stack for a Non Real-Time Service is shown in Figure 8. The Network uses the File Delivery Layer to deliver Files to Devices. The File Delivery Layer is described in subclause 5.2. The File Delivery Layer uses the services of the Transport Layer [20].

Files are subject to Message Coding to ensure they are delivered efficiently and reliably from the Network to Devices. Subclause 5.3 gives an overview of Message Coding.

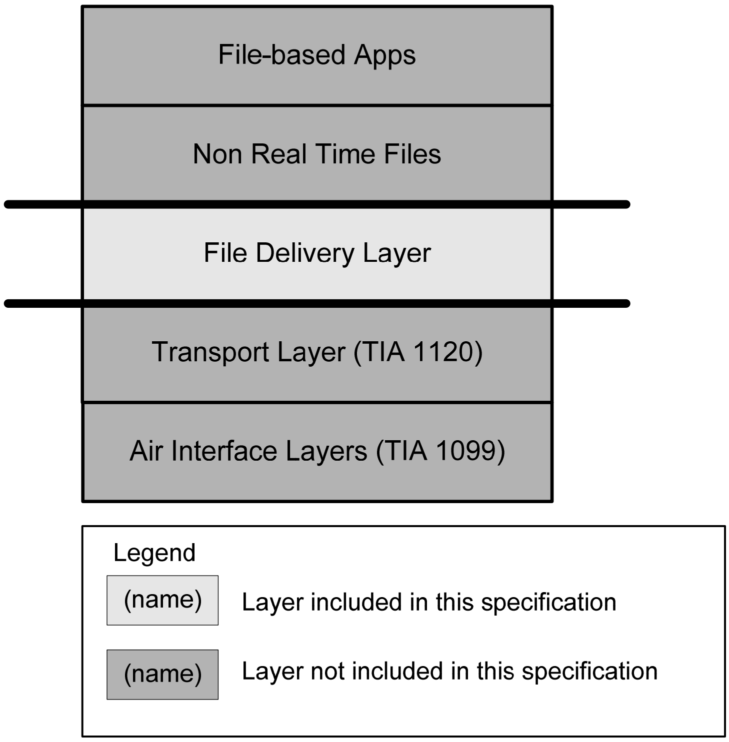

Figure 8: Non Real-Time Service Protocol Layers

5.2 File Delivery Layer

The Network uses the services of the File Delivery Layer to distribute a File to Devices over the Transport Layer [20]. The position of the File Delivery Layer in the Protocol Architecture for Non Real-Time Services is shown in Figure 8. The remainder of this clause specifies the Protocols and messages that belong to the File Delivery Layer.

5.2.1 Functions of the File Delivery Layer

The function of the File Delivery Layer is to distribute a File efficiently and reliably to a large number of devices over the Network. As shown in Figure 9, the Network first performs Message Encoding on the File and then uses the File Delivery Protocol (FDP) to deliver the Message Coded packets to Devices. As a part of Message Encoding, the File may be fragmented into file fragments.

The Device performs Message Decoding after receiving a sufficient number of Message Coded packets. The decoded File is then delivered to the Application Layer. As a part of Message Decoding, File reassembly will also be performed by the Device if the File is fragmented.

