**3GPP TSG- Meeting #**

**, , -**

|  |
| --- |
| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
|  |
|  |  | **CR** |  | **rev** |  | **Current version:** |  |  |
|  |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
|  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network |  | Core Network | **X** |

|  |
| --- |
|  |
| ***Title:***  |  |
|  |  |
| ***Source to WG:*** |  |
| ***Source to TSG:*** | S4 |
|  |  |
| ***Work item code:*** |  |  | ***Date:*** |  |
|  |  |  |  |  |
| ***Category:*** |  |  | ***Release:*** |  |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
|  |  |
| ***Reason for change:*** | Satisfy the objectives of the AMD\_PRO\_MED Work Item as documented in item 2.c in clause 4 of SP-250265. |
|  |  |
| ***Summary of change:*** | New annexes to introduce Coded Multi-Source Media Format (CMMF) for the purposes of enabling media delivery from multiple service locations within the 5GMS System. These annexes include:a. A new annex that specifies CMMF’s use within the 5GMS System.b. A new annex that provides examples of Media Entry Points containing CMMF configuration information required to be communicated to 5GMS Clients and examples of Content Hosting/Publishing Configurations that implement CMMF within the 5GMS network.c. A new annex showing how CMMF as specified in ETSI TS 103 973 can be implemented for the purposes of HTTP media streaming. |
|  |  |
| ***Consequences if not approved:*** | Objectives of the Work Item not completely satisfied. |
|  |  |
| ***Clauses affected:*** | Annex X (new), Annex Y (new) |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 26.510 CR 0016, TS 26.512 CR 0086, TS 26.501 CR 111 |
| ***affected:*** |  | **X** |  Test specifications |  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications |  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | S4-250952: New CR.S4-251109: Refactored and new material added to address concerns from Qualcomm and BBC. NotedS4al250099: Refactored. Noted.S4-251282: Updated to address comments received from BBC. |

===== CHANGE =====

# 2 References

…

[103973] ETSI TS 103 973: "Coded Multisource Media Format (CMMF) for Content Distribution and Delivery", October 2024.

===== CHANGE =====

## 3.3 Abbreviations

…

CMMF Coded Multisource Media Format

…

EFDT Extended File Delivery Table

…

TOI Transport Object Identifier

…

===== CHANGE =====

Annex X (normative):
CMMF-enabled media streaming

# X.1 Introduction

Coded Multi-source Media Format (CMMF) as specified in ETSI TS 103 973 [103973] is an extensible container format designed to facilitate the management and interchange of audio-visual media and metadata in one or more coded representations (e.g., encoded with Application Layer Forward Error Correction, linear, network, or channel codes). The coded media representations supported by CMMF enable the efficient use of multi-source, multi-path, and multi-access connectivity for network-delivered applications.

This annex specifies the use of multi-source object coding using CMMF within the 5GMS System.

# X.2 CMMF-enabled downlink media streaming

## X.2.1 General

When media is delivered from multiple service locations exposed by the 5GMSd at reference point M4d and/or by the 5GMSd Application Provider at reference point M13d, multi-source media streaming using object coding may be used. When CMMF as specified in ETSI TS 103 973 [103973] is used, media resources shall first be encoded into CMMF objects, either by the 5GMSd Application Provider or by using Content Preparation in the 5GMSd AS. These CMMF objects shall be made available to 5GMSd Clients from multiple reference point M4d and/or M13d service locations. A 5GMSd Client shall then request and download these CMMF objects from the service locations in parallel. A CMMF-enabled Media Access Client of the Media Player in the 5GMSd Client decodes the received CMMF objects, recovering the media resource required for playback and presents them to its Media Playback and Content Decryption Platform.

The remainder of this annex specifies requirements necessary to enable CMMF-enabled downlink media streaming within the 5GMS System. Further discussion of reference points M8d and M13d for use in streaming media with CMMF are omitted since they are out of scope.

## X.2.2 Procedures for CMMF-enabled downlink media streaming

### X.2.2.1 Provisioning (M1d) and configuration (M3d) interfaces for CMMF-enabled downlink media delivery

#### X.2.2.1.1 Overview

This clause defines all procedures and APIs used to provision and configure the 5GMS System to use CMMF for the purposes of downlink media delivery from multiple service locations.

#### X.2.2.1.2 Content Hosting

To provision CMMF-enabled downlink media streaming in the 5GMSd AF, the 5GMSd Application Provider shall use the Content Hosting Provisioning (M1) API specified in clause 7.6, following the Content Hosting provisioning (M1) procedures specified in clause 4.3.3.

To configure CMMF-enabled downlink media streaming in the 5GMSd AS, the 5GMSd AS shall use the Content Hosting Configuration (M3) API specified in clause 9.4, following the Content Hosting configuration (M3) procedures specified in clause 4.5.4.

When Content Hosting is provisioned, a service location exposed by the 5GMSd AS at reference point M4d shall host a unique CMMF representation of the media resources to be streamed. Each CMMF representation of a media resource shall be a uniquely addressable CMMF object.

