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3 Executive Summary

This document gives an actual view on the relevant VITAL++ markets. Starting with the individual needs of the relevant players on the market and the resulting technical requirements on peer-to-peer and SIP/IMS systems, this report continues with the specific peer-to-peer services already established on the market. The actual trends on combined peer-to-peer SIP/IMS technologies and solutions are presented, before commercial operator products deployed by Telefónica and Telekom Austria are finally presented.

The most important findings of D6.3 are coming from the multitude of peer-to-peer clients, which are well established on the video streaming and Internet TV market. The implementations comprise a broad variety of technologies, from proprietary to open source code implementations or from overlay-based peer-to-peer solutions to http-based applications.

The combined peer-to-peer-SIP and peer-to-peer-IMS solutions are still in an early stage of development, first approaches on the markets are shown in this document. For the implementations on a large scale, which is expected within the next couple of years, VITAL++ can play a significant role by contributing to the open source development. On the other hand, the R&D of peer-to-peer-IMS technology is mainly driven by industry and, thus, not visible to the general community.

Finally, commercial IPTV products have turned out that they are mature in providing centrally hosted streaming services, but are still far from peer-to-peer content distribution or SIP/IMS based signalling and procedures.

4 Introduction

4.1 Scope

The *Interim market assessment*, reported in this deliverable, gives an overview and analyses the relevant peer-to-peer (P2P) and SIP/IMS markets. Commercial TV solutions, combined P2P and SIP/IMS approaches, interworking requirements and commercial operator products are presented and discussed.

The use and exploitation of specific VITAL++ results by the project partners has already been presented within D6.2 "Impact creation plan", as a snapshot after the first six months. The final version at the project end will be part of D6.4, along with a final update on the market assessment.

4.2 Structure

This deliverable is structured as follows:

- Chapter 5 elaborates the requirements of the key players on the market.
- Chapter 6 continues with pure P2P services and clients, some of them already well established on the Internet TV market.
- Chapter 7 presents the combination of P2P and SIP technologies and the corresponding implementation initiatives, while chapter 9 shows the P2P/SIP solutions on the market.
- Chapter 9 describes combined P2P/IMS approaches.
- Chapter 10 gives an overview on commercial operator products on the market, which relate to content distribution.
- Finally, the market analysis of Chapter 11 concludes this deliverable.

5 Market Requirements

5.1 User Requirements

Though lately there has been a steady increase in available bandwidth resources to a home user, a tendency that will continue and probably speed up in the near future, the improvements in media quality tend to outweigh and cancel those advantages. For instance, the transition from SD video formats to HD formats has doubled and even tripled the user needs regarding home internet accesses.

The situation above described can worsen and even decay if the typical structure of a family unit is taken into account. Far are the times where the whole family sat before a single radio or TV set, because, quite the opposite, nowadays each member demands access to its own private set of media contents, which are enjoyed in intimacy, hence setting a further strain on the available bandwidth resources at the home internet access.

Besides, as bandwidth resources grow, a common user will expect to profit wholly from its full capacity, enjoying shorter response and download times, in the case of single files to be played offline, or a smaller percentage of interruptions/pixilation while playing, when video and audio streaming are involved, without leaving aside the need of keeping abreast of latest improvement in media quality (from SD formats to HD format).

Another interesting point arises from the current and ever growing variety of devices (iPods, mobile devices, handset players, multimedia disks, and the ever ubiquitous PC) together with an even larger range of software players that a user can choose to play the downloaded/streamed contents. Even non-sophisticated users will expect and demand that a retrieved content will be easily playable in any available device, without requiring further installations/configurations. This requirement may lead up to a reassessment of DRM technologies and its usage, which too often chain the user to a precise piece of software and prevent it from been played in other gadgets/devices at the user's disposal.

As a final point, while visiting a content provider's catalogue of media, a user will expect one of two situations, either browsing across a selection wide enough to enable him/her to find some of his/her preferences, or a site specifically catered to them, and of course large enough to include those contents absent in more generalist/commercial sites. In any case, powerful and easy to use search capabilities should be put at user's disposal for him/her to find the contents he/she like, either inter-site or intra-site.

All in all, the end user experience of the service depends on the following criteria:

- Service availability and reliability: Downtimes, congestions, available bandwidth, Streaming continuity, shared access networks (e.g. WiFi)
- Content type: Premium content, live events, exclusivity, VoD catalogue quality
- Content resolution: HD/SD, Dolby Surround, AAC (Advanced Audio Coding)
- Perceived quality: Quality of IP transmission, artefacts, video/audio synchronism, audio distortions, presentation of fast moving objects, responsiveness, channel change time
- Customer service: Time and way to solve end user problems
- Usability: Easiness and friendliness of service discovery and selection interface
- Additional features: Subtitles, multi-language support, IPTV features such as electronic program guide and time-shift
- Converged services: Integration with Internet, VoIP or personal content; Buddy lists with presence status, chat, see-what-I-see

5.2 Network Provider Requirements

From a network provider's point of view there are a number of paramount matters that should be taken into account.

As it is widely known, content sharing and media distribution services tend to exhaust network bandwidth resources too easily, especially when dealing with contents that remains under public's eye for a while (i.e. the latest blockbuster). Even when user connections' speed is growing steadily and the content could be streamed without any trouble through an isolated environment, that would likely lead up to bottlenecks through the access networks, as an increasing amount of users located in nearby areas request the very same content and/or this is located in a single site or a limited amount of them.