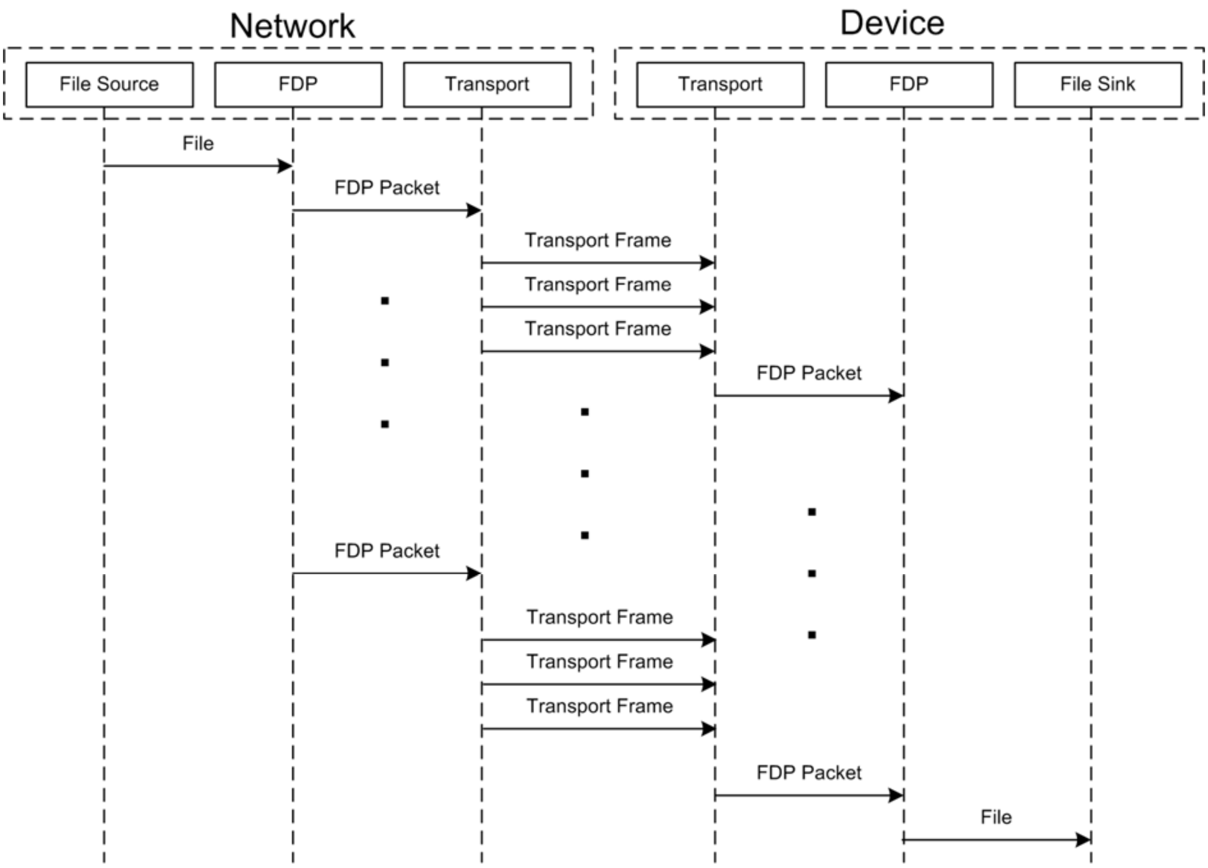

Figure 9: File Delivery Message Flow

5.3 Message Coding Framework

Message Coding is a scalable method to combat packet loss while efficiently and reliably delivering files to Devices in a mobile multicast environment. Message Coding consists of message encoding performed by the Network and message decoding performed by the Device. The Message Coding framework provides support for various file fragmentation algorithms and Forward Error Correction (FEC) schemes. The philosophy of the Message Coding framework is similar to [5]. Message Coding framework utilizes the File Delivery Control Message (FDCM) of the FDCP for conveying Message Coding parameters and it utilizes the File Delivery Message (FDM) of the FDP for deliverying the encoded packets. The format of FDCM is specified in subclause 5.5.2 and the format of FDM is specified in subclause 5.4.1.

FDM and FDCM messages are sent on different Flows. Each FDM and FDCM message is sent as a single Transport Layer Service Packet using the services of the Transport Layer [20]. The Transport layer provides a packet interface to the File Delivery Layer. The method to convey the Flow IDs for FDP and FDCP Flows is beyond the scope of this specification. The method to convey the time and duration when FDM and FDCM messages are broadcast is beyond the scope of this specification.

