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Technical Report

Media and Content Distribution
MCD Framework
Part 9: Content Delivery Infrastructures

Reference
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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Foreword

This Technical Report (TR) has been produced by ETSI MCD Technical Committee, Media and Content Distribution.

It is part of a series of Technical Reports that are providing a landscape of the subjects pertaining to Media and Content Distribution. This document reviews Content Delivery Infratsructures.

Introduction

The last decade has seen a flurry of standards compete for attention in the space of IPTV and mobileTV, in addition to an already large number of proprietary systems. This has resulted in confusion and a lack of agreed standards, leading to the domination of proprietary implementations. Because these implementations could work in isolation without adverse relationships with the IP networks, the damage was limited to the creation of non interoperable islands, with operators building their proprietary universe in a piecemeal fashion with very limited possible reuse, increasing costs.

The next steps are seeing how TV and video applications now connect to the internet at large. The internet is a different setting : it is shared by everyone, and based on strongly established legacy standards. But it is also facing the challenge of delivery content on a scale that may be above its capabilities. The growth of the Web has been made possible by the internet commercial Content Delivery Networks, which has allowed large-scale delivery of Web content.

The role of this document is to set the stage for creating Technical Specifications in the domain of Content Delivery Infrastructures standards.

Scope

The present document is part 9 of the set of documents described in TR 102 688-1 [i.1] .

This report describes the domain of Content Delivery Infrastructures and the existing solution elements. It also identfies the Use Cases and Requirements that should be satisfied by the resulting solution, perform a Gap Analysis of the state of the art wrt the requirements and outlines elements of solution that could result in new specifications.

References

Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

There are no normative references in a Technical Report. Refer to the next section for informative references.

Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area**.** For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] ETSI TR 102 688-1, ETSI MCD; MCD framework; Part 1: Overview of interest areas TR 102 688-1 .

[i.2] ETSI TR 102 688-2, ETSI MCD; MCD framework; Part 2: View from Content Providers TR 102 688-2 .

[i.3] ETSI TS 182 019 V0.2.7 (2010-07) Technical Specification Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Content Delivery Network (CDN) architecture - Interconnection with TISPAN IPTV architectures

[i.4] IETF RFC 3466: "A Model for Content Internetworking (CDI)".

[i.5] ETSI TS 102 990, ETSI MCD; Content Delivery Network Interconnection, TS 102 990.

[i.6] ITU-T Recommendation Y.1910, IPTV architecture document [Y.1910]

[I.7] Digital Video Broadcasting (DVB): Internet TV Content Delivery Study Mission Report, DVB BlueBook A145 (12/09)

[i.8] 3GPP TS 26.234 9.3.0; Transparent end-to-end Packet-switched Streaming Service (PSS); Protocols and codecs

[i.9] ITU-T Y.1901 Requirements for the support of IPTV services

[i.10] ITU-T Y.1910 IPTV functional architecture

[i.11] ITU-T Y.2019 Content delivery functional architecture in NGN

[i.12] ATIS IPTV Interoperability Forum IIF-WT-063 IPTV CONTENT ON DEMAND SERVICE

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Definitions, symbols and abbreviations

Definitions

For the purposes of the present document, the [following] terms and definitions apply:

Content Delivery Infrastrutures: Content Delivery Infrastructures are a system of equipments and networks which role is to ensure efficient delivery of Content to clients. Content Delivery Networks are typical examples.

Content Item : A content item is a piece of media "content" such as audio or video or computer software.

Content Delivery : Content delivery describes the delivery of Content Items over a delivery medium such as broadcasting or the Internet.

Content Delivery Network : A content delivery network or content distribution network (CDN) is a system of computers containing copies of data, placed at various points in a network so as to maximize bandwidth for access to the data from clients throughout the network.

Content distribution: The act of moving content between CDNs.

Content ingestion: The act of introducing content (and associated data) into the Content Delivery Infrastructure.

Content preparation: The act of preparing content and metadata before its ingestion into a CDN.

Web Proxy : In computer networks, a proxy server is a server (a computer system or an application program) that acts as an intermediary for requests from clients seeking resources from other servers

Web Cache : Web caching is the caching of web documents (e.g., HTML pages, images, video,…) to reduce bandwidth usage, server load, and perceived lag. A web cache stores copies of documents passing through it; subsequent requests may be satisfied from the cache if certain conditions are met.

Progressive Download: A type of streaming in which the audio or video file begins to play after a certain minimum amount of data has been transferred, rather than requiring the entire file to be downloaded before playback starts.

Adaptive Streaming: Adaptive streaming is a process that adjusts the quality of a video based on changing network conditions to ensure the best possible viewer experience.

Abbreviations

For the purposes of the present document, the following apply:

CDN : Content Delivery Network

CDI: Content Delivery Infrastructure

HTTP: Hyper Text Transfer Protocol

RTSP: Real-Time Streaming Protocol

RTP: Real-Time Protocol

WWW: World Wide Web

Role of Content Delivery Infrastructures

The role of Content Delivery Infrastructure is to efficiently, scalably and with adequate performance and timeliness distribute content items to final customers.

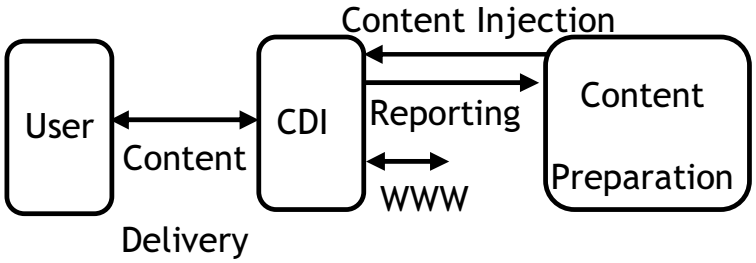


Figure 1: CDN in context

CDIs interact with two main entities : Content Provision on the upstream, and Clients (users) on the downstream.

CDIs get their content from an upstream source : the Content Provision. The Content Provision typically injects content into the CDI, and extracts or receives reports on content consumption.

The role of the CDI is to respond to user requests for given pieces of content. The "Content Delivery" relationship is constrained by what protocols clients implement.

Alternatively, the CDI can retrieve content from the internet on behalf of the client, thus behaving like a Web Proxy.

Use cases and Requirements

Editor's Note: it was noted that firm requirements using the verb "shall" are not appropriate in a TR. As a result, "should" were substituted ato "shall" in this section.

Requirements from Content Providers

The Following requirements are being abstracted from the "Needs of content Providers" document [i.3]:

R1 Support of Content access through a Content Portal

R2 Support for protected content delivery, support for different Content Protection Mechanisms

R3 Support for content delivery reporting mechanisms (optionally qualified by destination, time,…)

R4 Support for file-based and stream-based content delivery

R5 Support for Progressive Download and Adaptive Streaming.

R6 Support of a mechanism to remove content items from the CDI.

R7 Support for joint delivery of Metadata and Content

R8 Support for control of delivery based on geographic location criteria

R9 Support for Push and Pull models of content provision

R10 Content Format neutrality, including content encapsulation and content protection

R11 Support for Multicast Delivery

Specific Use Cases

The content Delivery Infrastructure should satisfy the following use cases :

User

- **UC1** : Operator content Live Streaming
- **UC2**: Internet content Live Streaming
- **UC3**: Operator content downloading
- **UC4**: Internet content downloading
- **UC5**: **Interconnection of CDNs for wide distribution**
- **UC6 Interoperable Content Injection**

CDN Interconnection Use Cases should be looked up in Annex A of document [i.5]

Specific Requirements

The following requirements should be satisfied by the Content Delivery Infrastructure :

Network

- RN01: Should work on basic IP networks
- RN02: Should be portable on different network infrastructures (ITU-T or ETSI NGN, 3GPP, IETF,…)
- RN03: Should not require deep integration with a specific underlying infrastructure
- RN04: Should not unnecessarily prescribe CDN implementation
- RN05: Should support delivery to mobile terminals as well as fixed terminals
- RN06: Should optionally support specific delivery modes for mobile terminals
- RN07: Should optionally support QoS for delivery of content to the user
- RN08: Should not expose QoS in the user interface
- RN09: Should reuse existing protocols to the maximum possible extent
- RN10: Should be reusable for different applications

User-related

- RU1: Should support basic delivery protocols : HTTP and optionally RTSP/RTP
- RU2: Should support progressive download and Adaptive Streaming delivery modes where applicable
- RU3: Should support trick modes for Content Delivery
- RU4: Should support geographic proximity Content Delivery
- RU5: Should support mechanisms for request routing (i.e. allowing requests to be transferred to different entities to improve the operation efficiency)

Content

- RC1: Should support CDI operator content
- RC2: Should support content accessed over the wwweb (through http) as an option
- RC3: Should be agnostic to content format
  - Accomodate different codecs

  - Accomodate different content protection mechanisms
  - Reduce need for processing metadata

Content Injection

- CI1 : Should allow Injection of Content Items in file format
- CI2: Should allow injection of Content in Stream Format
- CI3: Should provide clear indication of injection status
- CI4: Should provide the information necessary to access the content (e.g. URI)
- CI5: Should enable reporting of Content Access statistics for a given Content Item

CDN Interconnection

- RI1: Should support interconnection of Identical or Heterogeneous CDNs
  - Should support CDN federation use cases
  - Should support CDN resource sharing use cases

Editor's Note: these requirements should be clarified in line with the CDN Interconnection WI.