Therefore, a threefold strategy need to be explored and implemented. Firstly, the less congested path in the network linking user and server, have to be determined and the download/streaming being rerouted through it. Since network load is in a constant flux, forecasting and anticipation should make an integral part of routing procedures, without neglecting the resource reinforcing of the likely expected to be clogged areas.

Besides, each single content can demand very different bandwidth requirements according its popularity, even surpassing the transmission capabilities of the providing site and/or the network segment it gives access to. Hence, copies or replicas should be distributed across the network, whose creation and upkeep is a network manager's responsibility, not content provider's. This distribution should be carried out in response to consumers'

patterns, ensuring that the most requested contents are allocated most of the copies and that those fresh copies are located near the users requesting them, therefore reducing the amount of leaps to be crossed to reach the content and the impact of the transmission of a particular content on the network as a whole.

From this network's content awareness, it ensues that the network provider will have to ensure the existence of a growing amount of storage capabilities in its network, as well as the more commonly required transmission ones, plus the traffic overhead required to transfer those copies. The storage space so allocated will have to follow and even anticipate the growth of the offered content providers' catalogues and the users' demands, without incurring in excessive costs or resource waste on the network provider's side.

As a final point, those requirements in traffic and storage force the chosen network solution(s) to be highly scalable so that the arising demands in the network, either in a specific area or as whole, could be easily met by adding new elements of the type of those already installed, without compromising the performance or prompting a redesign, which tend to be costly both in resources and time.

5.3 Service Provider Requirements

Prior to the analysis of the service provider's requirements, it is important to realise that this label disguises a wide range of roles. There could be public and private broadcast companies, owning or with access rights to content catalogues more or less varied, service providers offering hosting to other content providers or simply compiling list of links to other people's contents, or merely the small creator or average individual who wants to disseminate its work or life experiences, either to a wide audience or a restricted circle or friends. However, in spite of this variety of possible actors, a common set of requirements can be extracted.

Firstly, cost matters should be assessed in a twofold way. On one hand, there is a growing need of bigger storages, as the amount of available contents steadily increases and, as better quality media are made available, the file size required for the encoding of those contents grows accordingly. On the other hand, those new bigger formats and growing content libraries will require wider bandwidths on the server's side in order to serve every user's request, whose amount can also dramatically increase as more and more people obtain an Internet access, without excessive delay or compromising its quality.

Therefore, Quality of Service should be assured so that those contents can be delivered to requesting user with the expected quality. What Quality of Service is or consists of, will generally depend on the provided service. For example, a file upload and download service will dramatically differ from a HDTV broadcast service, being the first roughly interested in contents being downloaded

without delay and transmission errors and the other broadly in keeping low the level of interruptions/pixilations while playing.

If some sort of business transaction between the user and the service is required (i.e. the purchase of a single content or the subscription to a broadcast) the security of all the data exchanges should be assured, besides providing the proper mechanism for the authentication of both user and provider, in order to avoid any sort of theft/forgery/swindle.

Besides, it is also important to provide some mechanism of DRM so that the service can define how and where copies of the available contents can be create, delivered and played, in order to protect author's rights or honour licence's terms.

To conclude, the service provider will also require that their contents will be available anytime, from anywhere and in (almost) any pertinent format, so that the provided service could be reached by any user interested in and granted access to. For a number of reasons, ranging from content privacy to license matters, the service provider should be endowed with tools to set up availability's policies on the offered contents, for instance, that a defined one could be retrieved by only a defined set of users, on a certain time margin or from a specific geographical area.

5.4 Legal Requirements

Copyright reserved content has to be protected with appropriate technologies so that unauthorized access can be avoided. The legal basis for the protection mechanism has been set in 1996 by the WIPO Copyright Treaty (WCT). The treaty requires the WIPO (World Intellectual Property Organization) members to implement national laws against DRM circumvention. All EU member states are subject to this Treaty.

In the US, the Digital Millennium Copyright Act (DMCA) has been implemented for this purpose, while in Europe the Treaty has been enforced by the 2001 European directive on copyright.

As a consequence, DRM technologies have been introduced to try to impose limitations on the usage of digital content and devices. While video content is in many cases still protected by DRM systems, some major audio labels have recently decided to publish DRM free audio content, e.g. in January 2009, Apple announced that DRM shall be removed from 80% of the music catalogue in the US.

6 Peer-to-Peer Services

6.1 Introduction

Peer-to-peer services have started in the late 1990s with file sharing systems. The respective P2P client evaluation and market overview has already been presented within D2.1. The rapid and widespread deployment of P2P services has been driven by the increasing number of Internet users, higher bandwidths at lower prices, coding schemes with higher compression (e.g. MP3), the multitude of appropriate audio players and the zero cost character of the P2P software.

Napster[1], as a well-known example, has undergone a typical life cycle of such early file sharing systems. While Napster has spread at an enormous pace at its beginnings in 1999, the opposition of the content owners has formed and became stronger almost at the same speed, leading into a shut down of the service in 2001. At the same time, a great variety of alternative solutions has been placed on the market, all with slightly different focuses and improved technologies.

After a period when file sharing was decisively restricted legally it has slowly won back grounds to grow and prosper. Music and other file sharing applications still seem to have the strongest appeal; the most popular BitTorrent software is used by many providers, distributing free and legal content as well as copyrighted material. MTV, Comedy Central, SEGA and Warner Brothers are among the most prominent content providers using BitTorrent technology.

This chapter will look into the market and technologies used, including various Internet-based TV Services, Skype, Adobe's Flash player. It will conclude with an overview of the requirements for the interoperability between different P2P systems.