5.3.1 Non Real Time Flow Configuration Options

For Flows providing Non Real Time data, the Flow Configuration flags of the FlowBLOB field specified in subclause 5.3.1 of the Transport Layer [20] shall be configured as follows:

- FASB_ALLOWED: selected
- CHECKSUM_ACTIVE: selected
- STREAM_ENCRYPTION_ACTIVE: configurable

5.4 File Delivery protocol

The File Delivery Protocol (FDP) is responsible for the delivery of encoded packets. FDP defines FDM that is used to deliver encoded packets. The FDMs are sent over the Network using the services of the Transport Layer [20]. Each FDM is sent as a single Transport Layer Service Packet.

5.4.1 FDM format

This subclause specifies the format of the FDM used to convey the coded packets in the Message Coding framework.

Table 16: Format of File Delivery Message

Field Name	Field Type	Field Presence	Subclause Reference
FILE_TRANSPORT_ID	UINT(16)	MANDATORY	5.4.1.1
FEC_PAYLOAD_ID	Variable	MANDATORY	5.4.1.2
ENCODED_SYMBOL	Variable	MANDATORY	5.4.1.3

5.4.1.1 FILE_TRANSPORT_ID

FILE_TRANSPORT_ID identifies the file whose file delivery attributes are described in the message. The network shall assign FILE_TRANSPORT_IDs in such a way that these IDs are unique across files that have overlapping FDM delivery durations in a FDP flow or overlapping FDCM delivery durations in a FDCP flow. The mechanism of conveying the mapping between a globally unique file identifier and these FILE_TRANSPORT_IDs is beyond the scope of this specification

5.4.1.2 FEC_PAYLOAD_ID

This field identifies the ENCODED_SYMBOL. The format of this field will be dependent on the specific FEC scheme utilized i.e the FEC_ENCODING_ID (subclause 5.5.2.3) and conditionally the FEC_INSTANCE_ID (subclause 5.5.2.5).

5.4.1.3 ENCODED_SYMBOL

This field contains the encoded packet. The format of this field is dependent on the FEC scheme utilized.

5.5 File Delivery Control Protocol

The FDP specifies the format of code packets. However, it does not specify file delivery parameters that are common to a File Delivery Session. This information is delivered using messages delivered by the File Delivery Control Protocol (FDCP).

As shown in Figure 7, FDCP messages are carried in a separate Flow between the Network and the Device from that used to carry FDP Messages. The FDCP messages are sent over the

Network using the services of the Transport Layer [20]. The general format of an FDCP message is defined in subclause 5.5.1.

5.5.1 General Format of FDCP Messages

All FDCP messages shall have a common format, shown in Table 17.

Table 17: General Format of FDCP Messages

Field Name	Field Type	Field Presence	Subclause Reference
MESSAGE_TYPE	UINT(8)	MANDATORY	5.5.1.1
Message Body	Variable	MANDATORY	

The messages consist of a MESSAGE_TYPE followed by a Message Body. The format of the Message Body depends on the value of the MESSAGE_TYPE field.

5.5.1.1 MESSAGE_TYPE

The MESSAGE_TYPE field identifies the type of FDCP message. The defined values for MESSAGE_TYPE are specified in Table 18.

Table 18: Defined values for MESSAGE_TYPE field

MESSAGE_TYPE	Value	Subclause Reference
FD_CONTROL_MESSAGE	10	5.5.2
Values 0-9 are Not available for use		
Values 11-255 are reserved for future use.		

5.5.2 File Delivery Control Message

The File Delivery Control Message carries file delivery attributes of File Delivery Sessions in the Message Coding framework. The maximum size of a FDCM Message shall not exceed P_{MAX_NRT} bytes, where P_{MAX_NRT}, is a configurable system parameter. See Annex A for details. Each FDCM is sent as a single Transport Layer Service Packet using the service of Transport Layer [20]. The FDCM message format is specified in Table 19.

