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Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Peer-to-peer for content delivery for IPTV services: analysis of mechanisms and NGN impacts

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN).

Introduction

There is an ever growing demand for an ever wider variety of content and content services ("the long tail"). Content may originate from all over the world, both from professional content makers and home-recorded user-generated content. Roaming users may want to access the same content (BC channels and CoD) that they can access when they are not roaming. The number of available "television channels" will explode from several tens to several hundreds and more. The number of available titles in a content-on-demand library will grow from thousands to ten thousands or even more. There will also be a separation between the delivery of the (encrypted) content itself, which is a bulk process, and the trade of viewing rights using conditional access and/or digital rights management.

Peer-to-peer technologies are very effective for the delivery of streaming content further down the "long tail". However, peer-to-peer content sharing also has some drawbacks on network capacity availability, the free cash flow of ISPs and on customer experience due to slowed down throughput of broadband access and internet.

Peer-to-peer mechanisms could be interesting to IPTV providers in various ways.

- IPTV providers could offer peer-to-peer support as a service:
  - caching and distributing content on behalf of the user;
  - content management services for the CNG;
  - session support for peer-to-peer delivery:
    - identity management (UPSF);
    - quality of service control (RACS);
    - service attachment (NASS).
- IPTV providers could also use peer-to-peer mechanisms for distribution of content (optimization):
  - peer-to-peer delivery as alternative to static multicasting;
  - peer-to-peer mechanisms to distribute content over regionally distributed MDF;
  - peer-to-peer mechanism to have content be exchanged directly between UE or CNG, bypassing MDFs;
  - super-peer-based solution architectures for content caching optimization.

The TISPAN Release-2 IPTV architectures (TS 182 027 [i.1] and TS 182 028 [i.2]) do not support peer-to-peer mechanisms for content delivery. The basic assumption of the TISPAN R2 IPTV architectures is that all content originates from an MDF, without any further assumptions how the content gets there in the first place.

TISPAN may develop a broader view on the origins of the content, and define interfaces for content origination for example from:

- content providers;
- other IPTV Services providers; and
- users themselves.

Because of this broader view on the flow of content origins, it was considered useful to have a better understanding of the mechanisms used to handle, distribute and deliver the content, resulting in the present document.

1 Scope

The present document is an ETSI Technical Report which contains only informative elements.

The words "shall" and "must" used in the present document either refer to requirements defined in other documents or propose requirements that could be used later on in a document containing normative provisions such as a Technical Specification or an ETSI Standard.

The present document analyses peer-to-peer technologies for content delivery for IPTV services: use cases, requirements, architecture studies and other aspects.

The scope of the present document includes:

- Use cases and requirements:
  - Types of peer-to-peer mechanisms:
    - delivery of stored/off-line content;
    - delivery of streaming content.
  - Application of peer-to-peer mechanisms:
    - deliver content from IPTV Service Provider to Consumer;
    - share User-Generated Content (UGC) between users via the IPTV solution;
    - acquire content from third-party Content Providers by IPTV Service Provider;
    - manage content within the IPTV solution;
    - customer profiling based on traffic characteristics.
- Architecture studies:
  - topology analysis;
  - super-peer-based solution architectures;
  - impact on TISPAN IPTV network architecture;
  - impact on Customer Premises Network architecture.
- Other aspects:
  - network aspects, transport level;
  - security aspects, risk analysis;
  - legal aspects;
  - charging aspects;
  - indexing aspects ("naming");
  - concatenation of peer-to-peer ("NNI").

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
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Not applicable.

2.2 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.

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3 Abbreviations

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

AF	Application Function
A-RACF	Access-Resource and Admission Control Function
ARC	Audience Research Collector
BC	BroadCast
BTF	Basic Transport Functions
CDN	Content Delivery Network
CNG	Customer Network Gateway
CoD	Content on Demand
CS	Content Server
CSBF	Capability and Service Binding Function
EPG	Electronic Program Guide
FTP	File Transfer Protocol
HTTP	HyperText Transfer Protocol
IGMP	Internet Group Management Protocol
IMS	IP Multimedia Subsystem
IPTV	IP Television
ISP	Internet Service Provider
MCF	Media Control Function
MDF	Media Delivery Function
MF	Media Function
NASS	Network Attachment SubSystem
NBAC	Network Based Application Control
NGN	Next Generation Network
NNI	Network Network Interface
NPTF	Network Pattern Triggering Function
OTT	Over The Top service
P2P	Peer-To-Peer
PASDF	Pattern Analysis and Service Discovery Function
PVR	Personal Video Recorder
QoE	Quality of Experience
QoS	Quality of Service
RACS	Resource and Admission Control Subsystem
RCEF	Resource Control Enforcement Function
RTSP	Real-Time Streaming Protocol
SIP	Session Initiation Protocol
SN	Super Node
SN-C	Super Node - Core
SN-T	Super Node - Tracker
SP	Service Provider
SPDF	Service-based Policy Decision Function
UE	User Equipment
UGC	User-Generated Content
UPSF	User Profile Server Function
URL	Uniform Resource Locator
VoD	Video on Demand

4 Overview of peer-to-peer

4.1 Network operator involvement in peer-to-peer

As the contributors to ETSI TISPAN are mainly network operators and their vendors, this Technical Report has expectedly a network-operator perspective. During this study, it became clear that there are many different perspectives that a network operator can look at "peer-to-peer". This is illustrated in figure 4.1.1. Notice that the business role of the "Network Operator" at the left gradually changes to "IPTV Service Provider" at the right.