6.2 Internet TV

6.2.1 State of the Art

One of the most common techniques for distribution of live media content is the peer to peer Internet Television. Internet television allows viewers to choose the show or the TV channel they want to watch from a library of shows or from a channel directory. The two forms of viewing Internet television are

[1] http://en.wikipedia.org/wiki/Napster, http://free.napster.com/

streaming and downloading onto a computer. The video may be broadcasted within a peer-to-peer network[2].

Internet TV, in case it is based on P2P techniques, it relies on the use of software applications that can support distribution of content to numerous endpoints based on the fact that they feed each other with content minimising the uploading requirements at the source of the stream. Such a system for Internet TV distribution is called P2PTV.

In a P2PTV system, each user, while downloading a video stream, is simultaneously also uploading that stream to other users, thus contributing to the overall available bandwidth. The arriving streams are typically a few minutes time-delayed compared to the original sources. The video quality of the channels usually depends on how many users are watching; the video quality is better if there are more users. The architecture of many P2PTV networks can be thought of as real-time versions of BitTorrent: if a user wishes to view a certain channel, the P2PTV software contacts a "tracker server" for that channel in order to obtain addresses of peers who distribute that channel; it then contacts these peers to receive the feed. The tracker records the user's address, so that it can be given to other users who wish to view the same channel. In effect, this creates an overlay network on top of the regular internet for the distribution of real-time video content. Some applications allow users to broadcast their own streams, whether self-produced, obtained from a video file, or through a TV tuner card or video capture card[3].

All Internet TV applications and products are pure P2P solutions. There may be involvement of an indexing server for locating available content or this can be done through the P2P network. Although some projects target broadcasters, most P2PTV technology is used to redistribute TV channels on the Internet without a proper licence to do so. The majority of applications available broadcast mainly Asian TV stations.

6.2.2 Branded P2PTV Services

A list of branded P2PTV services[4] for end users is presented here:

6.2.2.1 Babelgum

Babelgum.com is a free to view, interactive, TV-quality Internet platform supported by advertising. The platform features branded channels through licensing agreements with content providers such as Associated Press, BBC, PBS, 3DD, Shine Limited, IMG, Ministry of Sound, Off The Fence documentaries

2 http://en.wikipedia.org/wiki/Internet_tv

3 http://en.wikipedia.org/wiki/P2PTV

4 http://en.wikipedia.org/wiki/P2PTV

and Serie A Italian Football. Babelgum had originally developed its own proprietary technology based on secure peer-to-peer streaming, along with a system for video compression using H.264 codec, and a video player to show the content. In March 2009 the company abandoned P2P in favour of Flash technology.

6.2.2.2 BBC iPlayer

BBC iPlayer, a service available via website, P2P, cable television, and several mobile devices was developed by the BBC to extend its existing RealPlayer-based "Radio Player" and other streamed video clip content. On 19 December 2008, the BBC released, as part of the iPlayer Labs feature, iPlayer Desktop for Mac and Linux operating systems. This moved the download service away from the previous P2P based distribution model and onto an HTTP download model.

6.2.2.3 Joost

Joost.com, an Internet TV service that initially used peer-to-peer TV technology to distribute content to their Mozilla-based desktop player, now has migrated to use a Flash-based Web player instead. It is in negotiations with FOX networks. It has signed up with Warner Music, Indianapolis Motor Speedway Productions (Indianapolis 500, IndyCar Series) and production company Endemol for the beta. In February 2007, Viacom entered into a deal with the company to distribute content from its media properties, including MTV Networks, BET and film studio Paramount Pictures.

6.2.2.4 LiveStation

LiveStation.com provides a platform for distributing live television and radio broadcasts over a data network. It has been developed by Skinkers Ltd and is now a new company called Livestation Ltd. The service was originally based on peer-to-peer technology acquired from Microsoft Research. Current live TV news channels in the global offering (which comes with a default installation) include France24 in English, French, and Arabic, Al Arabiya in Arabic, Al Jazeera in English and Arabic, Bloomberg Television, C-SPAN, Deutsche Welle TV and radio in English and German, Democratic Voice of Burma, Euronews in English, French and Arabic (Italian, German, Russian, and Spanish are no longer supported), Russia Today in English and Arabic, BBC World News, BBC World Service Radio, BBC Arabic, ITN, Press TV and BBC Persian. Otherwise, reception is limited through GeoIP filtering, and depends on the location of the receiver. Livestation broadcast streams encoded in VC-1 format (Livestation is not currently using peer-to-peer). Playback controls are overlaid on top of the video stream. Unlike services such as Joost which offer video on demand channels, Livestation streams live broadcasts.

6.2.2.5 Miro

Miro is an Internet television application developed by the Participatory Culture Foundation. It is supported on Microsoft Windows, Mac OS X, and Linux. The program supports most known video files and offers sound and video, some in HD quality. Miro integrates an RSS aggregator, a BitTorrent client, and a media player.

6.2.2.6 ReelTime

ReelTime.com, an Internet-based video on demand provider located in Seattle, Washington, was founded in 2004 and went public in September 2006 at the same time that its online service was launched. ReelTime.com provides over 2500 movies and television shows in its catalog. It delivers these selections through a proprietary player that uses elements of peer-to-peer networking.

6.2.2.7 Zattoo

Zattoo.com, a proprietary peer-to-peer Internet Protocol Television system currently has its focus on European channels, licensed content, and Digital Rights Management. The service is currently restricted to Switzerland, Denmark, Spain, Germany, Norway, United Kingdom and France, offering different TV programmes in every region, depending on individual licenses.

6.2.3 Commercial P2PTV Solutions

A list of commercial solutions for broadcasters is presented in this chapter.