#### X.2.2.1.3 Content Preparation

To provision Content Preparation of CMMF objects in the 5GMSd AF, the 5GMSd Application Provider shall use the Content Preparation Templates Provisioning (M1) API specified in clause 7.4, following the Content Preparation Template provisioning (M1) procedures specified in clause 4.3.5.

To configure Content Preparation of CMMF objects in the 5GMSd AS, the 5GMSd AF shall use the Content Preparation Templates Configuration (M3) API specified in clause 9.3, following the Content Preparation Template configuration (M3) procedures specified in clause 4.5.3.

When Content Preparation is provisioned to encode media resources into CMMF objects, a CMMF Encoder (as specified in clauses 4.2.1 and 4.3.3 of ETSI TS 103 973 [103973]) is instantiated and configured in the 5GMSd AS by means of a Content Preparation Template. The following Content Preparation Template requirements apply:

- A Content Preparation Template used to encode media resources (e.g., audio segments, video segments, etc.) shall create CMMF objects whose bitstreams conform to ETSI TS 103 973 [103973].

- Depending on the Content Hosting Configuration, the CMMF Encoder may be a single input, single output or a single input, multiple output process. A media resource (e.g., audio segment, video segment, etc.) made available to the 5GMSd AS at reference point M2d or M10d shall be ingested into the CMMF Encoder where it is encoded and packaged as one or more CMMF objects (each a unique CMMF representation of the media resource), and those objects shall be made available at service locations exposed by the 5GMSd AS at reference point M4d.

- CMMF objects shall be accessible via URLs that allow for the appropriate mapping between CMMF object URLs used at service locations exposed by the 5GMSd AS at reference point M4d and their corresponding media resource URLs used for media ingest at reference points M2d or M10d. This mapping shall be determined using a member of the DistributionConfiguration.pathRewriteRules array specified in table 8.8.3.1-1 of TS 26.510 [56].

NOTE: Differences between the URLs of media resources and their associated CMMF objects are restricted to differences in the path part of the URL between and including the leading "/" and the final "/" owing to restrictions imposed by the definition of the PathRewriteRule data type.

The Content Preparation Template for CMMF-enabled downlink media delivery is specified in clause X.2.3.2.

### X.2.2.2 Media Streaming (M4d) interface for CMMF-enabled downlink media delivery

To serve CMMF objects to a CMMF-enabled Media Access Client, the 5GMSd AS shall use the media streaming (M4) interface specified in clause 10.3A.3, following the media streaming (M4d) procedures specified in clause 4.6.3.

A media resource required by a Media Player for immediate or delayed consumption shall be obtained by a CMMF-enabled Access Client by downloading one or more CMMF objects (either partially or in full) where each CMMF object is downloaded from a different service location exposed at reference point M4d.

### X.2.2.3 Media Session Handling (M5d) interface for CMMF-enabled media delivery

To perform media session handling for a CMMF-enabled media streaming session, the Media Session Handler shall use the APIs specified in clause 11, following the Media Session Handling (M5) procedures specified in clause 4.7.

In cases where the Service Access Information for media streaming includes one or more Media Player Entries, each of these Media Player Entries shall consist of a URL to a CMMF Media Entry Point as specified in clause X.2.3.3.

### X.2.2.4 UE Media Player interface (M7d/M11d) for CMMF-enabled downlink media delivery

To control a Media Player during a CMMF-enabled media streaming session, the 5GMSd-Aware Application or Media Session Handler shall use the Media Stream Handler (M7/M11) APIs specified in clause 13, following the UE Media Player (M7d) procedures specified in clause 4.9.

A Media Player shall configure and use a CMMF-enabled Media Access Client upon receiving a CMMF Media Entry Point as specified in clause X.2.3.3. At a minimum, the CMMF-enabled Access Client shall support the following:

- Translation of media resource (e.g., CMAF segment) URLs and the corresponding URLs pointing to CMMF objects containing encoded representations of those media resources that are available from service locations exposed by the 5GMSd AS at reference point M4d. This mapping shall be provided by the CMMF Media Entry Point.

- Decoding a received CMMF object or jointly decoding multiple partially received CMMF objects that conform to ETSI TS 103 973 [103973].

## X.2.3 Protocols and formats for CMMF-enabled downlink media streaming

### X.2.3.1 HTTP-based CMMF delivery conformance profile

This aspect is for future study.

NOTE: A normative reference to a HTTP-based CMMF delivery conformance profile based on ETSI TS 103 973 [103973] will be added when available.

### X.2.3.2 Content Preparation Template for CMMF-enabled downlink media streaming

This aspect is for future study.

NOTE: A normative reference to a compliant CMMF Content Preparation Template and HTTP-based CMMF delivery conformance profile based on ETSI TS 103 973 [103973] will be added when available.

### X.2.3.3 CMMF Media Player Entry based on Extended FDT

A CMMF Media Player Entry shall comprise:

- a CMMF Extended File Delivery Table (EFDT) as specified in clause D.2.3 of ETSI TS 103 973 [103973] containing a pointer to a media presentation description (e.g., URL to a MPD for DASH, URL to a video file, etc.) and

- any necessary CMMF configuration information required by the CMMF-enabled Access Client to download CMMF objects, decode them, and recover the associated media resource(s) (e.g., CMAF segments).