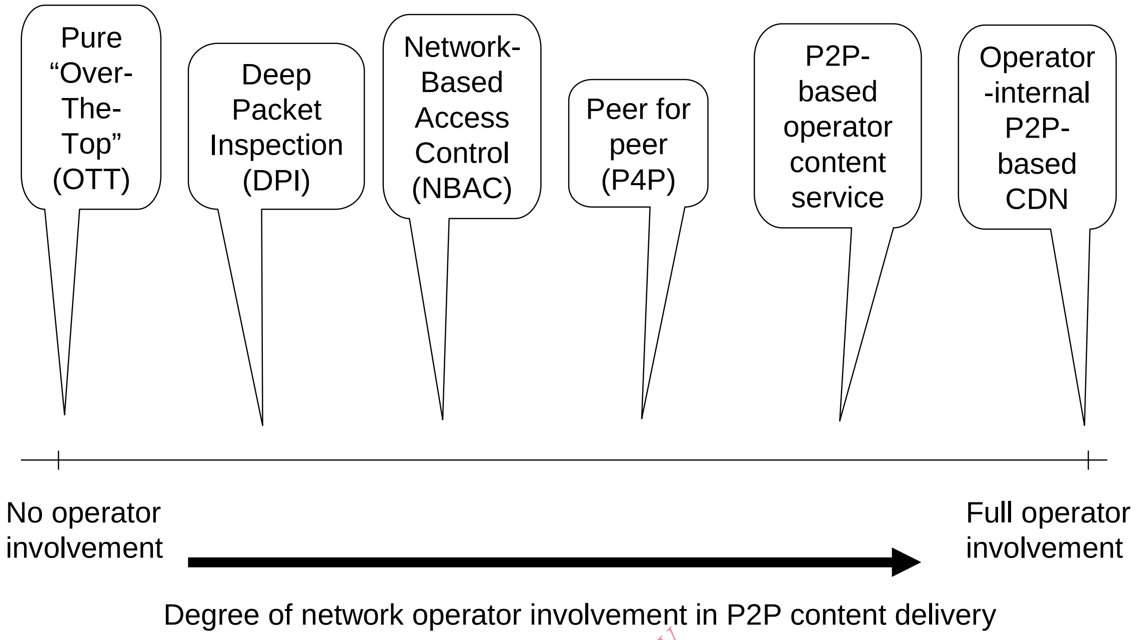

Figure 4.1.1: Many ways for an operator to look at "peer-to-peer"

First of all, P2P can be seen as a content-delivering application that runs over the top (OTT) of an operator network. From the operator perspective, P2P is than merely a use of their best-effort bit pipes.

Some network operators consider over-the-top P2P and other bandwidth-hungry applications as a threat to their network, as the P2P traffic may push aside other traffic and hence deteriorate the Quality of Experience (QoE) of those other services. Throttling the bandwidth-hungry applications by using Deep Packet Inspection is one of the approaches that network operators are considering and using.

The above threat may also be considered as a business opportunity to network operators. End users may be willing to reserve (and pay for) bandwidth guarantees for specific over-the-top applications in order to enhance their QoE. Network-Based Access Control (NBAC) technology is an example of technology in this area. NBAC is extensively described in the present document.

As a next step, network operators may try and get involved in the actual content delivery by the over-the-top application, e.g. by placing caches and stream replicators in the operator network. One initiative in this area is P4P, which is also described in the present document. P4P provides network operators an additional degree of freedom of investment, which can be in transport capacity, but now also in content delivery technologies.

Network operators may also decide to operate their own P2P-based content delivery system, using end-user equipment (UE) to cache and upstream content.

Finally, peer-to-peer technology may be considered a solution to implement large content delivery networks within an operator network. By enabling Media Functions (MF) to exchange mutually content, this reduces the load on the content sources and distributes traffic more evenly over the network.

4.2 Peer-to-peer in a network-operator CDN

In an IPTV system, the large size media contents normally vary from hundreds of megabytes to gigabytes and even above. As a result, network bandwidth and storage capability are facing higher requirements.

Figure 4.2.1 shows a traditional Content Delivery Network (CDN) with a centralized architectures and hierarchical layers. When the edge server receives a request from any UE, it will transfer the UE request to the central server when it exceeds its process capacity. With an increasing number of UEs, the burden on the central server will be becoming even heavier, and user experience will be badly influenced. The system will have to deploy more and more edge servers closer to UEs to provide better service. How to reduce the cost of the IPTV Service Provider, and how to improve user experience becomes crucial.