6.2.3.1 Octoshape

Beyond WebTV there is also a series of peercasting products and services that operate between webTV and community-based video streaming: the idea is to enable peercasting users to both receive streamed video as well as broadcast, i.e. stream their own video to others. Among these Octoshape[5] seems to be one of the truly successful businesses, streaming the EBU'S EuroVision Song Contest and related events since 2005.[6] CNN also has been using Octoshape for streaming since December 2008 and also at Obama's presidential inauguration in January 2009 serving more than 21 Million concurrent streams.[7]

Octoshape, a proprietary streaming media platform, provides a peer-to-peer streaming media-server and client system, which is based on the "peer-to-peer grid technology". It uses throughput optimization technology to both deliver

[5] http://www.octoshape.com/

[6] The opportunity to stream such big events may have arisen from the fact that Octoshape originated in an EC-funded project.

[7] http://technology.timesonline.co.uk/tol/news/tech_and_web/article5556788.ece

HD quality streams, as well as break through congestion in the last mile to provide more resilient delivery. The Octoshape technology has the option of using an enhanced and secure version of grid delivery technology to minimize the bandwidth for any CDN, ISP, broadcaster, or last mile provider to stream material. Web sites using the Octoshape Infinite Edge technology are: CNN.Com Live, Eurovision Song Contest, NBA League Pass Broadband, PGA British Open, Nascar RaceView, ESL TV, 2008 Olympics Asia Delivery, VRT: Tour de France, MLG/GotFrag, Radio Paradise.

6.2.3.2 Alluvium

Alluvium, an open source based peercasting software developed by the Foundation for Decentralization Research, first released in 2003. It comprises three components, Core, Media Player, and Server. Alluvium allows video and audio programming to be broadcast over the Internet using swarming technology. It is powered by Onion Networks' Swarmcast, and is notable for its incorporation of server-side time-based playlists, and client software which examines those playlists and begins streaming content from the server (and available peers) per that schedule, simplifying the creation of continuous-broadcast video and audio.

6.2.3.3 Adobe Flash Player

Adobe Flash Player 10 is said to have remarkable Peer-to-Peer features, i.e. it could turn existing services into P2P services or enable developers to create such a service with their technoplogy: with Adobe's Real-Time Media Flow Protocol (RTMFP)[8] Flash 10 offers the basic tools for developers to build P2P networks which could be the seed for a revolution that is, apparently, still in the making but potentially possible.[9] UDP would enable Flash Player 10 to contact other peers in a managed P2P connection which could make Flash the most widely available P2P client for streaming and VoIP and thus would turn YouTube and Google Video into major P2P streaming services. However, according to Adobe's official statement[10] the technology is not as powerful as to compete with BitTorrent and other "Massive File Sharing Applications" in the near future.

[8] http://www.flashrealtime.com/tuts/p2p-in-flash.html

[9] http://whydoeseverythingsuck.com/2008/05/adobe-introduces-p2p-flash-player-kills.html and http://gigaom.com/2008/05/15/flash-p2p-now-thats-disruptive/

[10] Justin Everett-Church, Senior Product Manager at Adobe for the Flash Player on 23 May 2008: http://justin.everett-church.com/index.php/2008/05/23/astrop2p/

6.2.4 Other Applications/Platforms

A number of notable applications/platforms are presented in the sequel (see also D2.1):

- PeerCast
- IceCast
- IceShare
- FreeCast
- PCast
- PPLive
- PPMate
- PPStream
- SopCast
- Shoutcast (Nullsoft Streaming Video)
- SwarmPlayer
- TVAnts

6.2.5 Indicative Statistics

An indication of the popularity among the above P2PTV systems/platforms is presented below[11]:

- SopCast 43%
- TVAnts 35%
- TVU Player 13%

and also a ranking of the channels watched through P2PTV:

- Star Sports 18%
- CCTV 5 13%
- FOX 10%
- ESPN(Asia) 10%
- CBS 7%
- Shanghai Sports 6%
- Guangdong Sports 6%

[11] http://allp2ptv.org

The above figures have been collected by the web surveys carried out among user fora and discussions groups at http://allp2ptv.org. They are presented as indicative figures although they may be outdated.

6.3 Skype

Outside the media distribution sphere Skype is certainly the most used and most successful P2P service. Focusing on telephony and text messages/chats, Skype is also a powerful tool for P2P file exchange up to real-time collaboration tools. According to market researcher TeleGeography, Skype carried around 33 billion minutes of international voice calls in 2008, or around 8% of all international voice traffic.[12]

Skype uses a proprietary Internet telephony (VoIP) network, called the Skype protocol. The protocol is not publicly available and official applications using the protocol are closed-source.

6.4 Interworking between P2P solutions

Towards the internetworking between different P2P solutions there is few work that has been done until now. This is due to three reasons.

The first is that in real time multimedia distribution as p2p live streaming the solutions are in an early stage and the problems are under research so only customized systems are available and are usually proprietary.

The second is that towards p2p solutions between different types of networks there is no attempt yet to unify the two systems and this effort is prevented mainly from network heterogeneity and the different protocols that run in different networks. On the other hand IMS offers an environment that can provide with the necessary tools towards this goal. For example functionalities as: authentication (AAA), IMS session management, session negotiation and setup and management of network limitations, Quality of Service, digital rights management and billing could offer a substrate towards this goal.

The third problem concerns interworking between different p2p solutions that perform different functionalities. For example we mention here Vuze and Tribler in which a DHT is used for distributed queries that concern objects and node addresses and it is combined with a content diffusion overlay and an offline content distribution scheduler that are responsible for the delivery of the object in each peer.