In the case where the media presentation description (e.g., MPD for DASH, HLS playlist, etc.) referenced by a CMMF Media Entry Point is a document containing pointers to media resources (e.g., URLs to CMAF segments), the reference (e.g., URL) to the media presentation description shall be listed within the EFDT as TOI=”0”. Subsequent transport object identifiers (TOIs) listed in the EFDT shall provide a mapping between each of the URLs contained within the media presentation description and the URLs of the CMMF objects containing encoded representations of those media resources that are available from service locations exposed by the 5GMSd AS at reference point M4d.

An example EFDT-based CMMF Media Player Entry referencing a DASH MPD can be found in clause Y.2.2.3.

When Content Preparation is provisioned within the 5GMS System to encode media resources (e.g., CMAF segments) into CMMF objects, URLs of the CMMF objects provided in the EFDT shall be formatted in such a way that they can be mapped back to the URLs of their corresponding media resources (e.g., CMAF segment) by the 5GMSd AS so that the media resource may be ingested at reference point M2d. As specified in clause X.2.2.1.3, the URL format of these CMMF objects is determined by the provisioned Content Hosting Configuration (see the definition of DistributionConfiguration.PathRewriteRules specified in table 8.8.3.1-1 of TS 26.510 [56]).

NOTE: A normative reference to a CMMF Media Entry Point specifically for HTTP media streaming protocols (e.g., MPEG-DASH, HLS, etc.) based on ETSI TS 103 973 [103973] will be added when available.

===== CHANGE =====

Annex Y (informative):
Examples of CMMF-enabled downlink media streaming

# Y.1 General

This annex provides examples of CMMF Media Player Entries and Content Hosting Configurations that support the delivery of CMMF-encoded media within the 5GMS System.

# Y.2 CMMF Media Player Entry examples

## Y.2.1 General

This clause provides examples showing how CMMF configuration information required by a 5GMS Client may be communicated within a Media Player Entry. When applicable, a general example of a media asset is used, described by the DASH MPD shown in listing Y.2.1-1, and notionally hosted by a hypothetical 5GMSd Application Provider at the URL https://example.com/manifest.mpd.

Listing Y.2.1-1: Example MPD

|  |
| --- |
| <?xml version="1.0"?><MPD profiles="urn:3GPP:PSS:profile:DASH10" type="static" minBufferTime="PT10S" mediaPresentationDuration="PT2H" availabilityStartTime="2010-04-01T09:30:47Z" availabilityEndTime="2010-04-07T09:30:47Z"  xsi:schemaLocation="urn:mpeg:dash:schema:mpd:2011 3GPP-Rel10-MPD.xsd" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="urn:mpeg:dash:schema:mpd:2011"> <ProgramInformation moreInformationURL="http://www.example.com"> <Title>Example</Title> </ProgramInformation> <Period start="PT0S"> <AdaptationSet mimeType="video/3gpp"> <ContentComponent contentType="video"/> <ContentComponent contentType="audio" lang="en"/> <Representation codecs="s263, samr" bandwidth="256000" id="256"> <BaseURL>"rep1"</BaseURL> <SegmentList duration="1000" timescale="100"> <Initialization sourceURL="seg-init.3gp"/> <SegmentURL media="seg-1.3gp"/> <SegmentURL media="seg-2.3gp"/> <SegmentURL media="seg-3.3gp"/> </SegmentList> </Representation> <Representation codecs="mp4v.20.9, mp4a.E1" bandwidth="128000" id="128"> <BaseURL>"rep2"</BaseURL> <SegmentList duration="10"> <Initialization sourceURL="seg-init.3gp"/> <SegmentURL media="seg-1.3gp"/> <SegmentURL media="seg-2.3gp"/> <SegmentURL media="seg-3.3gp"/> </SegmentList> </Representation> </AdaptationSet> </Period> <Period start="PT30S"> <SegmentTemplate duration="10" initialization="seg-init-$RepresentationId$.3gp" media="http://example.com/$RepresentationId$/$Number$.3gp"/> <AdaptationSet mimeType="video/3gpp" codecs="mp4v.20.9, mp4a.E1"> <ContentComponent contentType="video"/> <ContentComponent contentType="audio" lang="en"/> <Representation bandwidth="256000" id="1"/> <Representation bandwidth="128000" id="2"/> </AdaptationSet> </Period></MPD> |

## Y.2.2 Example CMMF Media Player Entries based on Extended FDT

### Y.2.2.1 Overview

The examples provided in this clause show how a CMMF Media Player Entry based on the extended File Delivery Table (EFDT) specified in clause X.2.3.3 may be used to explicitly communicate the necessary CMMF configuration information within the Media Player Entry itself.

### Y.2.2.2 Single file EFDT example

The following example shows an EFDT where a single MP4 file is delivered using CMMF from three service locations exposed by the 5GMSd AS at reference point M4d.