Table 19: Format of the File Delivery Control Message

Field Name	Field Type	Field Presence	Subclause Reference
MESSAGE_TYPE	UINT(8)	MANDATORY	5.5.2.1
FILE_TRANSPORT_ID	UINT(16)	MANDATORY	5.5.2.2
FILE_SIZE	UINT(32)	MANDATORY	5.5.2.3
FEC_ENCODING_ID	UINT(8)	MANDATORY	5.5.2.4
FEC_INSTANCE_ID	UINT(16)	CONDITIONAL	5.5.2.5
FILE_TRANSMISSION_INFO	Variable	CONDITIONAL	5.5.2.6

5.5.2.1 MESSAGE_TYPE

The value of the MESSAGE_TYPE field shall be set to FD_CONTROL_MESSAGE (10).

5.5.2.2 FILE_TRANSPORT_ID

FILE_TRANSPORT_ID identifies the file whose file delivery attributes are described in the message. The network shall assign FILE_TRANSPORT_IDs in such a way that these IDs are unique across files that have overlapping FDM delivery durations in a FDP flow or overlapping FDCM delivery durations in a FDCP flow. The mechanism of conveying the mapping between a globally unique file identifier and these FILE_TRANSPORT_IDs is beyond the scope of this specification.

5.5.2.3 FILE_SIZE

FILE_SIZE field gives the size of the file delivered in bytes.

5.5.2.4 FEC_ENCODING_ID

FEC_ENCODING_ID identifies a FEC scheme or a class of FEC schemes in the Message Coding framework.

5.5.2.5 FEC_INSTANCE_ID

FEC_INSTANCE_ID is used to differentiate FEC schemes that share the same FEC_ENCODING_ID. This field is used in addition with the FEC_ENCODING_ID to specifically identify the FEC scheme used to encode the file being delivered. This field is present for FEC schemes that share the same FEC_ENCODING_ID with other FEC schemes.

5.5.2.6 FILE_TRANSMISSION_INFO

This field contains additional file delivery attributes such as the parameters for the FEC scheme used to encode the file being delivered. The format of this field will be dependent on the specific FEC scheme utilized.

5.6 FEC schemes defined for Message Coding framework

Table 20 shows the FEC schemes defined for the Message Coding framework and their FEC_ENCODING_ID and FEC_INSTANCE_ID.

Table 20: Defined FEC schemes

FEC Scheme name	FEC_ENCODING_ID	FEC_INSTANCE_ID
Compact No-Code	0	Not applicable

5.6.1 Compact No-Code FEC scheme

The compact No-Code FEC scheme is defined in [6]. The term "Source Block" as defined in [6] is synonymous to a File Fragment. The file fragmentation algorithm for compact No-Code FEC scheme is specified as "Algorithm for Computing Source Block Structure" in [7].

The device shall support Message Decoding based on the Compact No-Code FEC scheme.

5.6.1.1 FEC_PAYLOAD_ID for Compact No-Code FEC scheme

The format of FEC_PAYLOAD_ID in FDM for Compact No-Code FEC scheme is given in Table 21.

Table 21: FEC_PAYLOAD_ID format for Compact No-Code FEC scheme

Field Name	Field Type	Field Presence	Subclause Reference
SOURCE_BLOCK_NUMBER	UINT(16)	MANDATORY	5.6.1.1.1

Field Name	Field Type	Field Presence	Subclause Reference
ENCODING_SYMBOL_ID	UINT(16)	MANDATORY	5.6.1.1.2

5.6.1.1.1 SOURCE_BLOCK_NUMBER

The Source Block Number is used to identify from which Source Block of the file the encoding symbol in the payload of the packet is generated.

5.6.1.1.2 ENCODING_SYMBOL_ID

The Encoding Symbol ID identifies which specific Encoding Symbol generated from the Source Block is carried in the packet payload. For the No-Code FEC scheme, the relationship between ENCODING_SYMBOL_ID and the ENCODED_SYMBOL carried in the FDM is defined in [6].