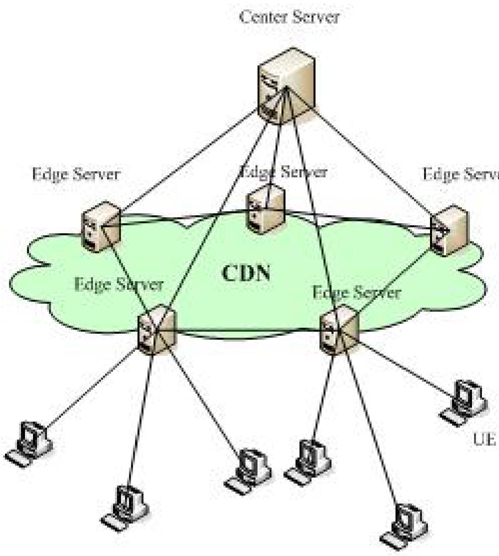

Figure 4.2.1: A traditional Content Delivery Network

Peer-to-peer technology is a way to overcome this problem. By sharing the capacity between different edge servers in a P2P network, more requests can be processed without reaching the central server.

Figure 4.2.2 shows how, when an edge server receives a UE request and it cannot serve it locally, instead of transferring the request to the central server, it searches for the requested content within all edge servers of current layers. It will transfer the request to central server only if none of the neighbouring edge servers do not have the requested content in storage.

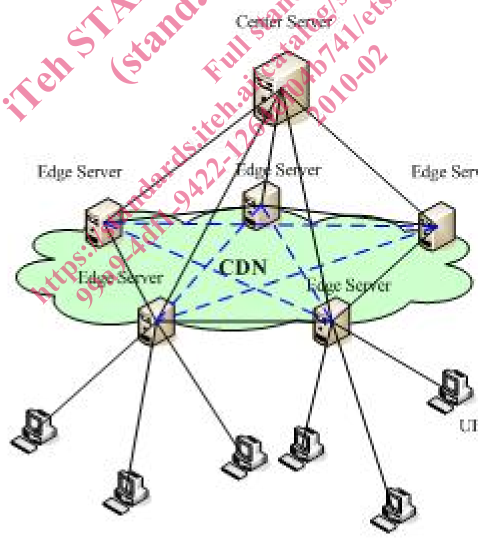

Figure 4.2.2: Using P2P within the CDN

Figure 4.2.3 shows the deployment of P2P technology in the user premises network. UEs can share media contents as well as their aggregate processing capacity, memory and disk storage with each other. This way the UEs can achieve a better Quality of Experience (QoE) for the user.

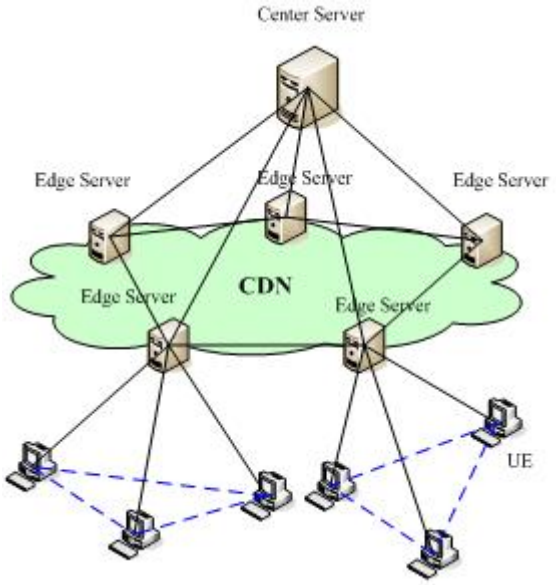

Figure 4.2.3: Using P2P within the user premises networks

5 Use cases and requirements

5.1 Use cases

5.1.1 Delivery of stored/off-line content

Peer-to-peer technology can be used for the delivery of stored/off-line content. As this is a classic P2P use case, it has not been worked out in more detail.

5.1.2 Delivery of streaming content

Peer-to-peer technology can be used for the delivery of real-time streaming content. The following use case is an example of this.

It is Olympic Games time, and millions of people want to watch the live final football game. Gradually, more and more people join the watching queue, but unfortunately, the network provider cannot provide access to multicast functionality. In this scenario, as servers become overloaded, the Quality of Experience (QoE) for the end user deteriorates. An alternative solution to the operator is using application level multicast based on Peer-to-Peer technology. Application level multicast can even improve the QoE with increasing numbers of UEs.

5.1.3 Time-shift TV

Peer-to-peer technology can be used for Time-shift TV. The following use case is an example.

It's 8 o'clock in the evening. Alice is watching a live football game and Rose is watching the same program at the same time. Suddenly the famous football star, Ronaldo contributed an excellent goal. Alice watched the fantastic scene again by using Time-shift TV functionality, almost at the same time that many football fans were also watching again that scene. Everyone can share the hot goal content by using peer-to-peer technology.

NOTE: User consent is required to make recorded content available for retrieval by other users.

5.1.4 Metadata exchange

Metadata is similar to other types of content. P2P solutions may be used to deliver metadata.