We consider that internetworking between p2p solutions that perform different tasks as the aforementioned is feasible through an interface in the application layer that can pass the required information between the different p2p

[12] http://www.networkworld.com/news/2009/032509-skype-is-largest-international-voice.html?tc=vc=html

functionalities. For instance a DHT can be used to inform the overlay manager about the network addresses that specific objects or specific blocks of an object can be found. The scheduler can dynamically inform the DHT about the blocks of an object that a peer owns each time instant. Further more different services can be combined through an interface where a content distribution system can be used to seed a system with peers that consume the objects in real time.

On the other hand the interworking between two p2p architectures that perform the same functionality is a difficult task to implement and it is not also beneficial for a system. For example two different scheduling architectures are very difficult to be combined as the first may requires a specific graph topology or/and specific block size. We will not focus in VITAL++ in this objective.

Objectives in VITAL++ are the detailed definition and implementation of:

- A generic interface where a content indexing can communicate with an overlay manager in order to dynamically update it with peers that participate in an object distribution
- A generic interface where an overlay manager dynamically provides and updates the neighbours of each peer that can be exploited from any type of scheduler for the block exchange and diffusion.
- An interface between a p2p authentication systems with the overlay manager in order to avoid the entrance in the overlay of unauthorized peers.
- Through IMS the discovery of peers in different networks and the creation and management of connections between them.

7 Peer-to-Peer SIP Technologies

The state of the art in peer-to-peer technologies has already been presented in D2.1, in terms of the peer-to-peer client evaluation. SIP technologies are already well established on the market, the relevant SIP standards including various extensions and the implemented technologies are well documented[13]. This chapter gives an overview on the combination of both technologies.

7.1 IETF Working Group

The P2P-IMS and P2P-SIP technologies are mainly focused in the creation of a decentralized solution by eliminating the need for centralized servers. In that aspect the IETF Working Group on "P2PSIP"[14] is working in order to take advantage of the distributed nature of P2P for achieving distributed resource discovery in a SIP network. "P2PSIP" group has released various RFC in order to provide useful information about the development of protocols and mechanisms for the use of the Session Initiation Protocol (SIP). These RFCs are describing settings where the service of establishing and managing sessions is in principally handled by a collection of intelligent endpoints, rather than centralized servers as in SIP is currently deployed.

7.2 Implementations

This chapter presents seven open source implementation initiatives as well as SIPeerior as commercial solution, which are all based on the specifications of the P2P SIP working group[15].

7.2.1 Cisco P2PSIP Project

This Cisco implementation branch revision 8528 is providing an open source code for downloading but is lacking of programming comments, documentation and analysis that can help programmers in the continuation of the project.

[13] http://www.tech-invite.com/, http://www.iptel.org/, http://www.packetizer.com/ipmc/sip/standards.html

[14] http://www.p2psip.org/, http://tools.ietf.org/wg/p2psip/, http://www.ietf.org/dyn/wg/charter/p2psip-charter.html

[15] http://www.p2psip.org/implementations.php

7.2.2 Columbia P2PP Project

Peer-to-Peer Protocol (P2PP) has released in the November of 2007 the internet draft- p2psip-p2pp-01 that expired on May 2008 in this document it defines the Peer-to-Peer Protocol (P2PP). The P2PP use an application-layer binary protocol, for creating and maintaining an overlay of participant nodes. This overlay is able to use varius structured or unstructured protocols such as Bamboo, Pastry, Kademlia, Gnutella, etc. P2PP is designed to support a P2P Session Initiation Protocol (SIP) network, but it can be used for other applications as well.

7.2.3 SIPDHT2 Project

Following the Chord algorithm SIPDHT in its first implementation is based in a ring arrangement Distributed Hash Table. However, with the new release in June 2007, it has switched from a ring arrangement of peers to a coordinate system arrangement called CAN (Content Addressable Network). In this implementation a virtual coordinate system for the peer to peer overlay is set up upon the first peer being created. That peer takes control of the whole overlay and stores the hash table entries in the form of a zone. From the website of SIPDHT2 we can see that there is not active implementation currently ongoing.

7.2.4 University of Parma Kademlia dSIP

The proposed protocol by University of Parma is based on dSIP. The dSIP protocol is a SIP-based protocol proposed in an internet draft by D. Bryan, B. Lowekamp, William & Mary C. Jennings on february 2007. In this internet draft it is proposed dSIP as generic framework for a distributed SIP Location Service. In the university of parma internet draft it is stated that they are using the dSIP protocol due to implementation simplicity, possibility of reuse of already available SIP stack implementations, easy integration into existing UAs, minimization of the number of required protocols for a P2P UA, and widespread support for (and relative maturity of) the SIP standard.

7.2.5 Huawei Service Extensible Protocol

Service Extensible Protocol (SEP) is Huawei's implementation of a peer to peer protocol spoken between P2PSIP Overlay peers to share information and organize the P2PSIP Overlay Network. SEP uses a flexible forwarding mechanism to avoid congestion in the Overlay. It also proposes a general service discovery method and a built-in NAT.

7.2.6 P2P Name Service

P2PNS (Peer-to-Peer Name Service) is a secure distributed name service for P2P SIP, which is based on a peer-to-peer network. The current focus of P2PNS is to provide a secure and efficient SIP name resolution for decentralized VoIP (P2PSIP). Peer-to-Peer Name Service is comprises a name resolution and caching layer (P2PNS Cache) on top of an overlay which provides Key Based Routing(KBR) and Distribution Hast Table(DHT) services. The P2PNS workgroup states that: the KBR service can be provided by any structured peer-to-peer protocol which provides a CommonAPI interface and contains our proposed security extensions. Applications like a SIP proxy connect to P2PNS by using a XML-RPC interface which provides register() and resolve() functions. The use of modular architecture offers a clean separation of layers and allows to easily exchange the protocols on KBR and DHT layer. P2PNS is developed at the Institute of Telematics (research group Prof. Zitterbart), Universität Karlsruhe within the scope of the ScaleNet project funded by the German Federal Ministry of Education and Research[16].