5.6.1.2 FILE_TRANSMISSION_INFO for Compact No-Code FEC scheme

The format of FILE_TRANSMISSION_INFO in FDCM for Compact No-Code FEC scheme is given in Table 22.

Table 22: FILE_TRANSMISSION_INFO format for Compact No-Code FEC scheme

Field Name	Field Type	Field Presence	Subclause Reference
ENCODING_SYMBOL_LENGTH	UINT(16)	MANDATORY	5.6.1.2.1
MAX_SOURCE_BLOCK_LENGTH	UINT(16)	MANDATORY	5.6.1.2.2

5.6.1.2.1 ENCODING_SYMBOL_LENGTH

This field gives the length of Encoding Symbol in bytes. All Encoding Symbols for a file shall be equal to this length, with the optional exception of the last symbol of a source block (so that redundant padding is not mandatory in the last symbol of a source block). The ENCODING_SYMBOL_LENGTH is an input for the file fragmentation algorithm specified in [7].

5.6.1.2.2 MAX_SOURCE_BLOCK_LENGTH

This field gives the maximum Source Block length in source symbols i.e this field gives the maximum number of source symbols in a Source Block. The MAX_SOURCE_BLOCK_LENGTH is an input for the file fragmentation algorithm specified in [7].

6 P DATACAST SERVICE

6.1 Introduction

Media Adaptation support is provided for IP Datacast Services. These services send multicast IP packets to an IP Datacast application on a Device over the Network.

The entities involved in the IP Datacast Service are shown in Figure 10. IP content is addressed to an IPv4 or IPv6 multicast address [11], [17].

The Network broadcasts IP Datacast streams to Devices using the services of the Transport Layer [20]. Each supported IP address and Port Number is mapped to a separate Flow in the Network. This mapping permits the network operator to offer subscription access to the IP Datacast service through an ESG, in the same way that users may subscribe to Real-time or Non Real-time services, while also providing network independence to IP-based environments. In this way minimal modifications are required to adapt those environments to the Network.

Figure 10: Data Flow for an IP Datacast Service

6.2 IP Adaptation Layer

The protocol stack for the IP Datacast Service is shown in Figure 11. IP Datacast services are assumed to use UDP [6] over IPv4 or IPv6, and are delivered over the Network using the Transport Layer [20]. The IP Adaptation Layer specified in this clause provides the services and protocols necessary to extend the Transport Layer to support distribution of IP data.

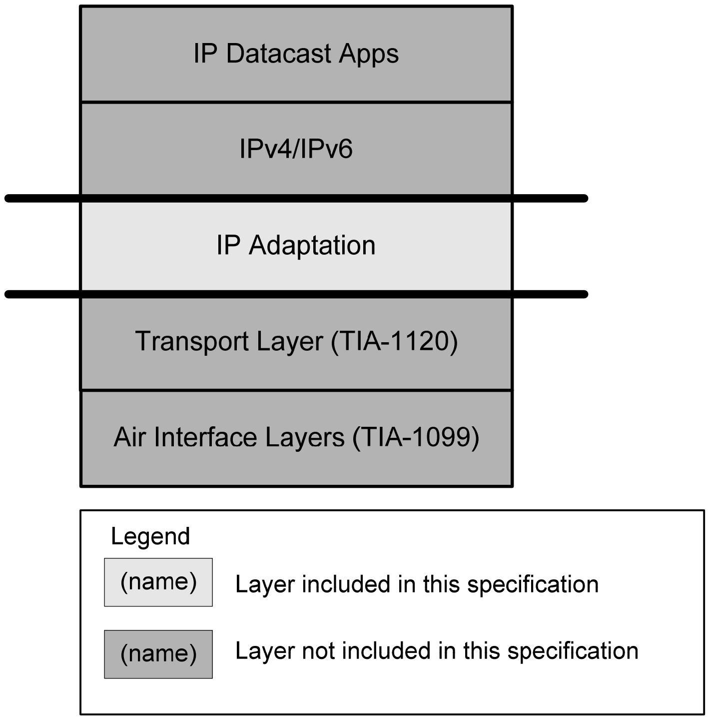

Figure 11: IP Datacast Service Protocol Layers

The functions provided by the IP Adaptation Layer are specified in the following subclauses.