Listing Y.2.2.2-1: Single MP4 CMMF EFDT example

|  |
| --- |
| <?xml version="1.0" encoding="UTF-8"?><FDTInstance xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="urn:ETSI:CMMF:2023:FDT" xsi:schemaLocation="urn:ETSI:CMMF:2023:FDT extendedFDT.xsd" Expires="2010-04-07T09:30:47Z" Complete="true" ContentType="video/mp4 codecs="mp4v.20.9, mp4a.E1" FEC-OTI-FEC-Encoding-ID="1"> <File Content-Location="https://example.com/video.mp4" TOI="0" Content-Length="64000"> <EncodedObjects type="source" complete="true"> https://example.com/video.mp4 </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/cmmf-a/video.mp4 </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/cmmf-b/video.mp4 </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/cmmf-c/video.mp4 </EncodedObjects> </File></FDTInstance> |

### Y.2.2.3 Example EFDT referencing a DASH MPD

The following example shows an EFDT where the contents of the presentation described by the MPD shown in listing Y.2.1-1 are delivered using CMMF. It is assumed that CMMF objects for the media resources referenced within the MPD are accessible from three service locations exposed by the 5GMSd AS at reference point M4d.

In this example, a CMMF-enabled Media Access Client uses the EFDT shown in listing Y.2.2.3-1 combined with the MPD shown in listing Y.2.1-1 as the Media Player Entry. The EFDT includes a reference to the MPD (File element with TOI 0) and references to all segments referenced within the MPD are mapped to CMMF objects assigned TOI values 1 through 16.

Listing Y.2.2.3-1: MPD CMMF EFDT example

|  |
| --- |
| <?xml version="1.0" encoding="UTF-8"?><FDTInstance xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="urn:ETSI:CMMF:2023:FDT" xsi:schemaLocation="urn:ETSI:CMMF:2023:FDT extendedFDT.xsd" Expires="2010-04-07T09:30:47Z" Complete="true" FEC-OTI-FEC-Encoding-ID="1"> <File TOI="0" Content-Location="https://example.com/manifest.mpd"> <EncodedObjects type="source" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/manifest.mpd </EncodedObjects> <EncodedObjects type="source" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/manifest.mpd </EncodedObjects> <EncodedObjects type="source" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/manifest.mpd </EncodedObjects> </File> <File TOI="1" Content-Location="https://example.com/rep1/seg-init.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/rep1/seg-init.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/rep1/cmmf-a /seg-init.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/rep1/cmmf-b /seg-init.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/rep1/cmmf-c /seg-init.3gp </EncodedObjects> </File> <File TOI="2" Content-Location="https://example.com/rep1/seg-1.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/rep1/seg-1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/rep1/cmmf-a /seg-1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/rep1/cmmf-b /seg-1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/rep1/cmmf-c /seg-1.3gp </EncodedObjects> </File> <File TOI="3" Content-Location="https://example.com/rep1/seg-2.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/rep1/seg-2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/rep1/cmmf-a /seg-2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/rep1/cmmf-b /seg-2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/rep1/cmmf-c /seg-2.3gp </EncodedObjects> </File> <File TOI="4" Content-Location="https://example.com/rep1/seg-3.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/rep1/seg-3.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/rep1/cmmf-a /seg-3.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/rep1/cmmf-b /seg-3.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/rep1/cmmf-c /seg-3.3gp </EncodedObjects> </File> <File TOI="5" Content-Location="https://example.com/rep2/seg-init.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/rep2/seg-init.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/rep2/cmmf-a /seg-init.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/rep2/cmmf-b /seg-init.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/rep2/cmmf-c /seg-init.3gp </EncodedObjects> </File> <File TOI="6" Content-Location="https://example.com/rep2/seg-1.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/rep2/seg-1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/rep2/cmmf-a /seg-1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/rep2/cmmf-b /seg-1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/rep2/cmmf-c /seg-1.3gp </EncodedObjects> </File> <File TOI="7" Content-Location="https://example.com/rep2/seg-2.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/rep2/seg-2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/rep2/cmmf-a /seg-2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/rep2/cmmf-b /seg-2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/rep2/cmmf-c /seg-2.3gp </EncodedObjects> </File> <File TOI="8" Content-Location="https://example.com/rep2/seg-3.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/rep2/seg-3.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/rep2/cmmf-a /seg-3.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/rep2/cmmf-b /seg-3.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/rep2/cmmf-c /seg-3.3gp </EncodedObjects> </File> <File TOI="9" Content-Location="https://example.com/seg-init-1.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/seg-init-1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/cmmf-a /seg-init-1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/cmmf-b /seg-init-1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/cmmf-c /seg-init-1.3gp </EncodedObjects> </File> <File TOI="10" Content-Location="https://example.com/1/1.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/1/1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/1/cmmf-a/1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/1/cmmf-b/1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/1/cmmf-c/1.3gp </EncodedObjects> </File> <File TOI="11" Content-Location="https://example.com/1/2.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/1/2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/1/cmmf-a/2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/1/cmmf-b/2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/1/cmmf-c/2.3gp </EncodedObjects> </File> <File TOI="12" Content-Location="https://example.com/1/3.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/1/3.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/1/cmmf-a/3.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/1/cmmf-b/3.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/1/cmmf-c/3.3gp </EncodedObjects> </File> <File TOI="13" Content-Location="https://example.com/seg-init-2.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/seg-init-2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/cmmf-a /seg-init-2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/cmmf-b /seg-init-2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/cmmf-c /seg-init-2.3gp </EncodedObjects> </File> <File TOI="14" Content-Location="https://example.com/2/1.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/2/1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/2/cmmf-a/1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/2/cmmf-b/1.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/2/cmmf-c/1.3gp </EncodedObjects> </File> <File TOI="15" Content-Location="https://example.com/2/2.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/2/2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/2/cmmf-a/2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/2/cmmf-b/2.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/2/cmmf-c/2.3gp </EncodedObjects> </File> <File TOI="16" Content-Location="https://example.com/2/3.3gp"> <EncodedObjects type="source" complete="true"> https://example.com/2/3.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-a.com-provider-service.ms.as.3gppservices.org/2/cmmf-a/3.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-b.com-provider-service.ms.as.3gppservices.org/2/cmmf-b/3.3gp </EncodedObjects> <EncodedObjects type="cmmf" complete="true"> https://distribution-c.com-provider-service.ms.as.3gppservices.org/2/cmmf-c/3.3gp </EncodedObjects> </File></FDTInstance> |