7.2.7 RELOAD

REsource LOcation And Discovery (RELOAD) is a peer-to-peer (P2P) signaling protocol for use on the Internet. Currently an internet draft that expires on January 2010 informs about RELOAD:[17]

A P2P signaling protocol provides its clients with an abstract storage and messaging service between a set of cooperating peers that form the overlay network. RELOAD is designed to support a P2P Session Initiation Protocol (P2PSIP) network, but can be utilized by other applications with similar requirements by defining new usages that specify the kinds of data that must be stored for a particular application. RELOAD defines a security model based on a certificate enrollment service that provides unique identities. NAT traversal is a fundamental service of the protocol. RELOAD also allows access from "client" nodes that do not need to route traffic or store data for others.

7.2.8 SIPeerior

Finally, one commercial implementation of the P2PSIP standard is presented: SIPeerior has been initiated by David A. Bryan (co-chair P2PSIP workgroup)

16 http://www.p2pns.org/

17 http://tools.ietf.org/html/draft-ietf-p2psip-base-03

and others. Currently, the site is offline and no documentation is available for the implementation of SIPeerior.

8 Peer-to-Peer SIP Solutions

This chapter deals with specific peer-to-peer SIP implementations, which are solution-oriented and not directly referring to the technology approach of the IETF Working Group presented in the previous chapter.

8.1 CoSIP

CoSIP has been developed by the University of Tübingen[18]. CoSIP uses a proxy server replacing the traditional SIP proxy in that way it can chose either to use a centralistic architecture or in case of failure, a P2P based DHT. The CoSIP approach is based in taking a "traditional" SIP infrastructure with dedicated SIP servers and it interconnect the User Agents to each other in a P2P network creating a Distribution Hash Table of the User agents that acts additionally to the traditional SIP infrastructure. CoSIP states that in that way it improves the reliability and recoverability from catastrophic failures Compared to traditional SIP.

8.2 SIP Thor

SIP Thor is a Peer-to-Peer overlay that allows for load balancing, self-organization and geographical distribution of SIP infrastructure elements. The Peer-to-Peer overlay provides Multimedia Service Platform with the primitives for self-organization, high availability and scalability[19]. SIP Thor implements an overlay network for SIP Proxy/Registrar and other network centric functions like DNS, presence agent, database storage, voicemail, xcap policy and provisioning. This P2P layer provides the base for self-organization and self-deployment bringing the operational costs to minimum by eliminating the need for monitoring and maintenance activities, which traditional SIP infrastructures require. Using SIP Thor all relevant computing resources can be virtualized allowing for running the SIP services "in the cloud" with a high scalability/cost ratio.

8.3 SIPshare

EarthLink SIPshare, a simple, SIP-based proof-of-concept content sharing application, demonstrates the viability of SIP as a protocol over which peer-to-

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18 A. Fessi, H. Niedermayer, H. Kinkelin, G. Carle: "A Cooperative SIP Infrastructure for Highly Reliable Telecommunication Services", IPTComm 2007, PRINCIPLES, SYSTEMS AND APPLICATIONS OF IP.

19 http://www.ag-projects.com/SIPThor.html

peer (P2P) applications other than the well-known voice and video cases may be implemented[20]. SIPshare uses stateful SIP Subscribe/Notify to build and maintain a network of peers, and stateless Subscribe/Notify to implement content search on that network. Sip share use this SIP signalling information's for the content searches. These content searches are passed from one peer to all other known peers in such a way that content can be located on a host of which the original requesting peer is not explicitly aware. Once content is located, a SIP Invite is used to request the content from the now-known host.

20 http://www.research.earthlink.net/p2p/

9 Peer-to-Peer IMS Solutions

Finally, as already described in D2.1[21], cooperation of P2P and IMS has reached the standardization bodies. At the ETSI, a Working group named TISPAN is currently working on the cooperation of P2P content delivery in IPTV service and a working item has been developed that is titled "Peer-to-peer for content delivery for IPTV services: analysis of mechanisms and NGN impacts".

9.1 Nokia Research Center

A solution that focuses in the IMS CORE network by creating a decentralized P2P like IMS system is proposed by Nokia Research Center (NRC)[22]. Nokia creates a Distributed Hash Table overlay network focusing in distributing the SIP proxies, such as the Serving-Call/Session Control Function (S-CSCF) and the Interrogating-Call/Session Control Function, as well as the Home Subscriber server (HSS), and up to some degree, presence servers. This distribution of the network functional elements in a DHT fashion leads to increased robustness of IMS network elements. Besides the self-organizing overlay network offers a significant savings in operational expenditures.

9.2 Hyson

A solution developed by the Beijing University[23] is Hyson where a hybrid Peer-to-Peer (P2P) based S-CSCF overlay network is designed. The novel approaches on implementing the S-CSCF module of the IMS CORE called HSA enhance the utilization of S-CSCF resources. HSA is accomplished by collaborative work of S-CSCFs. Hyson states that HSA enables not only IMS network to have a much greater user capacity but also S-CSCFs to produce much smaller processing delay than current approaches.

Concluding from the previous, it is obvious that IMS and P2P interworking is a hot topic not only for academic research, but also for standardization and thus for industry.