6.2.1 Service Discovery

The IP Application is presumed to have located the IP Address for the desired service through IP-based mechanisms such as DNS [10]. The Network shall support a mapping between certain ranges of IP addresses and Flow IDs in the IP Adaptation Layer, as defined in subclause 6.3.

6.2.2 Service Availability

IP Datacast services may be available intermittently. The Network determines the availability schedule of an IP Datacast Service with the IP source. In order to conserve Device resources, the Network shall notify Devices subscribed to the IP Datacast service of the availability for Flows transporting an IP Datacast Service, as specified in subclause 2.2.5.2.2.1 of ARIB STD-B47 [19].

6.2.3 IP Datacast Flow Configuration

For Flows providing IP Datacast Service data, the Flow Configuration flags of the FlowBLOB field specified in subclause 5.3.1 of the Transport Layer [20] shall be configured as follows:

- FASB_ALLOWED = selected
- CHECKSUM_ACTIVE = selected
- STREAM_ENCRYPTION_ACTIVE = configurable

Each IP packet shall be conveyed in a single Transport Layer Service Packet. The maximum size of a Transport Layer Service Packet conveying an IP Packet shall not exceed P_{MAX_IPDC} bytes, where P_{MAX_IPDC} is a configurable system parameter. See Annex A for further details.

6.3 Address Mapping

The IP Adaptation Layer shall support a fixed mapping between certain IPv4 or IPv6 addresses and Flow IDs as specified in this subclause.

If an IP-based application process requests access to an IP multicast address and port, the Device shall apply the address mapping to determine the Flow ID of the Flow transporting the IP packets.

6.3.1 Applicable Address Ranges

Address mapping shall apply to any IPv4 multicast address in the range 239.192.0.0 – 239.192.255.255, a subset of the multicast address range reserved by IANA for IPv4 organization-local scope.

Address mapping shall apply to any IPv6 multicast address in the range FF18::0 – FF18::FFFF, a subset of the multicast address range reserved by IANA for IPv6 organization-local scope.

For both IPv4 and IPv6 addresses, address mapping shall apply to private ports in the range 0xC000 = 49152 through 0xC00F = 49167.

Any Flow ID may be used to support IP Datacast Flows using the address mapping.

6.3.2 Mapping IP Addresses to Flow IDs

The least significant 4 bits (bits 3 to 0) of the Flow ID shall have the same value as the least significant 4 bits (bits 3 to 0) of the IP Port Number.

The most significant 16 bits of the Flow ID shall have the same value as the least significant 16 bits of the IP Address.

6.3.3 Mapping Flow IDs to IP Addresses

The IP Port Number shall have the value of 0xC000 = 49152 plus the value of the least significant 4 bits (bits 3 to 0) of the Flow ID.

The IP Address shall be calculated relative to a Base Address. For IPv4 addresses, the Base Address is 239.192.0.0. For IPv6 addresses, the Base Address is FF18::0. The IP address shall be set to the value of the Base Address plus the value of the most significant 16 bits of the Flow ID.

No Text

Annex A (Normative)

Media Adaptation System Parameters

This Annex specifies the configurable System Parameters required for Devices to support the Media Adaptation Protocols. The means by which the parameter values are configured is outside the scope of this specification.

The supported Parameters are specified in Table 23.

Table 23: Media Adaptation Parameters

Parameter Name	Range	Default Value	Units	Description
P_{MAX_IPDC}	1–65535	1500	Bytes	Maximum size of an IP Datacast Service message.
P_{MAX_NRT}	1–65535	1500	Bytes	Maximum size of a FDCM message.
P_{MAX_RT}	1–65535	65535	Bytes	Maximum size of a Real-Time Service message.

No Text

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