# Y.3 Provisioning Session and Content Hosting Configuration examples

## Y.3.1 General

This clause provides examples of provisioning the 5GMS System to deliver media resources using CMMF from multiple service locations exposed by the 5GMSd AS at reference point M4d. It is assumed within these examples that the CMMF-enabled Media Access Client extends functionality of the DASH Access Client (in particular the Downloader sub-function) specified in clause 13.2.1 to enable download and decoding of media resources encoded within CMMF objects.

### Y.3.2 Example of media delivery from multiple service locations using CMMF

### Y.3.2.1 Overview

This example shows how CMMF can be used in a basic deployment where a single Provisioning Session is configured by the 5GMSd Application Provider to expose multiple service locations. This example assumes the 5GMSd Application Provider provisions the system in the following manner:

1. A 5GMSd AS is provisioned to ingest media resources at reference point M2d.

2. Media resources ingested at reference point M2d are encoded into CMMF objects using an appropriate CMMF Content Preparation Template as specified in clause X.2.2.1.3.

3. A CMMF Media Player Entry is provided as specified in clause X.2.3.3.

This implementation example is illustrated in figure Y.3.2.1-1.



Media Player Entry, MPD, and CMMF-A

Media Player Entry, MPD, and CMMF-B

Media Player Entry, MPD, and CMMF-C

Figure Y.3.2.1-1: Basic deployment example for 5GMSd AS ingest, content preparation, and delivery using CMMF

The following clauses describe how the 5GMS APIs and protocols are used to realize this example.

### Y.3.2.2 Provisioning Session provisioning

A Provisioning Session is created by the 5GMSd Application Provider using the *create Provisioning Session* resource operation specified in clause 5.2.2.3 and the API specified in clause 8.2 of TS 26.510 [56]. Example values of the provisioning session API parameters used are shown in table Y.3.2.2-1.

Table Y.3.2.2-1: Example ProvisioningSession resource parameters

|  |  |  |
| --- | --- | --- |
| Property name | Property value | Assigned by |
| provisioningSessionId | provisioning.session.a | Media AF |
| provisioningSessionType | MS\_DOWNLINK | Media Application Provider |
| externalServiceId | com.‌provider.‌service |
| appId | dash.downlink.streaming |
| NOTE: Values for provisioningSessionId, externalServiceId, and appId are notional and may not reflect actual values. |

### Y.3.2.3 Content Preparation Templates provisioning

The 5GMSd Application Provider provisions one CMMF encoder Content Preparation Template within the provisioning.session.a Provisioning Session using the *create Content Preparation Template* resource operation specified in clause 5.2.5.2 and the API defined in clause 8.5 of TS 26.510 [56]. The following is assumed:

- Content Preparation is triggered upon the receipt of a pull-based request to the 5GMSd AS at a service location exposed at reference point M4d.

- The path of the requested resource is available to the Content Preparation Template associated with the service location that received the request.

- Media resources (e.g., video segments, audio segments, etc.) are ingested by the 5GMSd AS at reference point M2d and encoded into CMMF objects according to the Content Preparation Template. A sub-path URL added by the 5GMSd Client in the M4d request URL is used to determine which CMMF object representation of the media resource is generated. For the purposes of this example, the Content Preparation Template generates representation "CMMF-A" if a M4d request URL containing the sub-path cmmf-a is received; it generates representation "CMMF-B" if the URL contains the sub-path cmmf-b is received; and it generates representation "CMMF-C" if the URL contains the sub-path cmmf-c is received.

- Upon completion of the CMMF encoding operation, the resulting CMMF object is made available for caching by the 5GMSd AS and/or delivery to the requesting 5GMSd Client at the service location where the request was received.

Upon successful provisioning of the Content Preparation Template, the 5GMSd AF returns the cmmf.‌content.‌preparation.‌template Content Preparation Template ID to the Media Application Provider.