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21 Peer-to-Peer client evaluation and market overview

22 Matuszewski, Marcin Garcia-Martin, Miguel A.: "A Distributed IP Multimedia Subsystem (IMS) World of Wireless, Mobile and Multimedia Networks", 2007. WoWMoM 2007. IEEE June 2007

23 Lifeng Le Geng-Sheng Kuo: "A Novel P2P Approach to S-CSCF Assignment in IMS", Consumer Communications and Networking Conference, 2008. CCNC 2008. 5th IEEE

10 Operator Products

Current IMS implementations and respective services seem to focus almost exclusively on telephony services despite a much wider range of potential.

In addition, the most popular IPTV products from the operators participating in the Vital++ Project will be explained within this chapter.

10.1 IMS Products

10.1.1 Optimus Portugal's TAG

One of very few apparently not only working but successful IMS services is Optimus Portugal's TAG,[24] a service that bundles mobile subscription and the PC with the same services: "Everything the TAG subscriber can do on the mobile is accessible via the PC: voice calls, SMS, MMS, video calls, messenger and voice-mail" for one monthly fee.

10.1.2 Telefonica's WIMS2.0

In November 2008 Telefonica presented a number of services that merge IMS and Web 2.0 features under the label of WIMS 2.0.[25] The presentation included especially presence and localization information in combination with social websites like Blogger.com, Facebook, Flickr, etc. In these services presence and localization features can be used for relating spontaneous comments (text, picture or video) with the current location of the person posting it. In consequence, the posted media items can be connected with the location for future users using the service from the same location as a form of virtual graffiti. This combination of Web 2.0 and IMS also enables users to consume their daily services like last.fm and the like with their mobile devices.

10.1.3 Interworking between IMS Solutions

As described in D2.2, IMS is a standardised architecture for NGNs by the 3GPP (mobile access) and ETSI TISPAN (fixed access). This implies the existence of standards for IMS, which have been developed and are constantly adapted and improved by the named standardisation bodies. As many standards exist in

[24] http://archive.ericsson.net/service/internet/picov/get?DocNo=6/21331-FGB101165&Lang=EN&HighestFree=Y

[25] http://www.fokus.fraunhofer.de/en/fokus_events/ngni/ims_ws_08/_slides/_s3/S3_01_Galindo_Telefonica.pdf or http://www.wims20.org/index.php/lang-en/showroom

this area, vendors of IMS equipment are encouraged to give a statement of compliance, i.e. which standards do they implement in their product. Due to the fact that IMS does not specify network nodes or machines, but just functions and interfaces (reference points), IMS solutions can include many of those functions, which makes it even more important to specify the supported standards from the vendor side. Depending on the nature of an implemented set of functions, the relevant protocols need to be implemented and used correctly according to the relevant standards. E.g. for SIP, this means that the node knows which additional header fields it needs to include or evaluate, in order to find/provide the relevant information for the function.

Due to some freedom of interpretation, gaps in standardisation or simple misunderstanding it happens that products, which claim to be standard conform, do not interact properly, which results in services not being provided. In such cases, the operator who has deployed such products will have to achieve one or more changes in the products, usually in close contact with the vendor.

In order to avoid, or at least minimize such interoperability catastrophes in the productive deployments, vendors may participate in Interoperability test events. The outcome gives such vendors hints, where interoperability problems do exist and with which other vendors problems must be expected in real-world deployments. Providers for such events are e.g. the NGN Forum[26], the ETSI IMS Plugtest[27] or the MS Forum[28].

Additionally there are testing tools available, which can be used directly on-site to test certain aspects of an IMS network, like SIPNuke[29] or SIPp[30]. Also commercial institutions offer interoperability testing of IMS components.

As a conclusion, the interoperability of two components in an IMS network depends on the common understanding of both vendors regarding the relevant standards and protocols related to the implemented functions.

10.2 Current IPTV Products

10.2.1 Telefonica's Imagenio

Imagenio is Telefónica's answer for the entertainment services demand on the residential sector. Through *Imagenio* the clients have access to a completed

[26] http://www.imsforum.org

[27] http://www.3gpp.org/Testing-time-for-TS-24-229

[28] http://www.msforum.org/interoperability/GMI.shtml

[29] http://www.sipnuke.org/

[30] http://sipp.sourceforge.net/

services world which has the HQ video signals diffusion as a fundamental component.

Imagenio is an entertainment and communications services group oriented to the residential sector that uses the TV as basic visualization medium. From the infrastructure point of view, the *Imagenio* clients access the services using the same telephonic cable used for receiving the voice services. With this, complex client installations are avoided and the Internet broadband service is complemented.

Imagenio offers three different kinds of services:

1. **TV and audio channels broadcasting**: The client offers a wide range of digital TV channels with HQ through a satellite or digital cable platform.
2. **On demand contents**: The service allows accessing a catalogue of audiovisual contents with the same benefits as DVD. This is *Imagenio*'s most significant service, because it is exclusive of the services with this architecture where the communication between the client and the network is not shared with any other client.
3. **PC and TV Internet access**: *Imagenio* offers accessing to Internet from the TV adapted to the different *Imagenio* user profiles.

The 'VideoClub' option offers access to different services that are served thanks to video and audio capabilities that *Imagenio* has. With these capabilities, the client has absolute control of the contents emission, being allowed at any time to use the same controls as in a domestic video: forward, reviewed, pause or interruption if needed.

The Video On Demand service offered by *Imagenio* is based on three fundamental entities, whose architectural roles are closely related. These components are the video servers, in charge of feeding a requested video content to a client, the distribution systems, which deliver the contents to the video servers, according to the demand and availability, and the content management systems, which are in charge of controlling and automating the insertion and publication of new contents into the service..