Taxonomy of CDNs

There are different types of Content Delivery networks, that can be differentiated on their main purpose, where and how they obtain content items, how they are controlled and deliver the content. Some criteria are the following :

- Origin of the content (Internet, Internally stored content, Third party,…)
- Destination and protocol of the content (IPTV STB with specific protocols, HTTP browser,…)
- …

The categories described here are non-exclusive and can be combined to form a more elaborate form of CDN.

		Content Origin	
		Internet	Stored
Content Destination	IPTV STB	IPTV cache	IPTV CDN
	Generic HTTP client	Proxy cache	HTTP CDN

Traditional Internet CDN

The category for Traditional Internet CDNs encompass the common Internet commercial WWW content hosting solutions.

Functionally, they receive HTTP requests directly from users and serve those requests from a conglomerate of geographically distributed servers.

The Input interface is not specified, though it can be composed of different interfaces based on standard protocols (HTTP and HTTPS, FTP,…). Sometimes protocols are supported for specific purposes (Adobe RTMP, ...)

The reporting interface is even less specified, and can range from tailored HTTP+HTML to raw logs or text files obtained in a variety of ways.

Operator VOD CDNs

Operator VOD CDNs are specialized for the delivery of stored content items and serve those requests from a conglomerate of geographically distributed servers within an operator network.

In many cases, VOD CDNs are integrated within an IPTV system and are controlled by system-specific protocols (SIP, RTSP,…)

Caches

Caches (often designated in web architectures as proxy-caches because the cache impersonates servers) are mediators between the internet and users, storing popular content items to provide better response times and lighten the load on the connection towards the internet.

Editor's Note: Should be complemented with an abstract from "**A Taxonomy and Survey of Content Delivery Networks**", by Al-Mukaddim Khan Pathan et al.

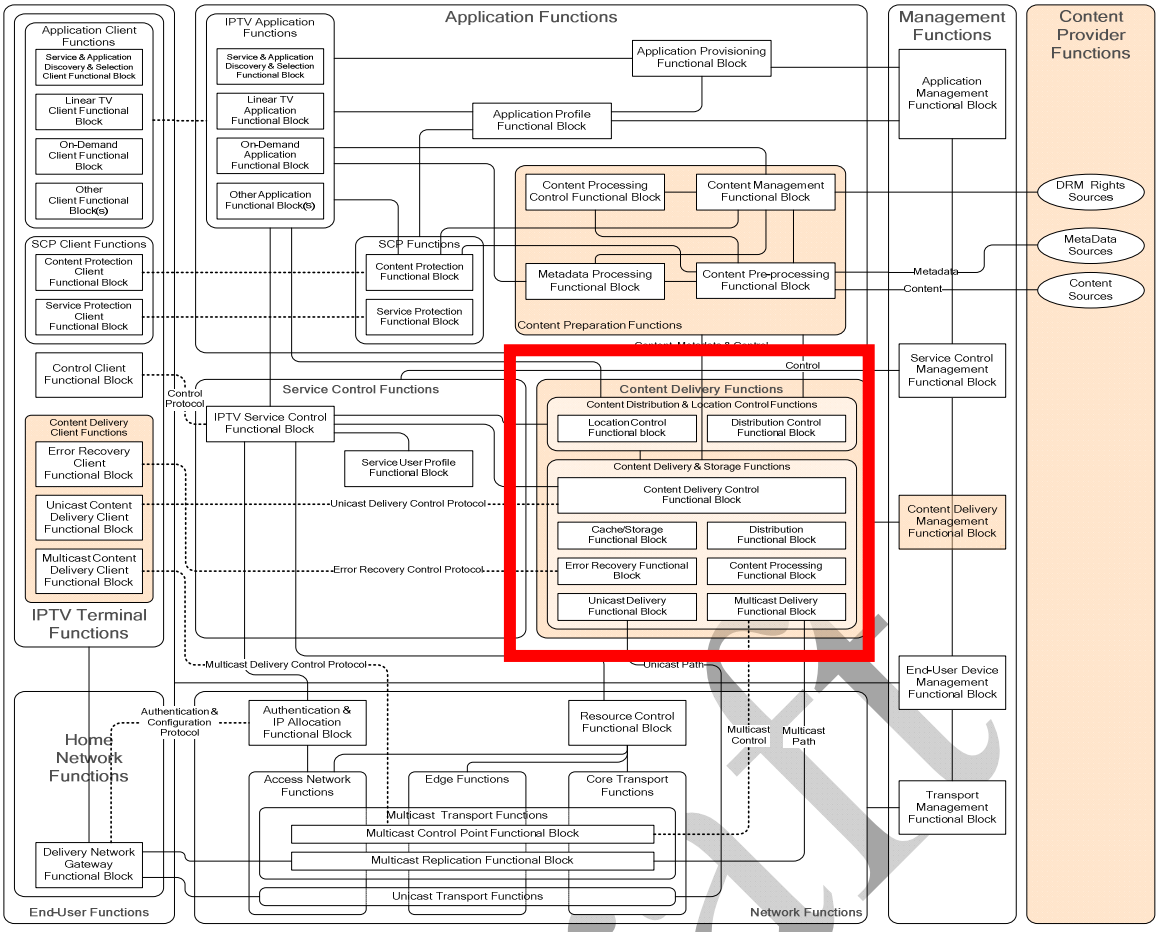
State of the art

This section goes through the main standards and proprietary solution elements related to Content Delivery.

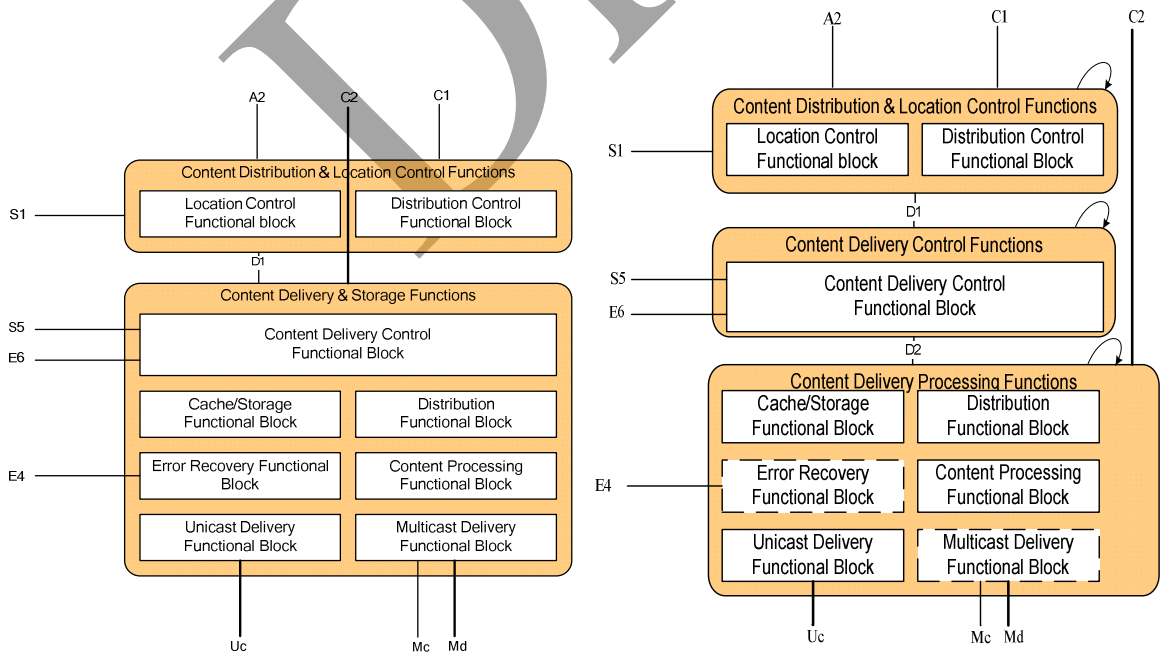
Existing and upcoming CDN Architecture Standards

ITU-T IPTV GSI, SG13 and SG16

Starting with the IPTV Focus Group, ITU-T has developed a "Content Delivery Functions" Functional Block which role is essentially an IPTV-targeted CDN (largely for the support of operator-hosted VOD) that was integrated in its IPTV architecture document [i.10]. More recently this CDN was precised in a specific recommendation on CDN functional architecture [i.11].