### Y.3.2.4 Server Certificates provisioning

The 5GMSd Application Provider provisions the Server Certificates for the Provisioning Session using the *create Server Certificate* resource operation specified in clause 5.2.4.2 and the API defined in clause 8.4 of TS 26.510 [56]. The Server Certificates assume a canonical domain name as specified in clause 6.0.2.2. Example values for the certificates generated by the 5GMSd AF are provided in table Y.3.2.4-1.

Table Y.3.2.4-1: Example Server Certificate parameters

|  |  |  |
| --- | --- | --- |
| CN | subjectAltName | certificateId |
| \*.com-provider-service.ms.as.3gppservices.org | \*.com-provider-service.ms.as.3gppservices.org | server.certificate.a |

### Y.3.2.5 Content Hosting provisioning and configuration

The 5GMSd Application Provider provisions the Content Hosting Configuration for each Provisioning Session using the *create Content Hosting Configuration* resource operation specified in clause 5.2.8.2 and the API defined in clause 8.8 of TS 26.510 [56].

Configuring the Content Hosting Configuration in the 5GMSd AS is performed according to:

- The example base URL of the 5GMSd Application Provider’s origin server is https://origin.media-application-provider.com.

The 5GMSd Application Provider provides the Media Player Entry URL to the 5GMSd-Aware Application via reference point M8d. Based on this, the 5GMSd Client can download the Media Player Entry from a service location exposed by the 5GMSd AS at reference point M4d. Example Media Player Entry documents are provided in clause Y.2.2.

Table Y.3.2.5-1 provides example values for the Content Hosting Configuration parameters.

Table Y.3.2.5-1: Content Hosting Configuration resource parameters

|  |  |  |
| --- | --- | --- |
| Property name | Property value | Assigned by |
| name | content-hosting-configuration-a | 5GMSd Application Provider |
| ingestConfiguration |
|  | mode | PULL | 5GMSd Application Provider |
|  | protocol | urn:3gpp:‌5gms:‌content-protocol:‌http-pull |
|  | baseURL | https://origin.media-application-provider.com |
| distributionConfiguration |
|  | affinityGroup | affinity.group.a | 5GMSd Application Provider |
|  | contentPreparation‌TemplateId | cmmf.content.preparation.template |
|  | certificateId | server.certificate.a |
|  | canonical‌DomainName | distribution-a.com-provider-service.ms.as.3gppservices.org | 5GMSd AF |
|  | baseURL | https://distribution-a.com-provider-service.ms.as.3gppservices.org |
|  | pathRewriteRule |
|  |  | requestPathPattern | cmmf-a/ | 5GMSd Application Provider |
|  |  | mappedPath |  |
| distributionConfiguration |
|  | affinityGroup | affinity.group.b | 5GMSd Application Provider |
|  | contentPreparation‌TemplateId | cmmf.content.preparation.template |
|  | certificateId | server.certificate.a |
|  | canonical‌DomainName | distribution-b.com-provider-service.ms.as.3gppservices.org | 5GMSd AF |
|  | baseURL | https://distribution-b.com-provider-service.ms.as.3gppservices.org |
|  | pathRewriteRule |
|  |  | requestPathPattern | cmmf-b/ | 5GMSd Application Provider |
|  |  | mappedPath |  |
| distributionConfiguration |
|  | affinityGroup | affinity.group.c | 5GMSd Application Provider |
|  | contentPreparation‌TemplateId | cmmf.content.preparation.template |
|  | certificateId | server.certificate.a |
|  | canonical‌DomainName | distribution-c.com-provider-service.ms.as.3gppservices.org | 5GMSd AF |
|  | baseURL | https://distribution-c.com-provider-service.ms.as.3gppservices.org |
|  | pathRewriteRule |
|  |  | requestPathPattern | cmmf-c/ | 5GMSd Application Provider |
|  |  | mappedPath |  |

### Y.3.2.6 End-to-end URL mapping

Table Y.3.2.6-1 provides an example of the end-to-end mapping for requests initiated by the Media Player for a subset of the URLs provided in the example MPD shown in listing Y.2.1-1 where the CMMF-enabled Media Access Client uses the corresponding URL mapping provided in the EFDT shown in listing Y.2.2.3-1.

Table Y.3.2.6-1: End-to-End URL mapping example

|  |  |  |
| --- | --- | --- |
| MPD URL | M4d Request URLs | M2d Request URL |
| rep1/seg-1.3gp | https://distribution-a.com-provider-service.‌ms.as.3gppservices.org/rep1/cmmf-a/seg-1.3gp | https://origin.media-application-provider.com/‌rep1/seg-1.3gp |
| https://distribution-b.com-provider-service.‌ms.as.3gppservices.org/rep1/cmmf-b/seg-1.3gp |
| <https://distribution-c.com-provider-service>.‌ms.as.3gppservices.org/rep1/cmmf-c/seg-1.3gp |
| http://example.com/1/1.3gp | https://distribution-a.com-provider-service.‌ms.as.3gppservices.org/1/cmmf-a/1.3gp | https://origin.media-application-provider.com/‌1/1.3gp |
| https://distribution-b.com-provider-service.‌ms.as.3gppservices.org/1/cmmf-b/1.3gp |
| https://distribution-c.com-provider-service.‌ms.as.3gppservices.org/1/cmmf-c/1.3gp |

## Y.3.3 Example of media delivery from multiple service locations using CMMF and 5GMSd AS service chaining at reference point M10d

### Y.3.3.1 Overview

This example shows how CMMF can be used in a deployment where 5GMSd AS service chaining at reference point M10d is provisioned. This example assumes the 5GMSd Application Provider provisions the system in the following manner:

1. A 5GMSd AS is provisioned to serve as an origin shield intended to reduce requests for content at reference point M2d. Furthermore, the creation of CMMF objects from ingested content at reference point M2d using Content Preparation is performed within this 5GMSd AS.