A service platform like *Imagenio* needs to automate almost all the processes, and one of these processes is the publication of the contents at the video servers. The Video On Demand service at Imagenio's platform is rendered based on a distributed architecture, with the video servers placed on the local Centrals, at the same area as the clients who receive this service. This results in having a considerable potentially increasing number of servers.

For these reasons, a mechanism is required that allows centralising the operations for all the network servers and that have the right tools that assure the contents consistence on all servers. This automatic mechanism is obtained with the Content Distribution System.

The Video On Demand service requires that a personalized video flux is sent to every client, who will be able to control it as he/she pleases. *Imagenio* uses this video transmission with the streaming procedure. The streaming implies that the client equipment is a passive element, being almost all the intelligence placed on the service operator equipments.

Depending on the final service, the content distribution will be different:

- VoD: Content distribution using shared distribution protocols with real time requirements (user delivery on line). The content is partitioned and every portion is obtained from different possible sources (other STB or Cache equipment), composing on the destiny the resource to be visualized.
- Downloading: It works using the same content distributions technique as VoD but the delivery requirement on real time is excepted. The user will be notified when the transmission is finished so he/she can enjoy the solicited content.
- UGC/ accessing friends' hard disks: Depending on the requirements of each exposed content (real time playing or mere downloading), one of the two previous techniques described above will be used.
- Visualization: The used technique is one variant of that used on VoD. In this case a bunch of users share the viewing of a single content and can interact with its playing, being those actions subsequently applied to the rest of the users. This characteristic will lead up to synchronise the reproduction and the updates effected by one of the user, i.e. pause, stop, rewind, etc.
- Browsing: VNC (Virtual Network Computing) technology that allows that two or more user devices share the same browsing screen through the transference of the screen image displayed on one of them.
- TV Channels: This service is based on shared distribution technologies, and, in particular, ALM (Application Layer Multicast) technology will be used for creating the TV Channels distribution trees. The TV Channel flux will be divided between the Cache TV resources into microfluxes (MDC technique) to guarantee its distribution.

10.2.2 Telekom Austria's aonTV

Back in November 2007 Telekom Austria has entered the residential consumer market with an attractive service bundle comprising[31]

- IPTV service called aonTV,
- Unlimited high-speed Internet,

[31] http://www.telekom.at/

- Fixed line telephony and
- Mobile telephony (optional) service.

The services are offered to the customer via copper access lines, using ADSL for the IPTV and for the high-speed Internet service as well as a splitter based POTS line for the telephony service. The POTS service will be replaced by a VoIP solution in the near future, completing the purely broadband based product bundle for residential customers.

Figure 1 Telekom Austria's aonSuperKombi

In particular, the IPTV service aonTV comes with

- more than 70 free TV channels,
- integrated video on demand system with more than 300 movies,
- free of charge content such as news clips,
- more than 300 radio stations and
- viewing and playing personal photos, videos and music on the TV by connecting the set-top box to the user PC.

Additionally, the customer has the opportunity to subscribe for

- aonTV Video-Abo including major TV series.
- aonTV Premium TV with 24 additional premium TV channels.
- aonTV HD Videothek delivering selected TV stations and movies in 720p/HD quality including Dolby Digital 5.1.

The IPTV platform is located at the service edge. The TV channels are fed into the Ethernet core network by satellite receivers or by direct IP links to the TV stations. The TV content is constantly broadcasted to the Ethernet DSLAMs in the Telekom Austria network, which in turn send the selected content to the user's set-top box. Contrary to the TV service, the video on demand system is streaming the content to the user. Certain time-shift capabilities are also available via the video streaming platform.

In comparison with the VITAL++ architecture, Telekom Austria's IPTV platform is neither using SIP/IMS on the control plane nor peer-to-peer mechanisms for the

distribution of the content. Calls for proposals have shown that commercial IPTV platforms are still in the early stage in terms of IMS standards; combinations with peer-to-peer mechanisms are yet not available.

11 Market Analysis

The market survey has turned out that there is a multitude of peer-to-peer software applications already on the market. Nowadays, even commercial broadcasters are deploying P2P technologies for efficient content distribution. The main usage scenario of P2P software is settled around Internet TV and video streaming.

Several legal and illegal Internet TV services have been well established on the content market. Most of them are coming with an own client used for receiving and also forwarding the media stream. For Internet TV services, there is normally no need to centrally store the content for later use. On the other hand, for web applications such as Joost, the video data is centrally hosted and distributed among several server sites. Joost, as a good example for a video streaming service, interacts with the user via a web GUI, through which the user has access to various media channel. Moreover, Joost earns money from video advertising, though the business case still has to be proved.

First open source implementations of combined P2P/SIP approaches have been released, mainly driven by the IETF working group on P2PSIP. The solutions are still at an early stage of development and far from being deployed on a large scale.

The combination of P2P an IMS technology is in an even earlier phase and not as transparent to follow, because the R&D is centered within the industry and market-ready solutions are yet not available. Nevertheless, P2P/IMS Solutions are in the very focus of the VITAL++ Project; two approaches have been presented. Nokia uses DHT for the distribution of the CSCF, while Beijing University follows a Peer-to-Peer (P2P) based S-CSCF overlay network called the Hyson.

Finally, commercial IPTV products have been presented, with Telefonica's Imagenio providing a powerful entertainment and communication solution settled around the TV as central visualization platform and Telekom Austria's aonTV as TV and video streaming service for residential broadband customers.