The CDN functional block is depicted with several sub-components and internal interfaces :



The above figure depicts the architecture as in Y.1910 on the left hand side, and as in Y.2019 on the right hand side. It should be noted that Y.2019 doesn't redefine or change the external interfaces defined in Y.1910 but adds internal components and interfaces.

The external interfaces to the CDN components are :

- Service Control
    - S1 (S1' is identical to S1) used to forward the service signalling messages, e.g., service requests, content resource requests, between the ITF/IPTV application functions and the CD&LCF. For the IMS variant, S1 is defined as SIP. For other variants, the protocol is not specified in Y.1910 (FFS).
    - E4 used to exchange messages for requesting and delivering error recovery information. Protocol not specified in Y.1910 (FFS).
    - E6 used to exchange content control messages, e.g., video recording commands. Defined as RTSP in Y.1910.
- Input (Ingestion)
    - A2 used by the IPTV applications functional block to request service parameters from CD&LCF. Protocol not specified in Y.1910 (FFS).
    - C1 used to facilitate content preparation functions to configure policies such as content distribution rules, selection criteria, etc., in the CD&LCF. Protocol not specified in Y.1910 (FFS).
    - C2 used to transfer content from content preparation functions to CD&SF. Protocol not specified in Y.1910 (FFS).
- Transport
    - Uc (also called Ud in Y.1910) used by the CD&SF to deliver content streams in unicast mode. Defined as RTP over UDP in Y.1910.
    - Mc used to pass information to allow for the dynamic computation, establishment and maintenance of multicast trees. Defined as PIM in Y.1910.
    - Md used by the CD&SF to deliver content streams in multicast mode. Defined as RTP over UDP in Y.1910.

Assessment

Editor's Note: it has been suggested that the text in this section should be refined to be more factual.

Many of the external interfaces appear to be in line with the CDI requirements (notably the Transport interfaces Uc/Ud MC/Md, possibly C2), however some introduce coupling that might be contrary to several requirements :

- S1 is based on IMS in one of the variants, which contradicts the requirement on network architecture neutrality.
- E4 introduces a dependency on error recovery mechanisms.
- A2 and C1 introduce coupling between the content preparation and CDN functions.

The internal structure appears to constrain the implementation in contradiction with requirement RN04.

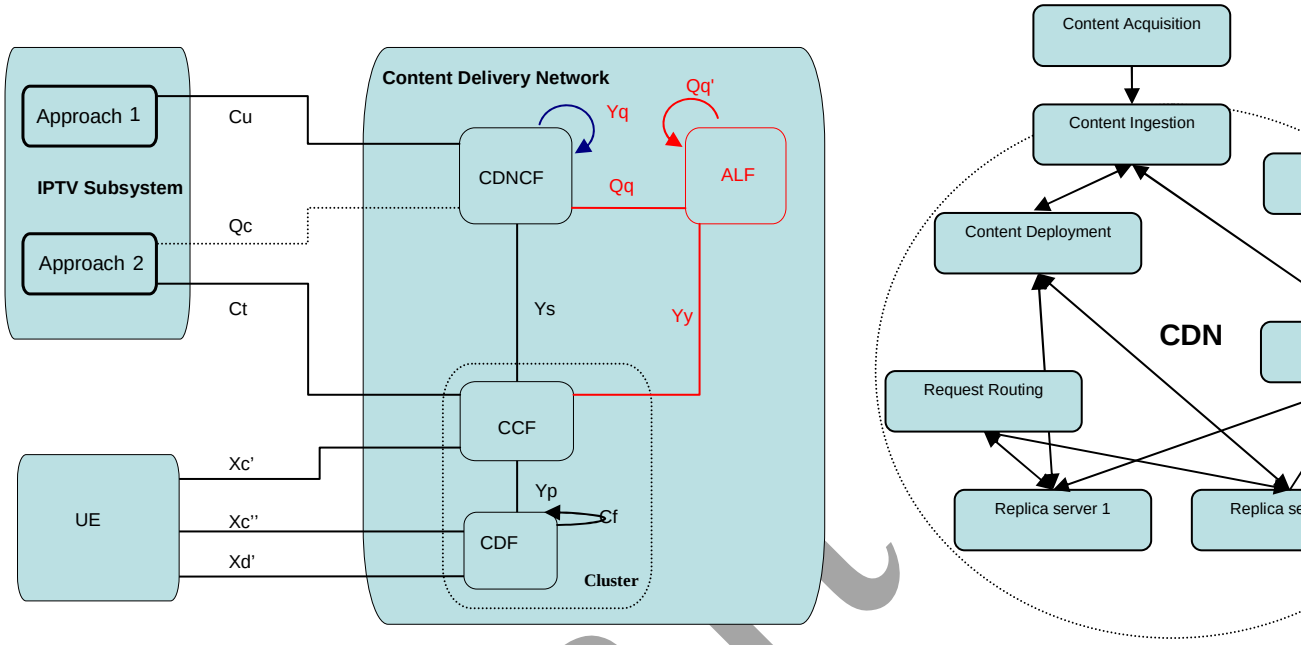
There is no explicit consideration of the requirement to interconnect CDNs between different operators, though there is provision of hierarchical relationships between CDN components. In all likelihood, this would prevent CDN interconnection of CDN components not compliant with Y.2019.

Overall the CDN appears to have been thought as tightly integrated within an IPTV system, which makes implementation more constrained and limits the applicability to more architecture-neutral systems.

However it may be possible to specify a subset of Y.1910 that would be appropriate for the purpose of CDI, if it is complemented with a CDN interconnection addition. That subset should concentrate on the external interfaces while omitting the specification of internal mechanisms and reference points. Because most of the specification in Y.2019 relates to internal coordination mechanisms and protocols, there is little that can be considered appropriate for CDI.

ETSI TISPAN

ETSI TISPAN started considering Content Delivery Networks as a late addition to its Release 3 IPTV specification. Starting first as an IPTV-oriented CDN for VOD in the IMS IPTV, it has grown in every direction to cover IMS-IPTV and dedicated IPTV, but also Internet-service and even CDN interconnection.



Editor's Note: This TISPAN diagram is evolving at a rapid pace and should be updated from WI2076 draft (currently at v44) before publication.

The above diagrams show in order : the CDN architecture and its relationship to the IPTV subsystem and UEs, the different CDN functional entities.

A number of external Interfaces are specified :

- Interfaces to IPTV service platforms (Cu Qc Ct)
  - Service control related interface, in charge of initiating the delivery the requested content to the UE (Cu, identical to Y2 in IMS-based IPTV, identical to Sa in Integrated IPTV)
  - Management related interface, in charge of administration and provisioning tasks
    - Allows the IPTV subsystem to query the CDNCF for the CCF to be contacted for a content (Qc)
    - Carries IPTV service control signalling originating from the IPTV subsystem to CCF (Ct, identical to Y2 in IMS-based IPTV, identical to Sa in Integrated IPTV)
- Interfaces to UE
  - Content control related interface (Xc' and Xc", functionally equivalent to RTSP).
  - Media delivery interface(Xd'): Delivery information is sent to the UE, after which delivery is initiated and completed by the UE.
- Interface towards content distribution systems :
  - Service control related interface:
  - Media delivery interface:

Assessment

Editor's Note: it has been suggested that the text in this section should be refined to be more factual.

Many of the external interfaces appear to be in line with the CDI requirements, however some introduce coupling that might be contrary to several requirements :

- Y2 ties to the IMS subsystem
- In effect each outside component needs to be aware of the existence of multiple internal CDN components, possibly requiring specific connection setup operations :
    - Integrated IPTV susbsystem needs to know about the CDNCF (for Qc) and CCF (for Ct)
    - UE needs to know about CCF (for XC') and CF (for Xc" otherwise identical to Xc',and Xd')

The internal structure appears to constrain the implementation in contradiction with requirement RN04.

Overall the CDN appears to have been thought as tightly integrated within an IPTV system, which makes implementation more constrained and limits the applicability to more architecture-neutral systems.

There is an explicit provision for CDN interconnection between TISPAN CDNs. In all likelihood this would prevent interconnection of CDNs which internal architecture and implementation is significantly different from TISPAN's.

At this point, there are no content ingestion interfaces specified, though it is mentioned in the overall diagram (4.2).

However it may be possible to specify a subset of TISPAN WI2076 CDN that would be appropriate for the purpose of CDI, if it is complemented with a heterogeneous CDN interconnection addition. That subset should concentrate on the external interfaces while omitting the specification of internal mechanisms and reference points. The exposure of different components to the outside interfaces should be hidden.

ATIS IIF

ATIS IIF has worked on an architecture that was close to that of ITU-T Y.1910 and inherited a similar Content Delivery Functional Block which is described in ATIS-0800007, *IPTV High Level Architecture,*. The specification with the best level of detail is the Content On Demand Working Text[i.12].

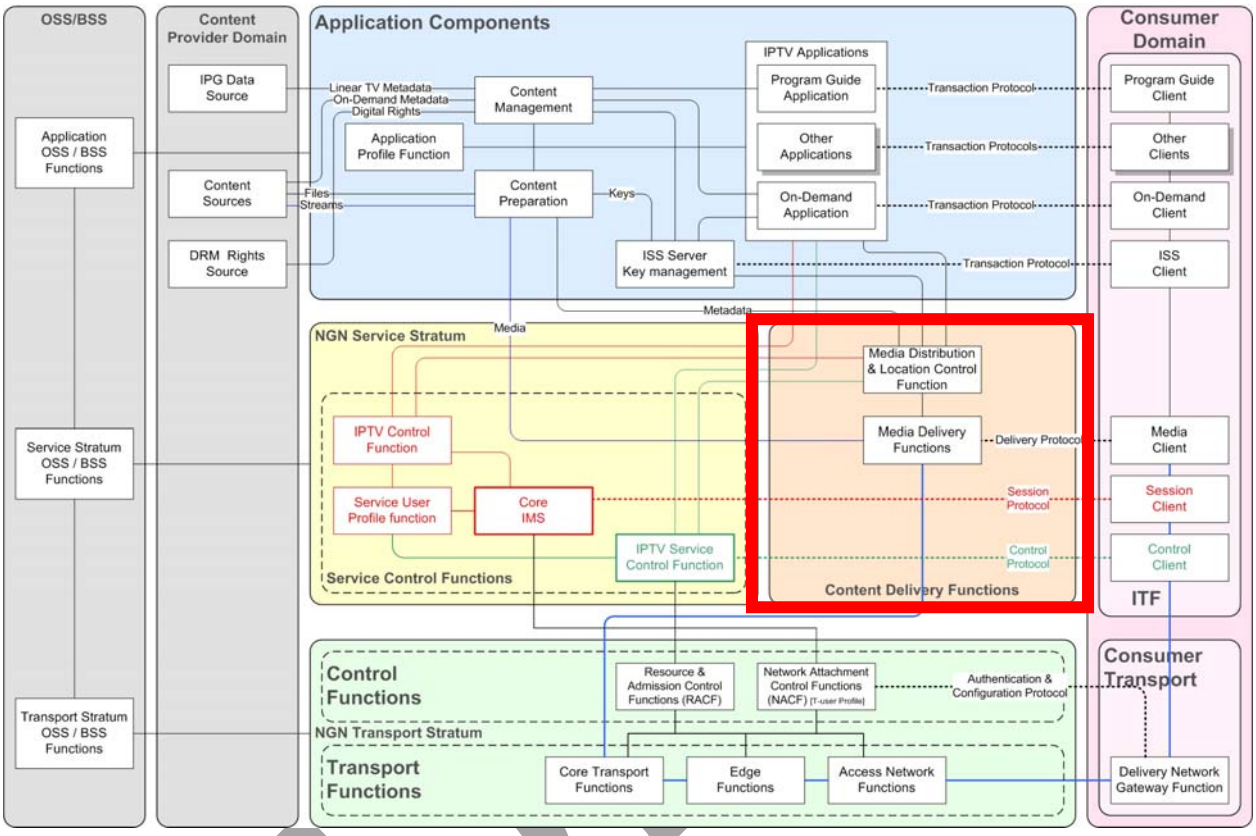
As with the ITU-T specifications, ATIS also retain an IMS-based and a non-IMS-based variant. The main diagram differs from ITU-T's by putting client functions on the right-hand side.

External Interfaces to the Content Delivery Component :

- End User Functions
    - E6, used to exchange content control signaling information (e.g., session setup and teardown in the redirect case, play, pause, fast forward, rewind, download) between the ITF and the CD&SF.
- Service Control Functions
    - S1, used by the CoD Service Control Function to locate an instance of the CD&SF capable of delivering the requested content to the ITF.
    - S5, used to exchange session management information between the CoD Service Control Function and the CD&SF.
- Application Functions
    - C1, used by the Content Origin Function to notify the CD&LCF of relevant information associated with an asset
    - C2, used by the Content Receiving Function to retrieve content from the Content Origin Function.

- C4, used to request security information for the purposes of session-based encryption of the content, if applicable.

- Transport Functions
  - Ud, used by the CD&SF to deliver content streams in unicast mode.



Assessment

Editor's Note: it has been suggested that the text in this section should be refined to be more factual.

Many of the external interfaces appear to be in line with the CDI requirements, however some introduce coupling that might be contrary to several requirements :

- C4 exposes content encryption functions, in contraction with the CDI requirement on content format neutrality.
- S1 exposes content location functions

The internal structure appears to constrain the implementation in contradiction with requirement RN04.

Overall the CDN appears to have been thought as tightly integrated within an IPTV system, which makes implementation more constrained and limits the applicability to more architecture-neutral systems.

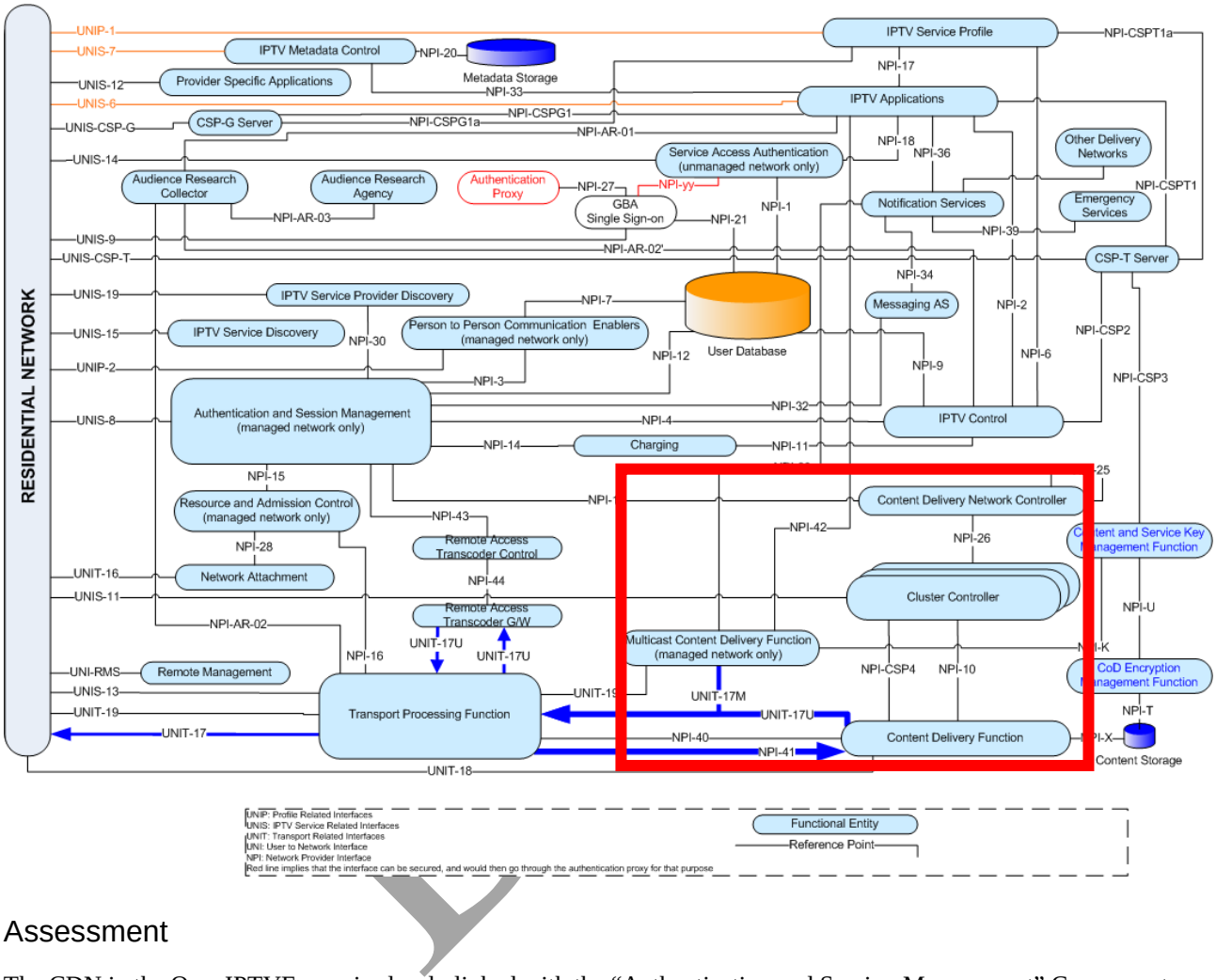
There is no explicit provision for CDN interconnection