2. Two 5GMSd AS instances are provisioned to serve 5GMSd Clients from exposed service locations at reference point M4d. Both 5GMSd AS instances are configured to ingest CMMF-encoded content (unique to their exposed service locations) from the 5GMSd AS serving as the origin shield at reference M10d.

2. Media resources ingested at reference point M2d are encoded into CMMF objects using an appropriate CMMF Content Preparation Template as specified in clause X.2.2.1.3.

3. A CMMF Media Player Entry as specified in clause X.2.3.3.

This implementation example is illustrated in figure Y.3.3.1-1.



CMMF-C

CMMF-B

Media Player Entry and MPD

MPD URL

Figure Y.3.3.1-1: Centralized 5GMSd AS content preparation and ingest deployment example

The following clauses describe how the 5GMS APIs and protocols are used to realize this example.

### Y.3.3.2 Provisioning Session provisioning

Three provisioning sessions are created by the 5GMSd Application Provider using the *create Provisioning Session* resource operation specified in clause 5.2.2.3 and the API specified in clause 8.2 of TS‌26.510 [56]. Example values for the three Provisioning Session parameters used are shown in table Y.3.3.2-1.

Table Y.3.3.2-1: ProvisioningSession resource parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Property name | Provisioning Session A(Trusted DN) | Provisioning Session B(Trusted DN) | Provisioning Session C(External DN) | Assigned by |
| provisioningSessionId | provisioning.session.a | provisioning.session.b | provisioning.session.c | Media AF |
| provisioningSession‌Type | MS\_DOWNLINK | MS\_DOWNLINK | MS\_DOWNLINK | Media Application Provider |
| externalServiceId | com.‌provider.‌service.a | com.‌provider.‌service.b | com.‌provider.‌service.c |
| appId | dash.downlink.streaming | dash.downlink.streaming | dash.downlink.streaming |
| NOTE: Values for provisioningSessionId, externalServiceId, and appId are notional and may not reflect actual values. |

### Y.3.3.3 Content Preparation Templates provisioning

The 5GMSd Application Provider provisions one CMMF encoder Content Preparation Template within the provisioning.session.a Provisioning Session using the *create Content Preparation Template* resource operation specified in clause 5.2.5.2 and the API defined in clause 8.5 of TS 26.510 [56]. The following is assumed:

- Content Preparation is triggered upon the receipt of a pull-based request at reference point M10d.

- The path of the requested resource is available to the Content Preparation Template.

- Media resources (e.g., video segments, audio segments, etc.) are ingested by the 5GMSd AS at reference point M2d and encoded into CMMF objects by the Content Preparation Template. A sub-path URL added by the 5GMSd Client in the M4d request URL is used to determine which CMMF object representation of the media resource is generated. For the purposes of this example, the Content Preparation Template generates representation "CMMF-A" if a M4d request URL containing the sub-path cmmf-a is received; it generates representation "CMMF-B" if the URL contains the sub-path cmmf-b is received; and it generates representation "CMMF-C" if the URL contains the sub-path cmmf-c is received.

- Upon completion of the CMMF encoding operation, the CMMF object is made available for caching by the 5GMSd AS and/or delivery to the requesting entity.

Upon successful provisioning of the Content Preparation Template, the 5GMSd AF returns the cmmf.‌content.‌preparation.‌template Content Preparation Template ID to the Media Application Provider.

### Y.3.3.4 Server Certificates provisioning

The 5GMSd Application Provider provisions the Server Certificates for each Provisioning Session using the *create Server Certificate resource* operation specified in clause 5.2.4.2 and the API defined in clause 8.4 of TS 26.510 [56]. The Server Certificates assume a canonical domain name as specified in clause 6.0.2.2. Example values for the certificates generated by the 5GMSd AF are provided in table Y.3.3.4-1.

Table Y.3.3.4-1: Server Certificates

|  |  |  |  |
| --- | --- | --- | --- |
| provisioningSessionId | CN | subjectAltName | certificateId |
| provisioning.session.a | \*.com-provider-service-a.‌ms.as.‌3gppservices.org | \*.com-provider-service-a.‌ms.as.‌3gppservices.org | server.‌certificate.a |
| provisioning.session.b | \*.com-provider-service-b.‌ms.as.‌3gppservices.org | \*.com-provider-service-b.‌ms.as.‌3gppservices.org | server.‌certificate.b |
| provisioning.session.c | \*.com-provider-service-c.‌ms.as.‌3gppservices.org | \*.com-provider-service-c.‌ms.as.‌3gppservices.org | server.‌certificate.c |

### Y.3.3.5 Content Hosting provisioning and configuration

The 5GMSd Application Provider provisions the Content Hosting Configuration for each Provisioning Session using the *create Content Hosting Configuration* resource operation specified in clause 5.2.8.2 and the API defined in clause 8.8 of TS 26.510 [56].