At this point, there are no content ingestion interfaces specified, though it is mentioned in the overall diagram.

However it may be possible to specify a subset of this CDN that would be appropriate for the purpose of CDI, if it is complemented with a heterogeneous CDN interconnection addition. That subset should concentrate on the external interfaces while omitting the specification of internal mechanisms and reference points. The exposure of different components to the outside interfaces should be hidden.

Open IPTV Forum

The OpenIPTVForum has introduced a Content Delivery Component for provision of VOD in the Enhanced Managed Profile based on IMS..



Assessment

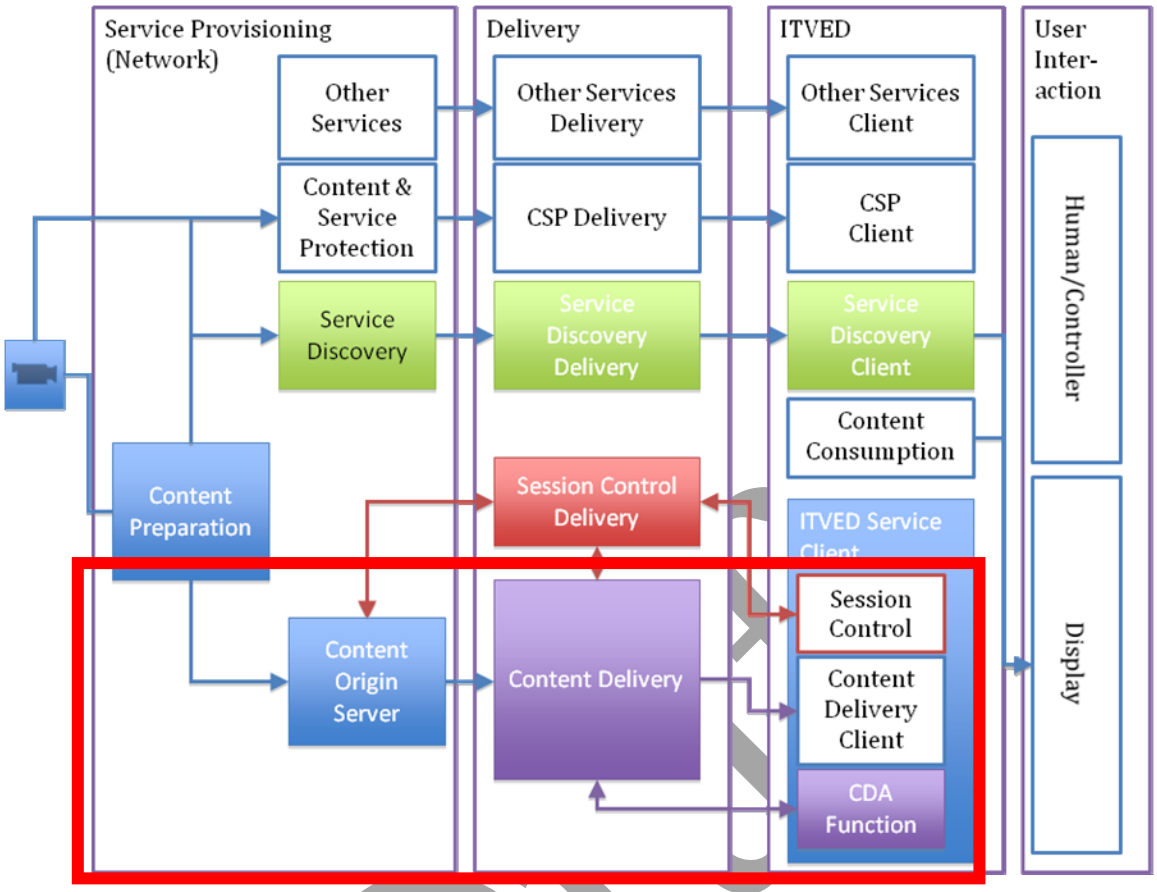
The CDN in the OpenIPTVForum is closely linked with the “Authentication and Session Management” Component (which refers to the IMS), and appears meant to serve only the Extended Managed Profile for the provision of operator VOD services. Control interfaces are based on SIP.

This means that the specification might not be able to support clients implementing simple internet-based interfaces (as included in the OIPF Open Internet Profile, or even the Baseline Managed Profile), which is in contradiction with the objectives of CDI.

DVB

DVB has produced commercial requirements for Internet-TV Content Delivery and is still in the decision process how to proceed with potential technical work.

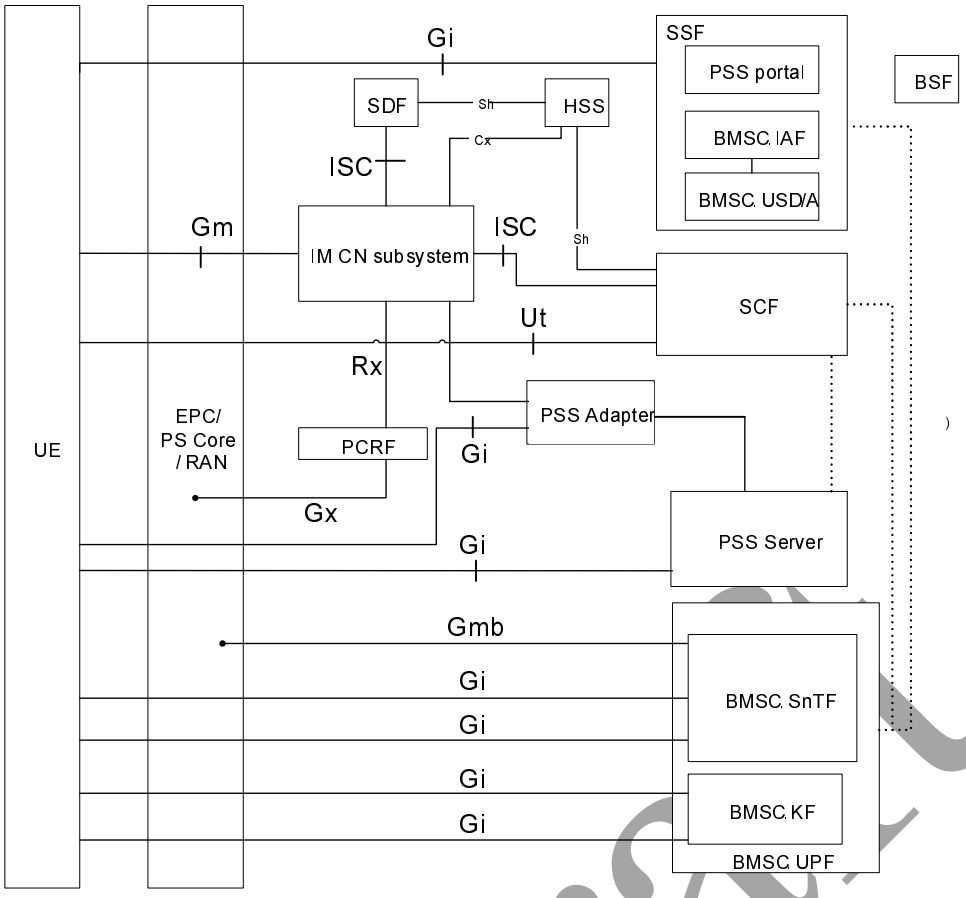
Assessment



3GPP

3GPP has a specification called Packet Switched Streaming which purpose is to stream content to terminals.

Editor's note: requires elaboration and references.



CCSA

Editor's note: more investigation is required to find appropriate information. CCSA has a working group dedicated to CDN, but it is difficult to ascertain their progress. CCSA members are highly involved in ITU-T and ETSI TISPAN, their views might already be reflected in those architectures.

OMA

Content distribution systems in OMA comprise OMA BCAST (Broadcast Services),OMA DCD (Dynamic Content Delivery), and OMA Push enablers, with binding to underlying delivery protocols as illustrated in the figures below.

Figure 2 OMA DCD and OMA BCAST below illustrates the content delivery framework provided by OMA DCD, which enables contextually adaptive delivery of discrete content, as defined by metadata associated with individual service channels and content items.

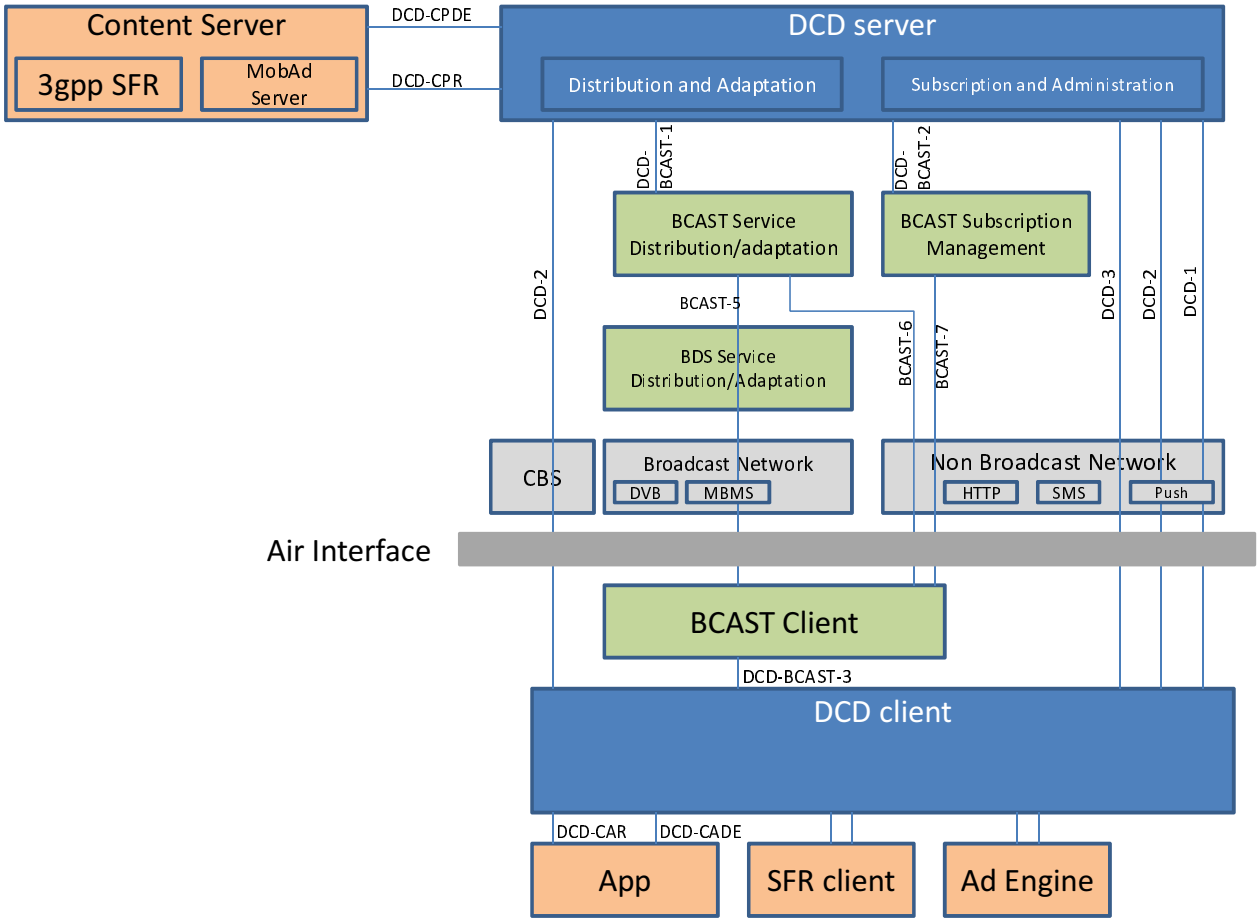


Figure 2 OMA DCD and OMA BCAST

Figure 3 OMA Push below illustrates the content delivery framework provided by OMA Push, which enables server-initiated, contextually adaptive delivery of discrete content across a variety of bearers and protocols.

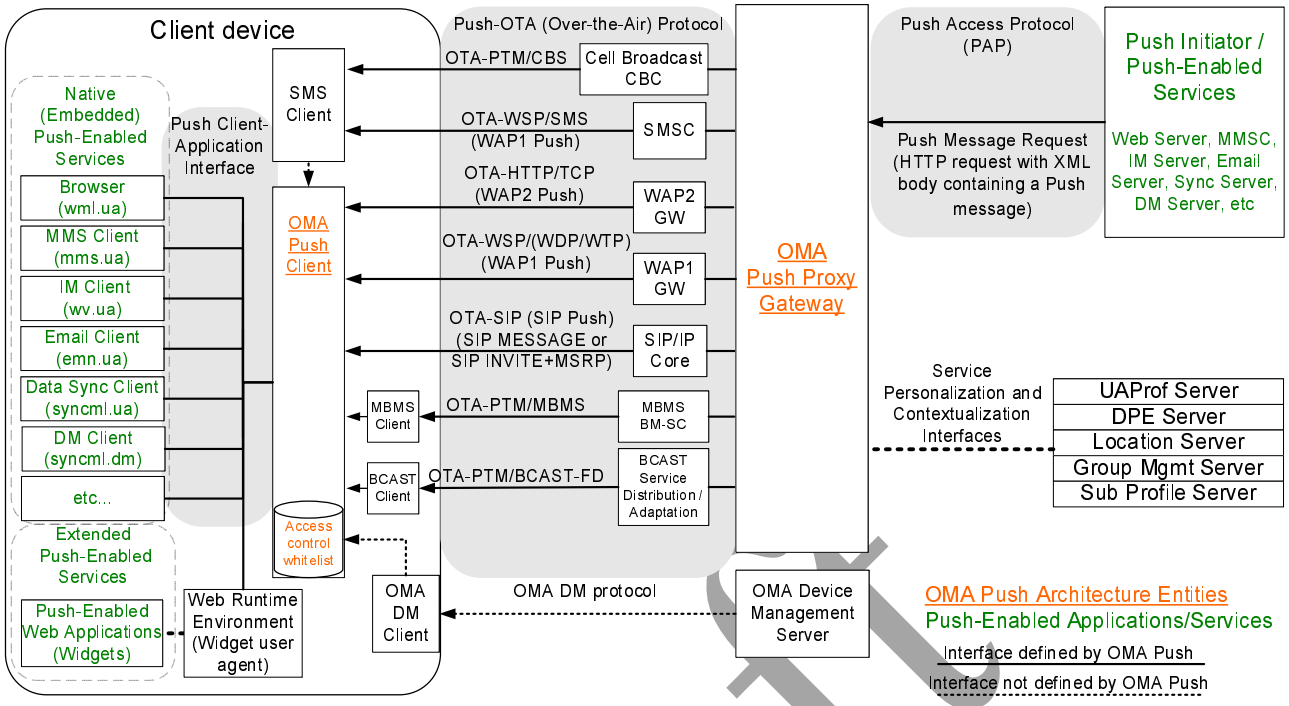


Figure 3 OMA Push

OMA Download

Reference OMA-Download-OTA-V1_0-20040625-A

Editor's note: More work is required on this section.

Existing and upcoming Content Delivery Protocols

HTTP

HTTP proxy caches :

- Known HTTP Proxy/Caching Problems RFC3143
- Internet Web Replication and Caching Taxonomy RFC3466

OIPF Adaptive Streaming

After starting an effort for Adaptive Streaming specification, OIPF has decided to follow 3GPP and to submit their requirements and extensions to 3GPP.

3GPP HTTP Adaptive Streaming

3GPP SA4 has published an adaptive streaming specification as part of its release 9 [i.8]. There will be a number of changes proposed (notably by OIPF) for the version included in release 10. There appears to be broad recognition in the industry that 3GPP HAS will be the reference.

ATIS Adaptive Streaming

Editor's note: there is a section on HAS in the Content On Demand specification which needs to be analyzed.

MPEG DASH

MPEG has launched a call for proposal on DASH (their adaptive streaming effort) and has received contributions, (notably from 3GPP), but has not decided yet on what would be included.

Editor's Note: some information from MPEG is required here.

DVB Adaptive Streaming

This effort was stopped as part of the interruption of the InternetTV End Device specification.

DTG Adaptive Streaming

DTG is considering 3GPP HAS, but has not concluded on the issue yet.

Editor's Note: some information from DTG is required here.

IETF HTTP Live Streaming

In 2009 Apple contributed an Adaptive Streaming draft (draft-pantos-http-live-streaming-01), which has been refined up to now (draft-pantos-http-live-streaming-04). It is said to be widely used in Apple Iphones.

IETF and Content Delivery

In 2002, the IETF has set up the Content Distribution Internetworking (CDI) WG chartered with creating a standard for CDN interconnection.

There were three published (informational) RFCs in 2003 :

- A Model for Content Internetworking (CDI) (RFC 3466)
- Known Content Network (CN) Request-Routing Mechanisms (RFC 3568)
- Content Internetworking (CDI) Scenarios (RFC 3570)

The group died in 2003 with 2 drafts in progress (long expired):

- Distribution Requirements for Content Internetworking
- Security Threat for Content Internetworking

The CDI group died notably because of the demise of several companies that pushed the effort in the dotcom bubble burst, and not from suddenly dying interest. There is still a vivid concern about content distribution in IETF.

Existing and upcoming Content Injection related protocols

Editor's note: work is required in this whole section.

Content injection is the action of introducing content items into the Contend Delivery Infrastructure. As the work on "Needs of Content Providers" demonstrated, this entails pushing content and the associated metadata into the CDI. A specific use was also mentioned to input continuous media (broadcast stream) rather than a single item.

A significant part of this domain entails the determination of injection success status and distribution statistics recovery.

The encoding of the metadata should allow to store the necessary information at CDI stage.

A number of base protocols are appropriate for pushing data files (FTP/SFTP, HTTP, WebDAV,…) and are routinely used by CDN providers in combination with Web-based interfaces.

CableLabs Asset Distribution Interface (ADI)

http://www.cablelabs.com/specifications/MD-SP-ADI1.1-I04-060505.pdf

The specification includes a content model, corresponding metadata specification and content transfer methods (ftp, http, file,…). The associated messaging protocol (based on CORBA) ensures proper completion status transmission.

ISO Archival Interfaces

- ISO 14721:2003 – OAIS (Open Archival Information System) Reference model http://public.ccsds.org/publications/archive/651x0b1.pdf
- ISO 20652:2006 – PAIMAS (Producer-Archive interface methodology abstract standard)

Used by Europeana (http://www.europeana.org/).

BT WCC / CDD

Existing CDN Proprietary Solutions

Editor's Note: it is extremely difficult to obtain information about CDN interfaces and internals of commercially deployed Content Distribution Systems. In addition, most of the information that can be obtained is subject to IPR constraints that render it unpublishable under ETSI rules. Failing proper IPR release by their owners, this section might need to be removed.

Akamai

Limelight

Amazon S3

Microsoft SilverLight

Adobe Flash Streaming

Editor's Note: This section has not changed since its creation, it could thus be removed if no significant progress is achieved before the document is finalized. There seem to be a real operational difficulty in getting reliable information on some of these solutions.

Gap Analysis

The analysis of the aforementioned state of the art solutions reveals that there is a lot of commonality between the different approaches. However there are reasons to believe that interoperability across them will be difficult. While there is a relatively small set of protocols to be supported, several solutions appears to bring specific elements that tie it with a larger architectural component.

This appears to be the consequence from the early birth of these CDNs as integral components of broader IPTV subsytems (as exemplified by ITU-T, ATIS IIF, ETSI TISPAN). In many cases, it is difficult to envision the deployment of these CDNs without the ensemble they were conceived with, though it is often possible to interconnect the internal CDN part with a generalized external CDN (which is the case for ETSI TISPAN).

In addition, many of the solutions take the approach of specifying in detail the internal workings of the CDN. The benefits that can be expected from this approach are to ensure substitutability of internal components (an approach that has been widely supported by such organisations as 3GPP, ETSI TISPAN, ITU-T and ATIS IIF).

However, if such a substitutability requirement is not explicitly stated, the CDI requirement to leave implementation latitude takes precedence. It allows to ensure that the CDN architecture and function adopts the most efficient implementation.

Nevertheless there seem to be potential to unify many of the traits of the aforementioned specifications by concentrating on the common points :

- User Equipment Interfaces, which need to be largely common to all, especially in the open internet.
- Content Ingestion Interfaces, which have little reason to differ sharply

The CDN interworking interface presents a different issue because it is not considered in its entirety, when it is at all. ITU-T and ATIS IIF do not mention it explicitly. ETSI TISPAN addresses interconnection between TISPAN CDNs. If there are non TISPAN CDNs in existence (which is non only likely but already a reality), there need to comply with large tracts of the TISPAN CDN architecture and protocols whatever their internal architecture is today.

CDN Architectures and Interfaces

MCD Work Item 2 (TR102688_02) had identified the following potential architecture :

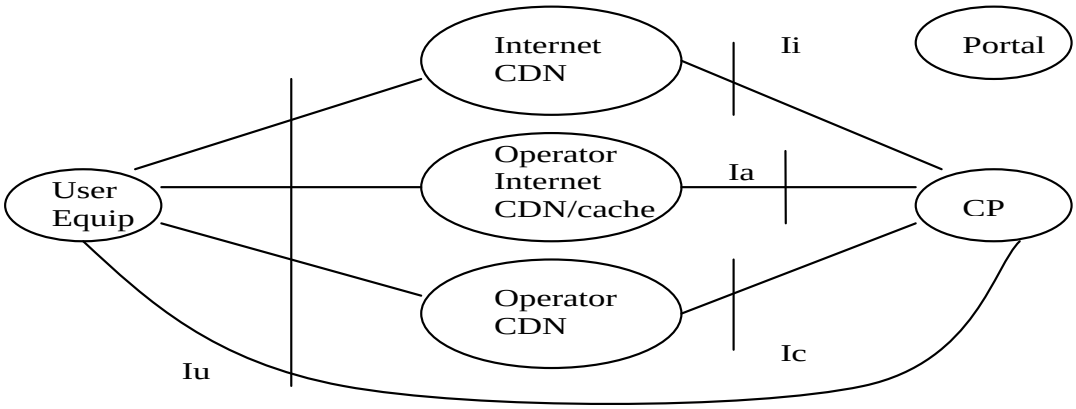


Figure 2: Components and interfaces

The evolution of the requirements has led to consider a number of changes to the original ideas.

Standardisation scope

Some standards call for a complete system specification of a CDN. This work item is attempting another approach, which is to specify the bare minimum to fulfill the desired functions. This allows for higher implementation flexibility, and permits the exploration of different internal design choices that might prove necessary or useful depending on the targeted use cases or deployment scenarii.

Separation of roles

In addition, to allow for maximal decoupling between the different functions, the architecture tries to define several large sub-blocks, of which the CDN itself is only one :

- Content Preparation
- Content Delivery (CDN)
- Content Publication (out of CDI scope)

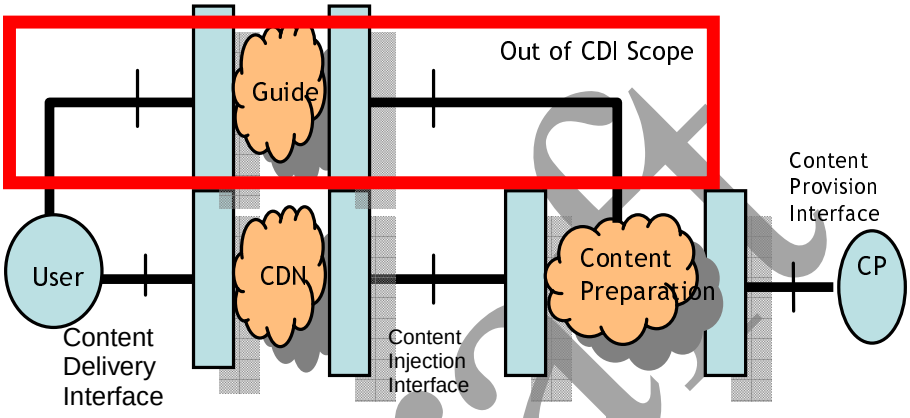


Figure 3 Functional CDI Blocks

In this diagram, each Functional Block is composed of one or several exposed components (the rectangular boxes) and an opaque component (the clouds). This is to outline that the implementation of these opaque parts is out of scope of the CDI work item, which is solely concerned with the exposed components in the Content Delivery Chain and their interfaces.

These functional Blocks host several interfaces :

- The Content Provision Interface, lying between the content provider and the Content Preparation Block
- The Content Injection Interface, lying between Content Preparation and the CDN itself
- The Content Delivery Interface, lying between the User and the CDN

Additional interfaces may be defined around the Content Publication Block, but the latter is out of the scope of this document.

Content Delivery

Content Delivery is the interface between the CDN and User Equipment. This interface is heavily constrained by the base of terminals already deployed, along with the common practises of the CDN industry.

This interface really consists in two phases : content request resolution, and content delivery proper. Content Request resolution starts from the user request for a given piece of content. Resolution is the process to turn this (abstract) content reference (typically an URI) into a workable (concrete) content reference (usually an URI). Many delivery protocols facilitate multi-step transparent resolution processes with “redirect” functionality, allowing sophisticated and late-binding resolution strategies.

Content Injection

Content Injection is the interface by which the CDN is being filled in “push mode”, usually by the Content Preparation system.

Note: Should investigate if there is a need for a "pull mode" interface.

Content Provision

Content Provision is the interface Content Providers use to push content into a Content Preparation system.

Note: Should investigate if there is a need for a "pull mode" interface.

9.4 CDN Interconnection

This interface supports the interconnection between two CDNs.

Note: CDN Interconnection is the subject of MCD WI13.

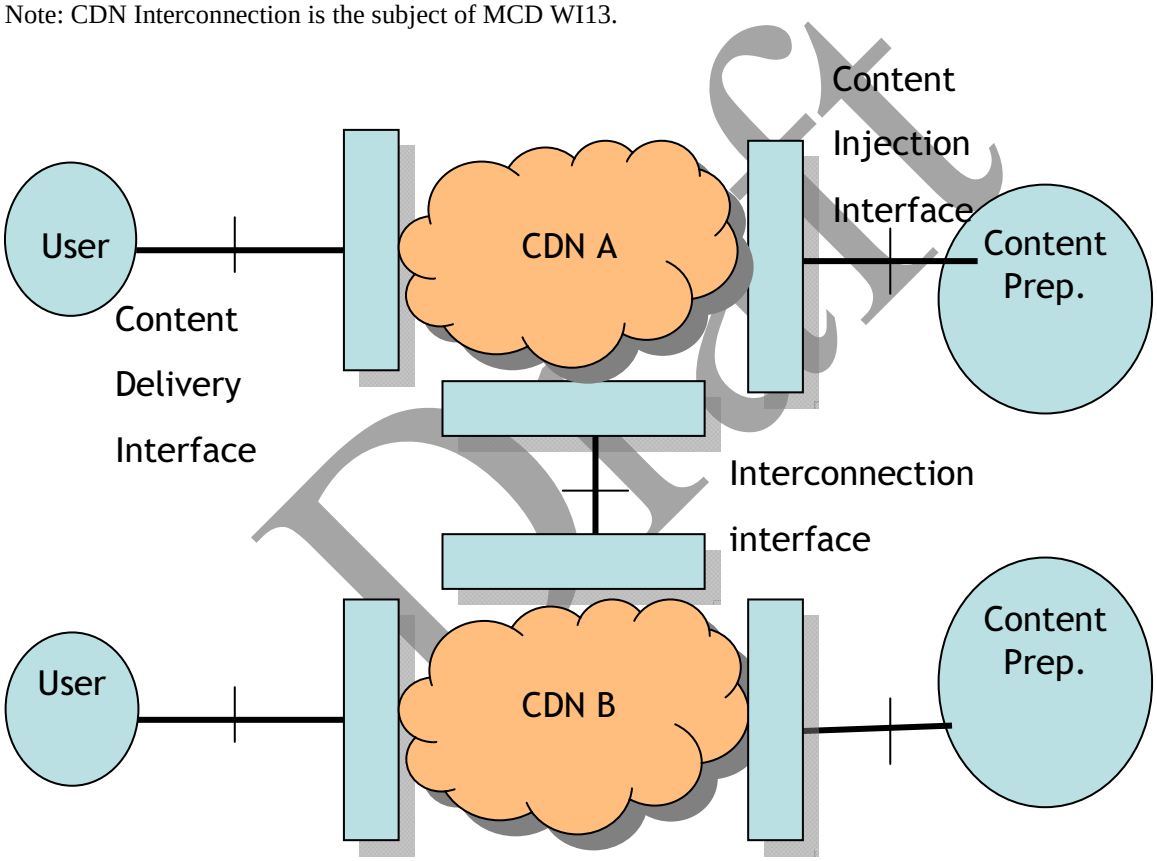


Figure 4 CDN Interconnection

Again, in this diagram the implementation of the opaque components is out of scope of CDI. Evidently, the interconnection interfaces may constrain the implementation, but they constitute the only relevant part for the CDI work.

Conclusions and Recommendations

Content Delivery is a very active domain where a flurry of standards and solutions are present with many others actively developed. There is a high risk for MCD to overlap with one of those initiatives if great care is not taken to concentrate on original requirements and specific areas.

Content Delivery Protocols are a booming area, and there is a significant chance that several Adaptive Streaming protocols will emerge within 2010. It is unlikely that MCD can provide value in this space, except possibly by endorsing one of the protocols defined by another organisation. The market is likely to resist embracing several contradicting solutions, and a small number of preferred solution could naturally emerge.

Content Delivery Architectures are also present in numbers, but most are linked to an IPTV solution, there is no clear neutral CDN appropriate for general content delivery within the internet. There is little work on the domain of content injection interfaces, though CableLabs's solution appears to get significant traction within the content community.

Overall, there appears to be room for work on the following areas :

- Overall architecture of Content Delivery Infrastructures
- Content Delivery Interface, between the CDI and the user, essentially to precise what client devices should support.
- Content Injection Interface, to harmonize different push interfaces (ADI…) and put them in a consistent picture, with harmonized metadata.
- CDN Interconnection Interface, to enable the connection of heterogeneous CDNs.

It is recommended that MCD works on these elements to achieve a consistent system for CDIs and prepares Technical Specifications.

Finally, there should be room for cooperation within ETSI by allowing MCD and TISPAN to collaborate on a specification that would bring :

- A simplified CDN high-level architecture similar to that of MCD, and close to the very high-level architecture of TISPAN
- A specification of the UE interfaces that are not linked to TISPAN IPTV (presumably a combination of HTTP, RTSP/RTP and Adaptive Streaming)
- A specification for a Heterogenous CDN interface (already the objective of a MCD work item).
- A specification for a Content Ingestion Interface

This specification could take the shape of a subset, superset or profile of the TISPAN CDN interface so as to reuse a maximum of the work already performed.

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Annex B
Bibliography

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History

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History box entries

Document history		
V0	2010.01.20	First draft with scope, initial proposed structure for the table of contents
V1	2010.02.12	Draft with initial content
V1.5	2010.11.23	Draft after 10 Q3 contributions
V1.5.1	2010.12.2	Draft before dec meeting
V 1.5.2	2010.12.6	Draft with corrections from dec meeting

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