Configuring the Content Hosting Configuration in each 5GMSd AS is performed according to:

- The example base URL of the Media Application Provider’s origin server is https://origin.media-application-provider.com.

- The creation of the Content Hosting Configuration for Provisioning Session provisioning.session.a is completed prior to the creation of the Content Hosting Configuration for Provisioning Sessions provisioning.session.b and provisioning.session.c.

The 5GMSd Application Provider provides the Media Player Entry URL to the 5GMSd-Aware Application via reference point M8d. Based on this, the 5GMSd Client can download the Media Player Entry from a service location exposed by the 5GMSd AS at reference point M4d. Example Media Player Entry documents are provided in clause Y.2.2.

Table Y.3.3.5-1 provides example values for the Content Hosting Configuration API parameters for all three Provisioning Sessions.

Table Y.3.3.5-1: ContentHostingConfiguration resource parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Property name | ProvisioningSession A | ProvisioningSession B | Provisioning Session C | Assigned by |
| name | content-hosting-configuration-a | content-hosting-configuration-b | content-hosting-configuration-c | 5GMSd Application Provider |
| ingestConfiguration |
|  | mode | PULL | PULL | PULL | 5GMSd Application Provider |
|  | protocol | urn:3gpp:‌5gms:‌content-protocol:‌http-pull | urn:3gpp:‌5gms:‌content-protocol:‌http-pull | urn:3gpp:‌5gms:‌content-protocol:‌http-pull |
|  | baseURL | https://origin.‌media-application-provider.com | https://‌distribution-a.‌com-provider-service-a.‌ms.as.‌3gppservices.org | https://‌distribution-a.‌com-provider-service-a.‌ms.as.‌3gppservices.org |
|  | distributionConfiguration |
|  | contentPreparation‌TemplateId | cmmf.content.‌preparation.‌template |  |  | 5GMSd Application Provider |
|  | certificateId | server.‌certificate.a | server.‌certificate.b | server.‌certificate.c |
|  | canonical‌DomainName | distribution-a.‌com-provider-service-a.‌ms.as.‌3gppservices.org | distribution-a.‌com-provider-service-b.‌ms.as.‌3gppservices.org | distribution-a.‌com-provider-service-c.‌ms.as.‌3gppservices.org | 5GMSd AF |
|  | baseURL | https://‌distribution-a.‌com-provider-service-a.‌ms.as.‌3gppservices.org | https://‌distribution-a.com-provider-service-b.ms.as.‌3gppservices.org | https://‌distribution-a.‌com-provider-service-c.‌ms.as.‌3gppservices.org |
|  | pathRewriteRule |
|  |  | requestPathPattern | (cmmf-[a-c]/)$ |  |  | 5GMSd Application Provider |
|  |  | mappedPath |  |  |  |

### Y.3.3.6 End-to-end URL mapping

Table Y.3.3.6-1 provides an example of the end-to-end mapping for requests initiated by the Media Player for a subset of the URLs provided in the example MPD shown in listing Y.2.1-1 where the CMMF-enabled Media Access Client uses the corresponding URL mapping provided in the EFDT shown in listing Y.2.2.3-1.

Table Y.3.3.6-1: End-to-End URL mapping example

|  |  |  |  |
| --- | --- | --- | --- |
| MPD URL | M4d Request URL | M10d Request URL | M2d Request URL |
| rep1/seg-1.3gp | https://distribution-a.com-provider-service-b.‌ms.as.3gppservices.org/rep1/cmmf-b/seg-1.3gp | https://distribution-a.com-provider-service-b.‌ms.as.3gppservices.org/rep1/cmmf-b/seg-1.3gp | https://‌origin.media-application-provider.com/‌rep1/seg-1.3gp |
| https://distribution-a.‌com-provider-service-c.‌ms.as.3gppservices.org/‌rep1/cmmf-c/seg-1.3gp | https://distribution-a.‌com-provider-service-c.‌ms.as.3gppservices.org/‌rep1/cmmf-c/seg-1.3gp |
| http://example.com/1/1.3gp | https://distribution-a.‌com-provider-service-b.‌ms.as.3gppservices.org/‌1/cmmf-b/1.3gp | https://distribution-a.‌com-provider-service-b.‌ms.as.3gppservices.org/‌1/cmmf-b/1.3gp | https://‌origin.media-application-provider.com/‌1/1.3gp |
| https://distribution-a.‌com-provider-service-c.ms.as.3gppservices.org/‌1/cmmf-c/1.3gp | https://distribution-a.‌com-provider-service-c.‌ms.as.3gppservices.org/‌1/cmmf-c/1.3gp |

|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |

|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |