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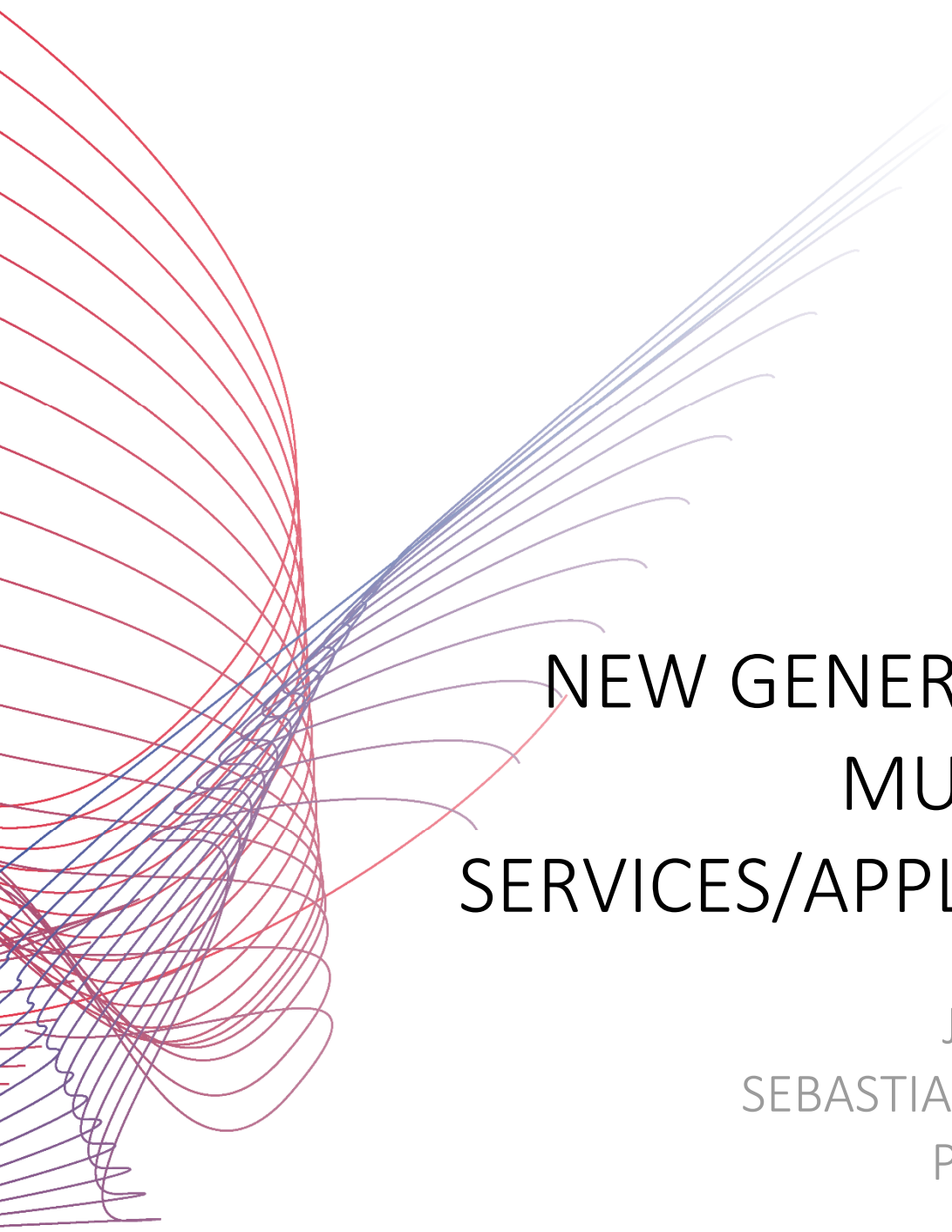

NEW GENERATION OF MULTIMEDIA SERVICES/APPLICATIONS

JURAJ LONDÁK,
SEBASTIAN SCHUMANN,
PETER TRÚCHLY

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Author: Juraj Londák, Sebastian Schumann, Peter Trúchly

Published by: Czech Technical University of Prague

Faculty of electrical engineering

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Explanatory Notes

	Definition
	Interesting
	Note
	Example
	Summary
	Advantage
	Disadvantage

ANNOTATION

End users' demands for new and more attractive services and applications are still increasing. Multimedia services based on integration of audio visual content are a basis for many modern services. A measure of customer's experiences with a service (quality of experience) is important factor at service sustainability. This module concentrates on modern multimedia services whether they are provided via Internet (IP based services) or integrated with digital broadcasting systems via cable, satellite or terrestrially (HbbTV services) or independently from transport networks within next generation networks (NGN services).

OBJECTIVES

Main objective of this course is to provide readers with basic knowledge in the area of current multimedia services. Students can become familiar with modern services and applications such as multimedia Internet services (software or game as a service, streaming services), HbbTV services, electronic and mobile services (e-commerce, e-government, e-health), NGN services (VoIP, IPTV, hosted IP services) and services and applications based on WebRTC.

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1 Introduction

The environment of the new generation of ICT network platforms provides the wide spectrum of new services and applications. In addition to Internet of things services which are presented in different module this material focuses on following multimedia services:

- Internet multimedia services and applications
- Hybrid Broadband Broadcast TV services
- eServices and mServices
- NGN services
- WebRTC

2 Internet multimedia services and applications

2.1 Software as a Service

Software as a service (**SaaS**) is sometimes presented as a "software on-demand" service.

SaaS delivers and licenses software to users. Licensing process is realized on a subscription basis.

Licensed software is centrally hosted and provided to customers over a network, typically the Internet. Interested users use a web browser as a thin client to access this service [1]. SaaS is most used for following purposes:

- business applications (including office and messaging software),
- management software,
- games,
- computer-aided design software,
- payroll processing software.

In case of conventionally sold traditional software users receive a license which is valid entire their life. Users pay a software price in advance plus some optional ongoing support fee.

In case of SaaS users generally pay to providers a subscription fee. This fee is most commonly paid monthly or annually. Consequently, SaaS providers offer applications with lower initial setup cost in comparison with equivalent enterprise software. The price of SaaS applications is derived by vendors from some application usage parameters (e.g. how many users are using given application).

The SaaS model includes following benefits:

- generally global accessibility,
- administration is easier,
- compatibility (same version of software at all users),
- collaboration is easier (same version of software at all users),
- automatic updates and patch management.

Online video and picture editors (studios)

Few of the most popular online services today are online picture editors and video studios. These are typically packed with social media service providing ability to quickly and conveniently share user's creations on the Internet.

You don't need to download and install any picture, audio and video editing software. All you need is good computer system and a decent connection to Internet.

Some examples of online video editors are: YouTube Video Editor, WeVideo, PowToon, Wideo, Weavly, Kaltura, MIXMOOV, Shotclip, Magisto.

Personal Cloud

Personal cloud is a platform where various digital content and information services are concentrated and accessible from any device in Internet. For user this platform (cloud) doesn't appear as a tangible entity. Personal cloud provides users with the ability to upload, store, synchronize, stream, retrieve and share content.

There are several realizations of Personal clouds. One group is implemented in local (home) data network (homemade clouds) while other group is available on Internet. A lot of people are familiar with public clouds (e.g. Dropbox or Google Drive cloud services) which are the most used types of personal cloud. As was mentioned the public clouds are available over the Internet and provided by service providers. They contain various online resources mostly data storage and software. Public clouds are built as a virtualized ecosystem.

2.2 VoD streaming

Video on demand (VOD) are systems as well as services which allow users to find, select and then watch or listen to favorite audio or video content.

This content is available to users anytime, i.e. when they choose and they don't have to adapt and watch at a specific broadcast time.

Users can use personal computers or TV sets to receive video on demand when IPTV technology is used. This is often used scenario. In case of television VOD systems VOD content is streamed directly through a set-top box, PC or other device which allows viewing in real time. VOD content can be also downloaded to a VOD compatible device (e.g. computer).

There are several modes of VOD distributions [2] which are briefly described below.

Transactional video on demand

When customers/consumers pay for each particular piece of video on demand content we talk about a distribution model referred as *Transactional video on demand* (**TVOD**) or as well as Pay-Per-View VOD or standard VOD. iTunes and Google Play are examples of TVOD services.

Catch up TV

A lot of TV stations in the world (and this number still grows) offer Catch up TV service which allow users to watch TV shows and series through their VOD service for a couple of days after their original broadcasting.

Subscription video on demand

Subscription VOD (**SVOD**) services are based on a subscription business model. Users don't pay per view of particular video content (movies, shows, etc.) but they are charged a monthly fee to access unlimited programs. Amazon Video, Hulu Plus, Netflix and HBO Go are examples of SVOD services.

Near video on demand

TV broadcasters who provide multiple channels can use high bandwidth distribution mechanisms (e.g. satellite or cable television) to offer a special pay-per-view video model referred as *near video on demand* (**NVOD**). In this type of VOD service a TV program is broadcasted in multiple copies at short time intervals (typically 10–20 minutes). This concept helps viewers to watch program because they don't have to accommodate for regular scheduled time of program broadcast.

Advertising video on demand

Advertising (or Ad-based) *video on demand* (**AVOD**) is a model that is free for the users. Users don't pay for the content in return for spending time watching ads. An example of AVOD is YouTube.

2.3 Live streaming

Live streaming is a process when multimedia is delivered to a client (user) live over the Internet. Streaming means that multimedia is constantly received by the end user device and then shown to that end user. Streaming is similar to downloading, i.e. it is a process of delivering media but this delivering has to meet special regular conditions. In case of downloading data are available after last byte is received. In case of streaming data (e.g. movie) can be processed (e.g. played by a user's media player) before the entire file has been transmitted.

The streaming process must be allowed by convenient audio and video codec in case of multimedia. In case of audio streams audio codec such as MP3, Vorbis or AAC can be used for audio compression. In case of video streams a video codec such as H.264 or VP8 can be used for video compression. Encoded/compressed audio and video streams are assembled/multiplexed to a container bit stream. Examples of available containers are ASF, MP4, WebM, FLV or ISMA.

A streaming server delivers the bit stream to a streaming client using a transport protocol. The most used transport protocols are Adobe's RTMP or RTP. There is also adaptive bit rate streaming over HTTP (as an alternative to proprietary transport protocols) which originated by merge of modern technologies such as Adobe's HDS, Apple's HLS, Microsoft's Smooth Streaming and non-proprietary formats such as MPEG-DASH. Live streaming is often used when video from an event venue is delivered using a streaming transport protocol to a cloud transcoding service and CDN. Then CDN distributes video to user homes using HTTP based transport protocols.

2.4 Cloud gaming or Game as a Service

Cloud gaming (or Game as a service or Gaming on demand) belongs to online gaming. Currently, we can distinguish two main types of cloud gaming:

- cloud gaming based on video streaming,
- cloud gaming based on file streaming.

Basic task of cloud gaming is to provide end users with an ability to play smoothly games on various devices.

In case of cloud gaming based on video streaming the games are streamed to user's computers, terminals and mobile devices like video using a thin client, so it is similar to the video on demand service. The user's computer receives streamed video over the internet which is sent from game company's server (cloud) where particular game is executed and rendered to video data.

This type of cloud gaming doesn't put on users high requirements on a performance of their computers, because server side performs all necessary processing. All users' activity (button pressing and controlling) is transmitted directly to the server. Server records this activity data and sends back to user's computer a game's response to those input controls.

In case of cloud gaming based on file streaming user's device runs actual game. At the beginning small part of the game is downloaded to user's device and quickly executed so the user can start to play. The rest of the game data is downloaded to the device during playing.

This allows users with low bandwidth Internet connections instant access to games without lag.

3 Hybrid Broadband Broadcast TV services

Hybrid Broadcast Broadband Television (**HbbTV**) represents a consortium of industry companies engaged in digital broadcasting, Internet domain and standardization.

HbbTV is also an international standard (specification) defining a delivery of digital interactive TV to the users through a common user interface on TVs or set-top-boxes.

Digital TV can be delivered via broadcast technologies (DVB over cable, satellite or terrestrially) as well as broadband technologies allowing access to Internet.

HbbTV is not only about digital TV but brings users a lot of information and entertainment services to augment user experiences. HbbTV tries to combine the best of Television and the Internet.

The broadcast connection is mainly used to transmit standard TV, radio and data services (linear content), transport and signaling of broadcast-related applications and associated data and synchronization of TV/radio/data services and applications. The broadband connection is used to carry on demand related content (e.g. video on demand - VoD), transport of applications and associated data which are or not related to broadcasted content (e.g. teletext), serve as a duplex channel for an exchange of information between applications and application servers and to discover broadcast-independent applications. This concept is depicted in Fig. 1.

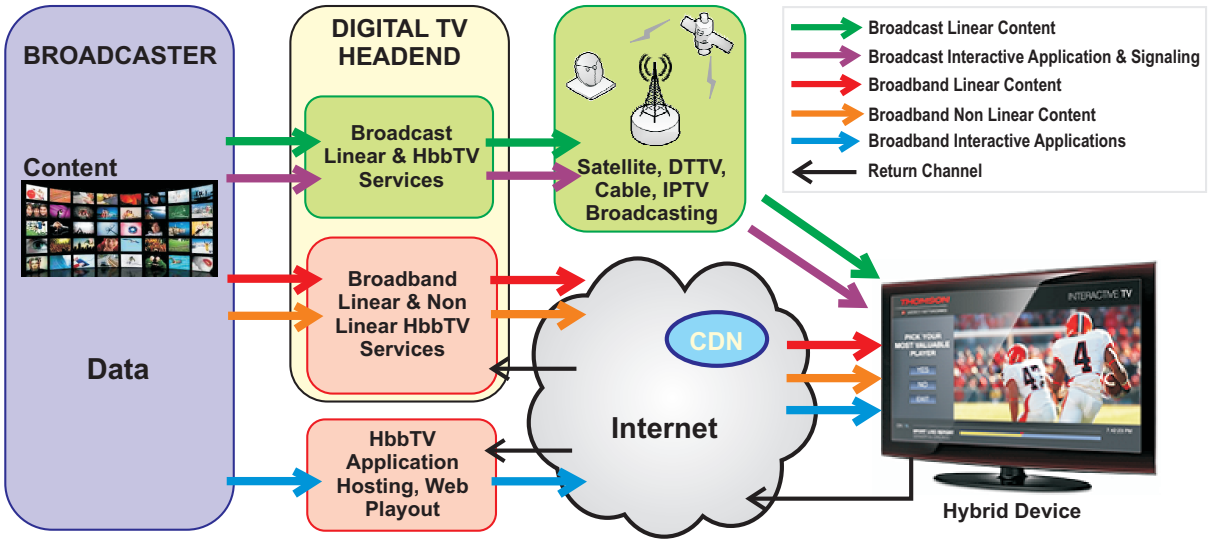

Fig. 1 - Basic architecture of HbbTV system

So far the HbbTV consortium defined three versions of HbbTV standard. First version (1.0) published in June 2010 specified basic aspects of HbbTV technology allowing users to watch digital media coming via broadcast connection as well as streamed via broadband access [3]. Users can download and record content to local

storage (internal or USB drives). They also can access channel list and view **EPG** (*electronic program guide*) data. And above all they can use broadcast-related and broadcast-independent applications. The later version extends HbbTV technology by a dynamic adaptive streaming, common encryption scheme and enhanced support for EPG (from Now/Next to 7day schedule).

The latest version (v2.0, published in 2015) brings a lot of new features to make HbbTV services more attractive for users and service providers as well such as improved support for HTML5, support for companion screens applications (launch and synchronization), improved synchronization between application and content (media), advert insertion into VoD content, support for push VoD services, support for new HEVC video compression standard, etc. [4].

3.1 HbbTV service concept

It is clear that HbbTV services can be activated by a user when user end device (TV or set-top-box) is connected to Internet. In that case a procedure of HbbTV service activation can be simply described as follows:

1. TV channels (broadcasted by digital TV providers) supporting HbbTV technology carry in the simplest case special metadata (Internet link) signaling broadcast related application that is prepared on server of TV companies for downloading. There is also an option to carry application data inside the broadcast signal but its free capacity is usually low.

2. When the user navigates to such TV channel the HbbTV compatible end device will download this (autostart) application and notify the user about new service that is available using simple activity on TV screen, e.g. red button blinking or little animation shown in a corner or an entire bar with options displayed at some edge of screen. This notification is active (depicted) for a few seconds and then hides.

3. If the user presses a red button on the remote, this application is shown in full mode and offers all its functions.

Currently, smart TV technology offers users digital television and a lot of interactive services. Users can watch linear broadcast (TV or audio) programmes (left part of Fig. 2) and they can also activate smart platform (e.g. Samsung Smart Hub) offering access to a number of attractive applications utilizing broadband connection of TV set to provide necessary information (right part of Fig. 2 - Portal).

However, these applications are called as broadcast independent applications, i.e. they have no close relation to broadcast linear service (content).

Fig. 2 shows how HbbTV can integrate these applications and some of them to tie up to broadcasting services [5].

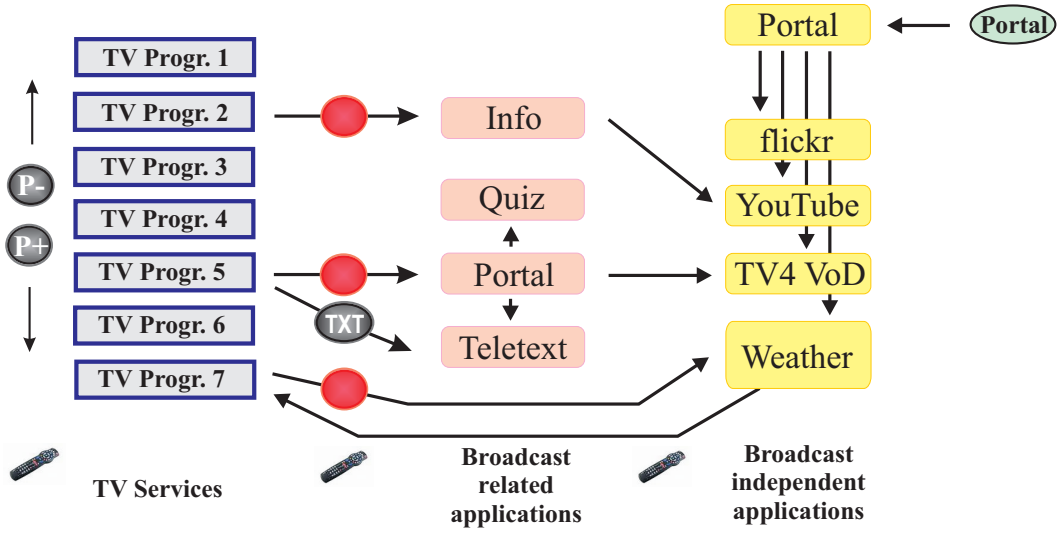

Fig. 2 - HbbTV service concept [5]

As was already mentioned, HbbTV technology supports broadcast related as well as broadcast independent applications. The broadcast independent applications have no relations to any broadcasting service and they just allow the users to play games or access web social networks like e.g. Facebook, Flickr, Twitter, Youtube or other web services providing required information (e.g. weather). However, the HbbTV standard doesn't specify concrete access mechanisms for them and manufacturers (or even third party operators) can develop and implement flexible portals where users can find and access applications they are interested in. Fig 2 also shows broadcast related applications which are activated by red button (or e.g. TXT button) and provide users with functions and information related to broadcasted content (quiz, voting, EPG).

3.2 HbbTV services

In previous section we mentioned terms - services and applications. To provide HbbTV services the end user device has to start particular application to allow the users to access all service functions.

HbbTV technology extends functions of DVB and smart TV technology by following services [6]:

- Video On Demand
  - Catch-Up TV (catch-up TV is a term used to describe VoD service in which TV shows are available for a period of days after the original broadcast)
  - Start-Over service
  - Push VoD support
  - Live streaming (direct access to additional TV channels that do not have broadcast)
- Information services
  - news, weather, traffic, sport
  - eGovernment (a digital newsstand for services by the local or national government)
  - enhanced teletext, guides, EPG
- Enhanced TV (additional information on TV programs, e.g. basic statistics in sports programs, extras with biographies, etc.)
- Games
- Courses and education
- Interactive advertising
- Voting and polling (participation in TV programs, voting for candidates in talent shows, join programs like the National IQ test, etc.)
- Social networking
- Home shopping
- TV portals
- 2nd screen
- Social and accessibility services - Amber Alert, speech in other languages, synchronous, computer - generated sign language, spoken subtitles
- PVR (personal video recording)

- Personalization

If we only want to concentrate on multimedia HbbTV services then every service providing users with audio/video content belongs here.

3.3 Video (content) on Demand services

Video (content) on demand service is a very attractive service for users because it sets users free from scheduled broadcasting of programs. The users can select and choose what and when they want to watch (or listen) to some video (or audio) content. VoD applications offer users a list with a number of movies, programs, shows and etc. organized and presented in attractive form (GUI). This service comes from IPTV technology and allows streaming required video/audio content from operator's storages to end user devices through the broadband connection.

Example of VoD service is a **push VoD** that provides users with video content on demand. The push VoD system is based on a presence of user's local storage that is usually implemented inside a set-top-box.

This push VoD technique allows users to select (in advance) and watch content when they find free time. Selected content is downloaded to this local storage and available to users anytime to watch without a need to wait for buffering and so suffer from actual connection state related problems.

The push VOD system utilizes a *personal video recorder* (**PVR**) service to store selected content that is often transmitted overnight (low traffic) or all day long at low bandwidth. Since downloaded content occupies a lot of storage (hard drive) space it is usually deleted after some time (e.g. week) to make space for newer content. Thereby, the storage space is often restricted to most popular content.

However currently, new generation set-top-boxes can be equipped by storage with capacity up to 2 TB what can represent more than 500 hours of HD content.

The push VoD service is suitable for broadcasters and users who lack network connectivity or broadcasters who want to optimize their video streaming network infrastructure because the most popular content is preloaded to the consumer device. By integration of the push VoD into HbbTV standard interactive services will be accepted faster and simpler and bandwidth which is more and more occupied by video transmissions will be utilize more efficiently.

Another application of VoD service is in **catch-up TV** applications. The HbbTV catch-up TV brings users new features of freedom against watching linear TV content.

Users can watch TV channel content no matter it was already broadcasted. The catch-up TV service provides users with access to an archive with television shows and other TV content for a certain period of days after their original television broadcast.

This period can be 7 days or it depends on TV service provider. Users can also watch TV channel content through their TVs or set-top-boxes and are no longer limited to view it only on PCs, laptops or tablets via Internet.

Currently, catch-up services are provided by e.g. FreeviewPlus service in Australia, Ruutu HbbTV service in Finland, FRANSAT Connect interactive portal in France, RAI, SKY, ARD, PRO7, ARTE and France Television channels, iVysílání service of Czech television.

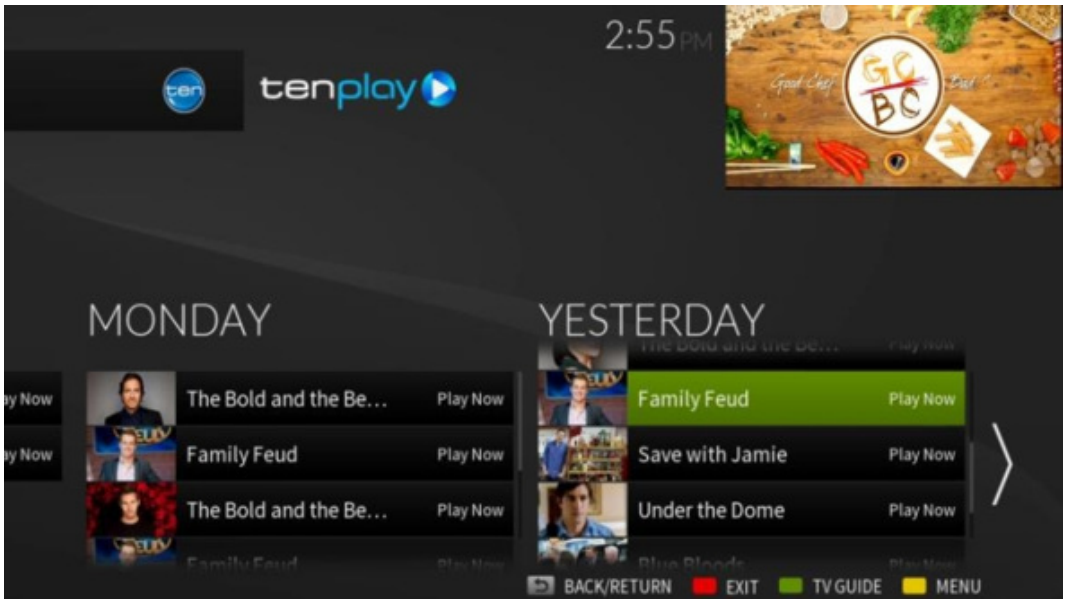

Fig. 3 - FreeviewPlus catch-up service

Fig. 4 - ARTE channel with catch-up features

A **start-over** service is another HbbTV service which should be also very interesting and valuable function for end users. It is also called as a Restart function.

This function comes in handy mainly when you came to watch a favorite program that already started broadcasting some time ago.

Using this function you simply restart broadcasting of a program and you don't miss its beginning anymore.

However, this function is only active for given program during its broadcasting (from e.g. second minute until the program is finished). When this program is over the user can use catch-up service to watch it from an archive. The start-over function can be limited to certain period of day. Users can also return back to the live session.

The start-over service is available in e.g. Ruutu HbbTV service in Finland, France Television Salto HbbTV service.

Fig. 5 - TV channel with start-over function

Regional TV channels are usually available only in particular regions or via internet. Suitable HbbTV application can make these and various other theme oriented TV channels accessible to all users via Live streaming. For example, Polish public broadcaster TVP provides HbbTV users with a new application for live streaming 16 regional channels (TVP Katowice, TVP Kraków, TVP Lublin, TVP Lódz, TVP Poznam, TVP Warszawa, TVP Wroclaw, and others).

TV broadcasters can also offer users HbbTV applications which make accessible their various TV and video portals with a number of videos of diverse genre.

3.4 Other HbbTV multimedia services

Information services provided by HbbTV applications are equipped by an attractive GUI and allow users to browse various theme oriented information (news, weather, exchange rates, stock market, sports, traffic, eGoverment). Thanks to HTML this GUI can shows texts, pictures, graphs, maps and even videos. Old fashioned teletext can be also modernized in this way to become so called super-text. Similarly, the electronic program guide can be enhanced by various video shots (movie trials, video clips, movie shots) and can contain direct links to catch-up TV. Educational courses as well as games can also integrate audio, video and interactive content to improve user's quality of experience (QoE).

As was already mentioned HbbTV v2 defined support for *companion screens* (**CS**) applications. Using HbbTV application on TV set users can launch CS application on other device. These applications can communicate each other. There is also possibility for an application on companion screen to discover HbbTV terminal and launch a broadcast independent CS application on it. Using this service e.g. video can be started on a companion screen (unfortunately, synchronizing applications and content wasn't defined yet).

Some of social and accessibility services can also be characterized as multimedia services (e.g. linear TV content can be enhanced by synchronous, computer - generated sign language or subtitles can be spoken).

4 eServices and mServices

The delivery of services was always linked with actual technology in some way to facilitate and make this process more efficient. With emerging the *information and communication technologies* (**ICT**, especially Internet and web technologies in the last decade) new type of services started to appear. These services are called electronic services (e-services) and their concept is a subject of research for many years. There are also several definitions of e-services slightly differing and often depending on research discipline. However, we can mention two of them [7]:

- an e-service is any asset that is made available via the Internet to drive new revenue streams or create new efficiencies.
- an e-service is defined as deeds, efforts or performances whose delivery is mediated by information technology.

E-services distinguish three main components: service provider (public agencies, universities, commercial companies, etc.), service receiver (citizens, students, firms, etc.) and delivery channel (i.e. technology used – Internet, television, telephone, radio, CD-ROMs).

E-services can help in accessing broader customer base. They can be available 24 hours a day and accessible from anywhere. Installation and operation costs can be significantly decreased.

Since the electronic services are currently provided in a digital form they can be also considered as digital services in general. There are a lot of applications of e-services such as e-business, e-government, e-shopping, e-health, e-learning (e-education), e-banking, e-consulting, e-working. However, we can also meet other words emerging which are associated with this domain such as e-society, e-entertainment, e-culture, e-science, e-inclusion, etc. Recently, there has been rapid progress in mobile communications and computing. Mobile phones, tablets, PDAs and various other wireless enabled devices are common part of end user's everyday life providing sufficient usability (comfort of usage) and high instantaneity (speed and efficiency of transaction/activity execution). Then electronic services that are provided and consumed through wireless/mobile handheld devices are often called mobile services (m-services) [8]. We can encounter e.g. m-government, m-health, m-learning, m-banking and other m-services.

4.1 E-commerce / e-business

E-commerce or electronic commerce is a service covering online business activities related to products and services. Very simply said it is about selling and buying the goods realized over Internet, i.e. particular parties interact mostly in electronical way (than by direct physical exchanges). It also covers every business transaction conducted over ICT and resulting in transfer of ownerships and copyrights for using various goods and services [9].

Sometimes e-commerce is considered being the same as e-business. However, they are different and e-commerce constitutes a significant component of e-business. E-commerce realizes such business processes which directly touch the other parties (customers, goods suppliers and other external partners). These processes are such as sales, taking orders, customer service, marketing, delivery, purchasing of materials and supplies.

E-business represents a complex application of ICT into all parts and processes of the business world. All e-commerce activities are within e-business extended by internal business processes. These processes include inventory management, risk management, production and product development, finance, human resources and knowledge management.

Examples of e-commerce services:

- online shopping (e-shopping),
- online banking (e-banking, Internet banking), payment systems, digital wallet,
- automated online assistant,
- online reservations and electronic tickets,
- shopping cart software,
- online office suites, teleconferencing, instant messaging,
- social networking.

E-commerce allows transforming local markets to national and international level. Sellers can easily and quickly gain much more customers, partners and suppliers at less cost. It also brings administrative costs reduction because a lot of information is not more processed in paper format but electronically. E-commerce can reduce company inventories (just-in-time production). It also decreases time between a capital investment and its return. Companies can save costs in using Internet instead of private networks. On the other hand, customers can perform business transactions anytime and anywhere (on the Earth). They have access to larger number and variety of products and services as well as sellers. By e-commerce customers can often buy products at lower prices with fast delivery. Electronic

commerce supports faster competition resulting in various customer oriented benefits.

E-commerce can make use various sales scenarios:

- *business-to-business* (**B2B**) – when companies sell their products (services) online to other companies. It is based on a principle that Internet simplifies their mutual communication. These Internet transactions and services represent signing contracts among companies. Entering the company web will often require a log in.

- *business-to-consumer* (**B2C**) – this is the most used e-commerce scenario. Companies sell their products and services online to end consumers (anonymous clients). Company's web shops have an open access to their products for any visitor. Online shops can often be a supplemental traditional business for enterprises. Examples are Amazon, Zappos, MALL.

- *consumer-to-business* (**C2B**) – customers (consumers) offer their products or services online to companies. Companies can post their bids and customers can select winning company which offers best price or meets other business conditions.

- *consumer-to-consumer* (**C2C**) – it is a scenario where consumers (people, citizen) offer and sell online their goods directly to other consumers (people). Internet provides just a platform for trading rooms and auctions on C2C servers owned by third parties. Examples of C2C are eBay, Amazon, BrickLink which use a PayPal system. This system allows the buyers and sellers realize/receive secure and quick online payments. Peer-to-peer sites also fall under this category.

- *government-to-business* (**G2B**), *business-to-government* (**B2G**), *government-to-citizen* (**G2C**), *citizen-to-government* (**C2G**), etc. – other e-commerce scenarios where transactions are realized with the government (procurements, tenders, voting, renewing licenses, tax forms and tax reporting).

	Business	Customer	Government
Business	B2B	C2B	G2B
Customer	B2C	C2C	G2C
Government	B2G	C2G	G2G

Fig. 6 Types of e-commerce

4.2 E-government, e-signature

E-government is a term which includes usage of various tools, methods and information and communication technologies with aim to provide and improve public services for enterprises, companies and citizens [9].

It is e-business service in public sector. E-government delivers government services to companies (G2B), citizens (G2C), employees of public administration (**G2E**, *government-to-employee*) and among various government organizations, institutes and departments (**G2G**, *government-to-government*).

The main objective is to bring the public administration closer to citizens and companies in an efficient and cost effective manner. Its main idea is to provide citizens with constant access to public services as well as to improve efficiency of (internal) public administration operation.

There is also broader term – e-governance – which represents the development, implementation and enforcement of policies, laws and regulations which are necessary to support an operation of governmental units.

E-government can realize following activities:

- one-way delivery of information (over the Internet) – from government (information portals, regulatory information, forms, registers, certificates) or for government (e-taxes, tax return submitting)
- two-way communications between the public agency and citizens, companies or another public agency – users can post comments, questions, problems and other requests to public agencies (data boxes)
- conducting transactions – applying for grants, contracts, tenders, auctions (e-procurement)
- governance – when people becomes active and are involved in public processes (e-participation), e.g. electronic voting, reputation systems, petitions

In order to make use of some of the above-mentioned e-government services it is necessary to adapt the Law on electronic signature (e-signature) [10].

E-signature is the electronic version of a handwritten signature which is associated with a person indicating his adoption of the document.

It can be a digitized image of a handwritten signature, a symbol, voiceprint, etc., used for identification of authors of an electronic document, message or report. E-signature is vulnerable to copying and tampering, and needs proprietary verification software. Examples of e-signing systems are eSign (Adobe), DocuSign, Sertifi, RightSignature. On other hand, a **digital signature** relies on a special mathematical scheme which ensures authenticity of the document.

The digital signature is based on **PKI** (*Public Key Infrastructure*) technology. It guarantees signer identity and intent, data integrity, and the non-repudiation of signed documents. The digital signature cannot be copied, altered or tampered with.

4.3 E/m-banking

When financial institutions (e.g. banks) allow their customers to perform financial transactions via their secure websites we can talk about the online banking service. This service can also be referred to electronic banking (e-banking), Internet or virtual banking. Customers need Internet access and have to be registered for this service with the institution. If this service is accessed via mobile devices such smart phones or tablets it is called mobile banking (m-banking).

Electronic banking allows customers to access bank from anywhere (and to maintain permanent access) and they can acquire lower transaction costs.

Online banking can provide customers with services related to:

- non-transactional tasks – viewing account balances, recent transactions, downloading account and bank statements as well as applications (e.g. for m-banking), other bank, finance and general related information
- transactional tasks – funds transfers, bill payments, investment purchase/sale, loans, credit cards application, etc.

Actual trends in e/m-banking cover e.g. video interaction with financial agents and advisors, mobile wallet, connection with games and social networks, voice authentication, etc.

4.4 E-health

eHealth can be defined as the usage of modern information and communication technologies to provide correct healthcare information in right time at right place to improve healthcare process and quality of life and to meet the needs of citizens and patients, healthcare professionals and providers, and policy makers [11].

It is based on digital data (patient records) which are electronically transmitted, stored and retrieved for clinical, educational and administrative purposes. eHealth cover for example:

- communication of patient (health) records between healthcare professionals
- e-consulting – electronic communications (by phone, emails, information sharing, video call) between patient and healthcare professional
- ePrescribing – access and printing patient prescriptions
- diagnostic tests, diagnosis, treatments and telemonitoring at a distance
- information services - provision of health and medical information to citizens
- mHealth - eHealth using mobile end devices
- healthcare management system – appointment scheduling, patient records management

4.5 E/m-learning

Electronic learning can be characterized as an application of ICT into development, distribution and management of educational process.

E-learning covers various forms of education such as web education, distant education, e-teaching, computer supported education, virtual classes, m-learning, cooperation. The educational process is usually realized via Internet, Intranet, audio or video conferences, terrestrial or satellite broadcasting, media such as CD or DVD ROMs, USB flash drives. Based on learning content distribution students need some of these devices: TV set, PC, laptop, tablet, smartphone, media player. E-learning also represents a form of self-education through electronic training materials distributed aforementioned channels. It can be also a part of combined form of education. The educational process is often delivered, tracked and managed by *learning management system* (**LMS**, e.g. Moodle). Currently, great emphasis is put on quality of training materials which should contains animations, multimedia objects, games, simulations, interactive tasks, virtual experiments.

New research is also realized in so called mulsemedia when multiple (not only two) human senses are involved in educational process. Virtual classrooms supported by a *virtual learning environment* (**VLE**) and user's webcams make learning more attractive.

4.6 E-working (teleworking)

Teleworking, telework, telecommuting, e-working or remote/distance working represent a form of working when worker doesn't have to commute to a central place of work. Although, a lot of workers work from home some workers can work at various places (shops, abroad). Current teleworker utilizes computer for a work which is connected to the company network. Technologies that facilitate teleworking are virtual private networks, collaborative software, (video)conferencing, **VoIP** (*Voice over IP*).

Teleworking reduces operation costs and enhances the labor productivity and results.

However, teleworking has also some drawbacks. It puts higher stress on worker's motivation to work. Distractions at home can be finally more critical than in work (e.g. children, pets, and neighbors). Teleworker can loose a professional contact with nonteleworkers.

5 Internet of things

Topic Internet of things is elaborated and provided to students and teachers in details within the separate Learning module LM 08: Internet of things.

6 NGN services

6.1 VoIP

Voice over IP (**VoIP**; or IP telephony, Internet telephony) is a set of technologies necessary for voice communications delivering and multimedia sessions providing over **IP** (*Internet Protocol*) networks (Internet).

The Internet telephony represents the delivery of communications services such as voice, fax, SMS, voice-messaging over Internet, rather than via the *public switched telephone network* (**PSTN**). VoIP telephone call setup process is similar to traditional digital telephony and includes actions:

- signaling exchange,
- channel setup,
- analog voice signals digitization,
- voice data encoding.

The encoded voice data are packetized and transmitted as IP packets over a *packet-switched data network* (**PSDN**). Examples of VoIP applications are Skype, Google Talk.

There are several competing approaches how to implement the VoIP. Each one is based on a set of protocols to handle signaling, data transmission, and other tasks. The most used protocol in a VoIP world is SIP [12]. The *Session Initiation Protocol* (**SIP**) is a communication protocol which provides signalization of control for multimedia communication sessions. It is independent on the underlying transport protocol and can use:

- *Transmission Control Protocol* (**TCP**),
- *User Datagram Protocol* (**UDP**), or
- *Stream Control Transmission Protocol* (**SCTP**).

Consequently, SIP is an application-layer control protocol that handles the setup, modification, and tear-down of multimedia sessions. Media can be added to (and removed from) an existing session. SIP is used in combination with other protocols to describe the session characteristics to potential session participants. SIP is based on a request and response transaction model similar to HTTP. Each transaction consists of a request that invokes a particular method or a function on the server and at least one response.

There are several popular codecs used for voice encoding in VoIP sessions such as G.711, G.722, or G.729.

6.2 Hosted Call Centers

Over the last decade contact centers have experienced an extensive evolution overall. Many companies utilize a number of contact centers to manage all interactions with their customers (whether it is an in-house team or outsourced to third-party assistance). Hosted VoIP telephony is quickly becoming the standard communications platform for organizations of all sizes. The wholesale transition to feature-rich Hosted VoIP service (from traditional telephone systems) has already begun and offers considerable benefits:

- immediate cost savings,
- increase in system reliability and worker productivity.

Deployment of Hosted VoIP technology requires little on-premises equipment. In most cases, needed equipment is limited to a high-quality router, *Integrated Access Devices* (**IADs**), and IP telephones (Fig. 7). Analog telephones can be also used in some cases, but IP telephones are strongly recommended because they

- offer more functions,
- require less hardware,
- are easier to use.

IADs are used to allow companies access to their existing analog handsets, credit card machines, alarms, fax machines, etc.

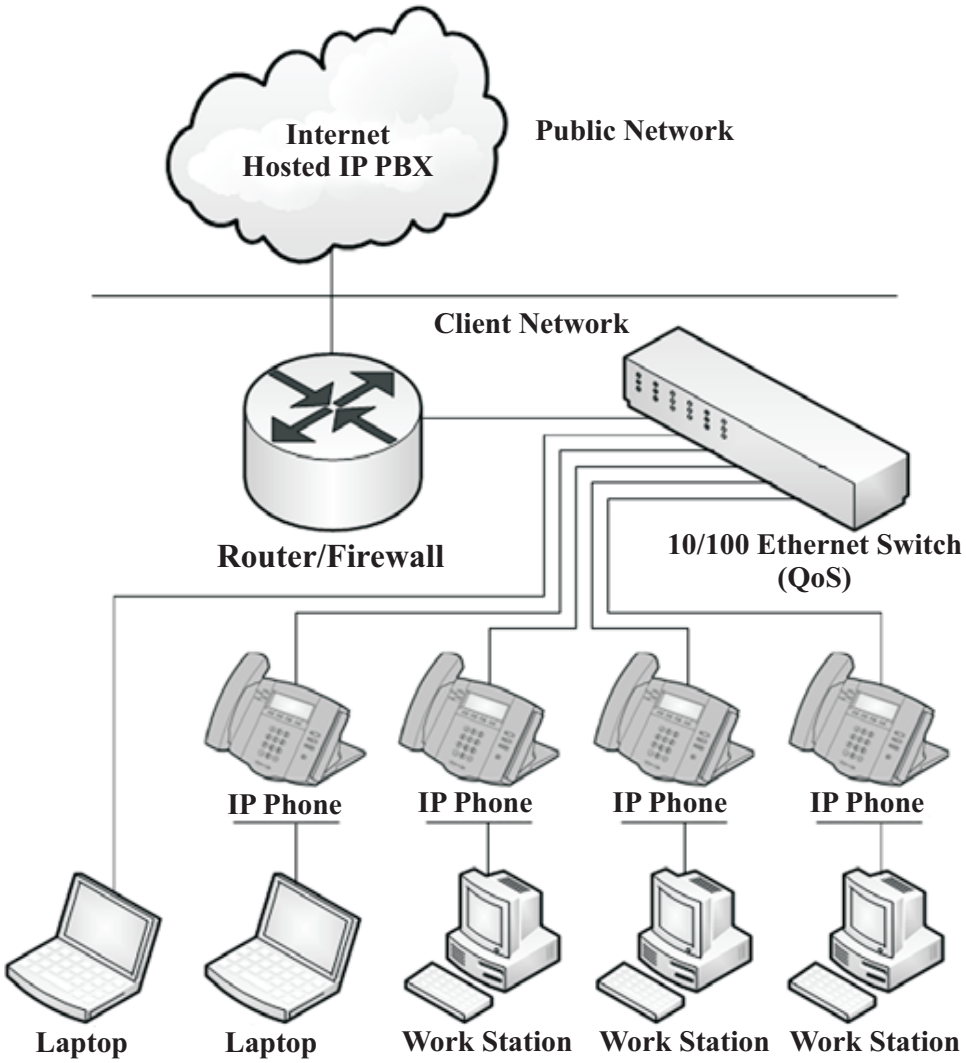

Fig. 7 - Hosted VoIP network topology [13]

6.3 IPTV

ITU-T defines the **IPTV** (*Internet Protocol Television*) by the following definition [14]:

IPTV are multimedia services such as television/video/audio/text/graphics/data delivered over IP-based networks managed to support the required level of QoS/QoE (Quality of Service/Experience), security, interactivity and reliability.

In other words, IPTV is a system which delivers (using streaming technique) television services using IP suite over PSDN networks (LAN, Internet) instead of being delivered through traditional terrestrial, satellite or cable television systems [15]. End to end chain for delivery of the IPTV content to the end user usually contains these 4 main domains that are involved in the provision of an IPTV service (Fig. 8):

- Content provider,
- Service provider,
- Network provider,
- End-user.

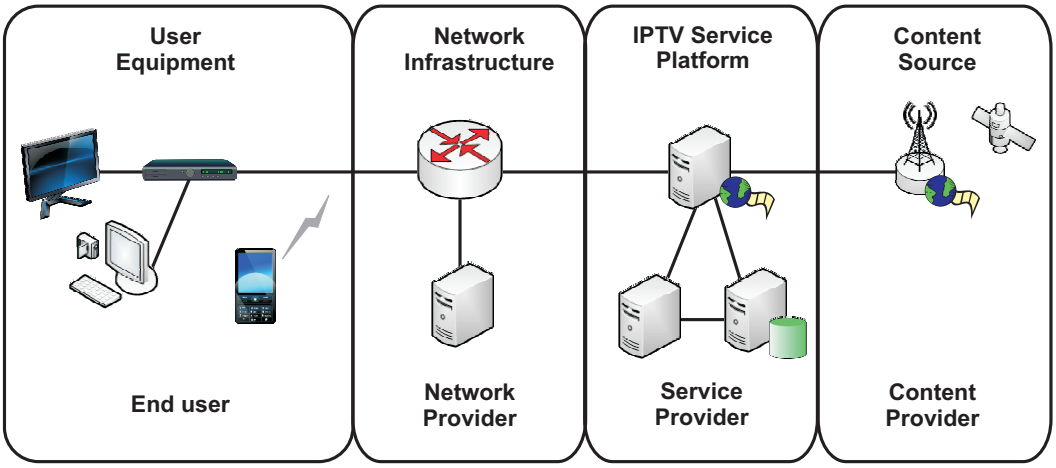

Fig. 8 - IPTV domains

There are two main aspects of the IPTV:

1. technological aspect - the IPTV architecture,
2. user's perspective aspect - provided IPTV services and user experience.

Most of the existing non-NGN IPTV solutions provide only basic set of services like linear TV, VoD, and some of them also PVR.

New NGN based IPTV solution should therefore provide much more services, features and what is the most important also new user experience in watching TV with more interactivity, personalization, mobility and last but not least comfort in consumption of the right content in the right time and right way.

There is no single approach to the IPTV service provisioning [16]. Due to huge costs involved in the network equipment, operators usually follow incremental approaches to network upgrading, always relying on existing premises and procedures.

Interested readers can find more details about IPTV networks and services in Annex of Learning module LM 19 - Modern TV standards – Internet Protocol Television.

6.4 VoIP VPN

Combination of two technologies: the voice over IP and virtual private networks provides VoIP VPN technology which offers a delivery of secure voice. As was already mentioned, the VoIP transmits a human voice as a digital data stream.

Then it is quite easy to provide voice encryption via VPN tunnels just by applying standard data-encryption algorithms which are inherently available in protocols used to implement VPN tunnels.

Application of the Voice over IP through VPN brings another benefit, however. It is difficult to pass the SIP protocol through a firewall because it uses random port numbers for connections setup. A VPN is good solution how to avoid firewall problems when configuring remote VoIP clients.

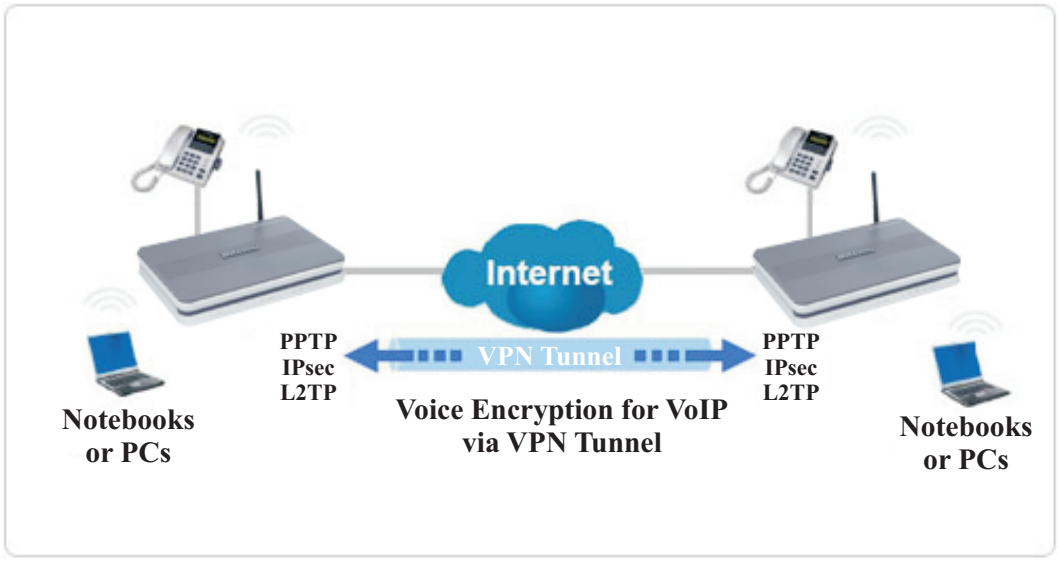

Fig. 9 - Secure Voice over VPN Tunnels [17]

6.5 Supported service (ISDN services emulation/simulation)

During evolution to NGN, NGN shall support legacy terminal equipments (e.g. PSTN/ISDN phones) and PSTN/ISDN-like capabilities.

PSTN/ISDN Emulation:

- from the end user perspective, the NGN "appears" supporting the same types of services offered by the existing PSTN/ISDN,
- legacy terminals can use existing telecommunication services while connected to NGN.

PSTN/ISDN Simulation:

- NGN terminals in an NGN network can use PSTN/ISDN- like service capabilities,
- legacy terminals with terminal adaptations may be used too,
- Implemented over IP-based control infrastructure (e.g. using SIP).

6.6 QoS

Multimedia services require from networks to ensure **QoS** (*Quality of Service*) parameters. IP networks have been designed with a best-effort delivery model which doesn't meet these requirements. Therefore some QoS mechanisms must be implemented in IP transport networks:

- **DiffServ** (*Differentiated Services*),
- **IntServ/RSVP** (*Integrated Services / Resource Reservation Protocol*),
- **MPLS** (*Multi-Protocol Label Switching*).

Unfortunately, these mechanisms are not aware of communication sessions (e.g., VoIP sessions) started by higher layer protocols such as SIP.

NGN networks provide a lot of services (applications) which generate many different types of traffic in the network and which require a more controlled way of traffic handling. QoS enabled networks are based on a concept which divides all network traffic into different classes with different characteristics.

An end-to-end **packet delay** is referred as a time necessary to transfer a packet from its source to its destination. A **packet jitter** is defined as variations in the packet delays. *Packet error ratio* (**PER**) is defined as the percentage of sent packets that were dropped or lost. Based on the PER we can divide applications into two groups error tolerant and intolerant. Table 1 summarizes these applications in relation to the packet delay parameter.

Table 1 Application categorisation based on packet delays and PER

	Error tolerant	**Error intolerant**
Interactive (delay <<1 s)	Conversational voice and video	Command/control (e.g. Telnet, interactive games)
Responsive (delay ~2 s)	Voice/video messaging	Transactions (e.g. E-commerce, WWW browsing, Email access)
Timely (delay ~10 s)	Streaming audio and video	Messaging, Downloads (e.g. FTP, still image)
Non-critical (delay >>10 s)	Fax	Background (e.g. Usenet)

RSVP (defined in RFC 2205 in 1997) is used by the IntServ model and more importantly MPLS to realize a resource reservation. It provides applications with the means to let the network know what and how much resources it requires. This process is called signalling.

In order to support QoS policy in NGN, ITU has recommended an infrastructure with a *Resource and Admission Control Function* (**RACF**). The resource allocation

and admission control is realized in the transport layer. At the same time ETSI developed a functional architecture for resource management called a *Resource Admission Control Subsystem* (**RACS**) for access and aggregation networks. Both systems show a lot of similarities and only a few minor differences.

7 WebRTC

Web Real-Time Communications (**WebRTC**) is a collection of open standards for real-time communication, mainly developed by the WebRTC World *Wide Web Consortium* (**W3C**) Working Group and the *Real-Time Communication in Web-browsers* (**RTCWEB**) *Internet Engineering Task Force* (**IETF**) Working Group.

The W3C focuses their work with WebRTC mainly on the browser *Application Programming Interfaces* (**API**s) to interact with the audio/video sources. The IETF created the RTCweb group to focus on the inter-browser interface and definition of (signaling) protocols.

WebRTC [19] opens up possibilities for real-time communications such as audio and video calls, screen sharing and video conferencing within web-browsers, but without any use of additional software (only modern web browsers are required). This makes it easy for web developers to implement WebRTC features only by using *Hypertext Markup Language version 5* (**HTML5**) and a variety of JavaScript Application Programming Interfaces (API).

Besides providing a powerful decentralized media engine within browsers, WebRTC has other benefits such as open-source code & APIs, free audio & video codecs (adaptive, high definition), and network support inbuilt (e.g. encryption, network discovery).

However, due to its technical design, WebRTC is not narrowed to the use within browsers. It can also be used via apps and native implementations, so that nearly every modern connected device - computers, tablets or even televisions - could become a WebRTC peer and thus a fully-fledged communications device. These participants of a communication can be named as WebRTC peers or shortly peers, which can also be seen as a synonym for the entire communication device. Besides it is easy to handle characteristics the most revolutionary aspect of WebRTC is its communication concept.

In contrast to other real-time communication systems, providing communication using WebRTC does not require a big infrastructure which handles the communication traffic throughout the peers.

Usually, there are two communication patterns in WebRTC, the basic pattern, called the WebRTC Triangle and a more advanced pattern, the WebRTC Trapezoid.

In the case of a Triangle pattern (shown in Figure 10), in the first place, all peers or respectively browsers, which shall communicate with each other connect to a web server. This web server provides a WebRTC web application, often implemented as a JavaScript file, which invokes a set of APIs that are provided by the web server. In order to set up the WebRTC session, those API requests are used to set up the signaling channel. The signaling in WebRTC is not standardized and thus depending on the specific WebRTC implementation, between the peers via the web

server. The transport of user data (such as audio, video or others) is done via the PeerConnection, which is established directly between both peers.

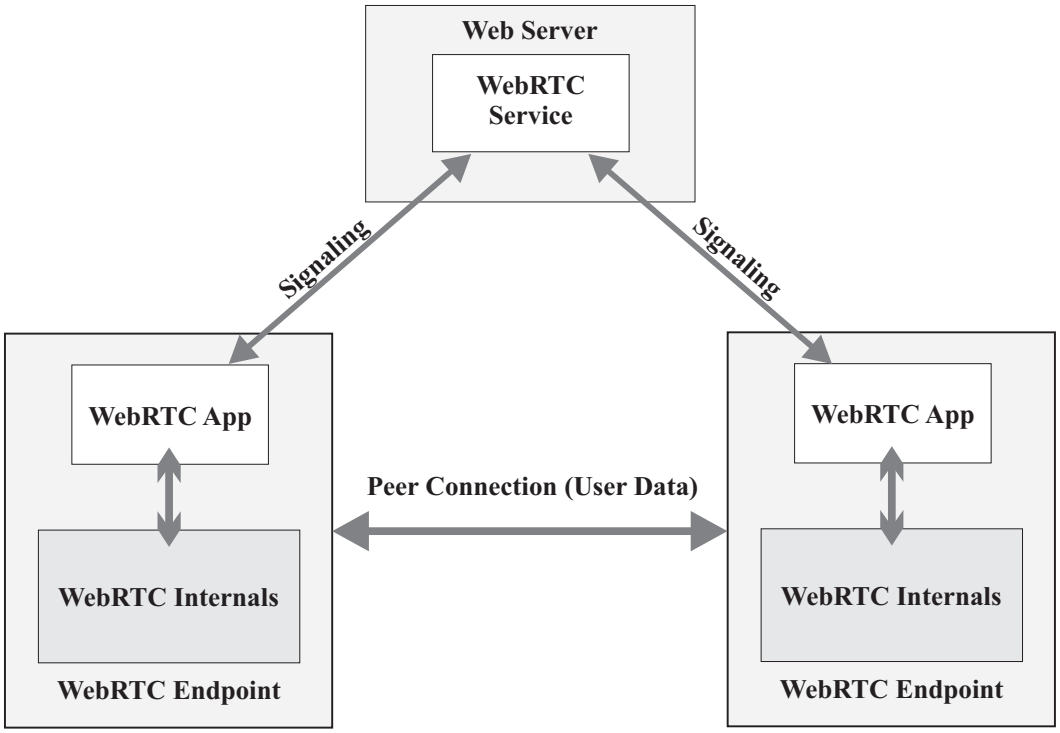

Fig. 10 - WebRTC Triangle

Figure 11 depicts the trapezoid communication pattern, which is used for communication between the peers that are not connected to the same web server. In this case, the communication throughout the web servers is done with the use of a standardized signaling protocol such as the SIP. However, the user data transmission via the PeerConnection remains unchanged and therefore is still done directly between the peers.

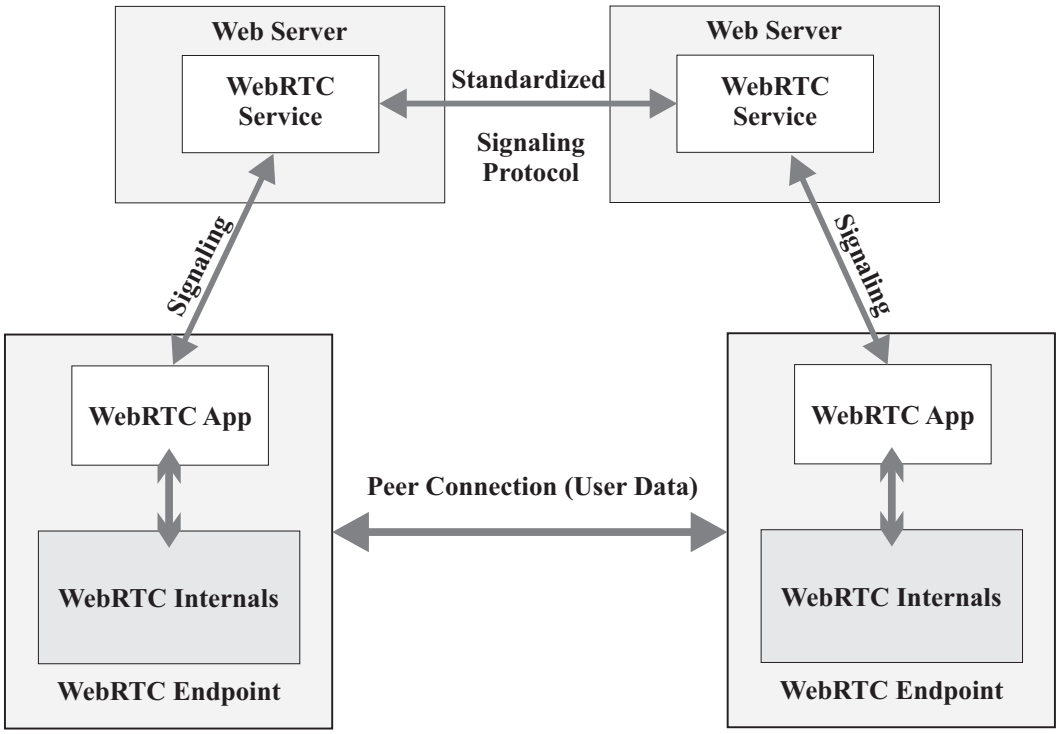

Fig. 11 - WebRTC Trapezoid

7.1 Applications

With WebRTC [20], various applications can be built – not only limited to communication features. WebRTC is not (only/mainly) about "calling" from within the browser, but about enabling web developers to access to audio/video input devices via JavaScript as well as abstracting the problem of browser-to-browser communication for ordinary web developers.

Once the browser-to-browser communication problem has been solved, WebRTC provides both a user data channel for real-time communications data, but also a data channel to send any kind of other data in a peer-to-peer manner.

All of this does mostly not require plug-ins – but is natively supported in the browsers (currently Google Chrome, Mozilla Firefox, Opera, Microsoft Edge).

Browser-to-browser applications for voice calling & video chat

The simplest application for WebRTC is the audio/video communication between browsers. The inbuilt WebRTC capability provides microphone (audio) and camera (video) access (the user can select the device and grant permission).

The important API functions for this use case are

- MediaStream/getUserMedia (HTML 5)
- RTCPeerConnection

Before getUserMedia was available, browsers handled already "static" media objects (<img>, <video>, <audio>). These objects could be displayed, but also manipulated (e.g. an <img> tag can scale using width="400" attribute). The getUserMedia API adds access to dynamic sources such as microphones and cameras. The characteristics of these sources can change in response to application needs. MediaConstraints are used as standard way of restricting resources.

The PeerConnection is a media technology that allows two users to communicate directly, browser to browser. This communication is coordinated via a signaling channel which is provided by unspecified means, but generally by a script in the web page that has been provided by the web server. Many websites do already have the possibility to exchange messages between web client and server (e.g. via web sockets).

Sample services are:

- appear.in
- talky.io

P2P file sharing

The RTCDataChannel lets a web application send and receive generic application data peer-to-peer.

The DataChannel interface represents a bidirectional data channel between two peers. While the PeerConnection is a channel for RTC only, the DataChannel can transport any type of data.

A sample service is sharefest.me.

Screen sharing

The getUserMedia API can not only access camera/microphone as media source, but also the shared screen. For security reasons, accessing the screen requires a plug-in. This plug-in is however not providing screen sharing as such (this is done by the WebRTC part of the browser), but only access to the browser API for certain domains that are explicitly permitted through the plug-in.

Most services that are used to communicate with audio/video also offer screen sharing.

Collaborative whiteboard

Besides A/V communication and screen sharing, the applied data channel can also be used to transfer not only files, but also control information. This control information can be used to modify displayed browser content.

A sample application for this can be a collaborative whiteboard. By sending the inputs from one whiteboard (“editor”) to all other whiteboards under the same link (“viewers”) the browser application can act as shared whiteboard. Supported by WebRTC communication features such a website can be used e.g. within e-learning.

Conferencing

From the pure browser concept, WebRTC is conceived as peer-to-peer communication, without requiring additional infrastructure.

This architectural approach makes it difficult to realize sessions with multiple streams such as group video conferences or other "n-to-m" broadcasting scenarios.

This is the place, in which the conferencing building block comes into play. The conferencing building block cares about the distribution of media traffic to a group of peers. That distribution is possible in three different ways, which are primarily differing in their requirements of additional servers.

Let’s start with the peer to peer concept, which results in a fully meshed network approach.

The biggest advantage of this approach is its simplicity of being built by a developer, since it does not require any kind of distribution point in the center of the network (compare Figure 12).

On the other hand, this simplicity comes with a price of a very high demand in terms of network performance. The more participants attend a conference, the higher the required network performance becomes in general.

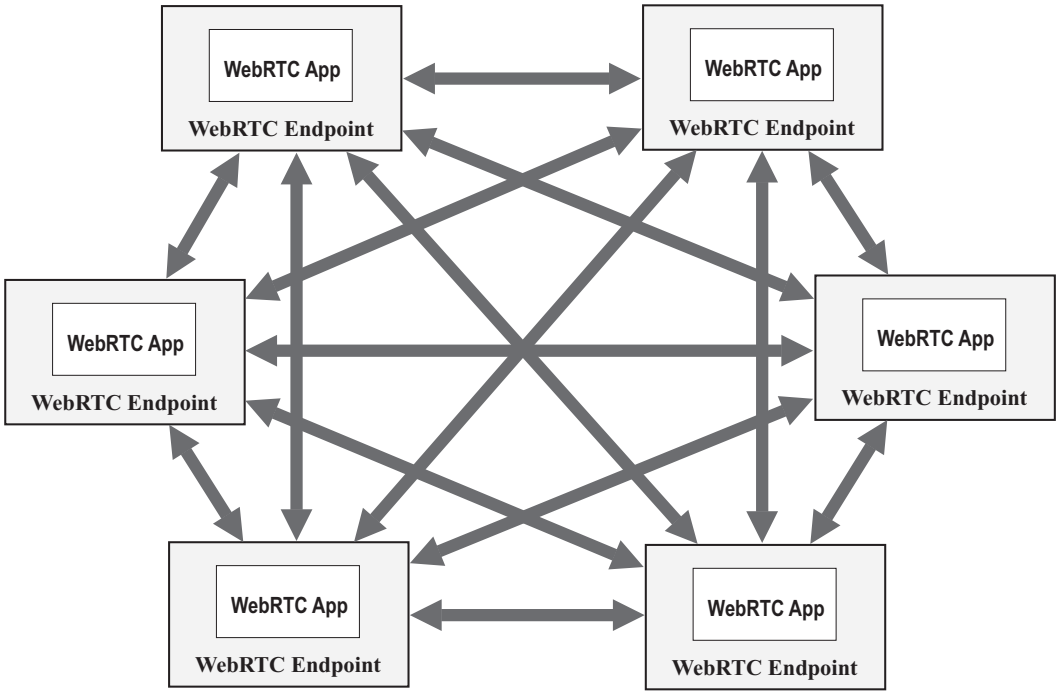

Fig. 12 - Peer-to-Peer Network Approach

In contrast to the peer-to-peer approach, involving a selective forwarding unit or respectively a media control unit requires additional servers (see Figure 13). A selective forwarding unit acts similar to a router or proxy, which broadcasts each media stream that it receives from one peer to all the other peers.

On the one hand, this reduces the required network performance as result of uploading only one media stream per peer.

On the other hand, the required network performance is only shifted towards the selective forwarding unit.

In the case of a media control unit, the central unit receives all the media streams from the peers, similar to the selective forwarding unit. However, in a second step, the traffic is processed by the central unit, in order to build one individual stream for every peer. Finally, the media control unit transmits only the one individual stream to every single peer, which results in a great improvement in terms of the

required network performance. Additionally, this approach also enables a broad variety of conceivable application cases by using different types of media processing on the central unit.

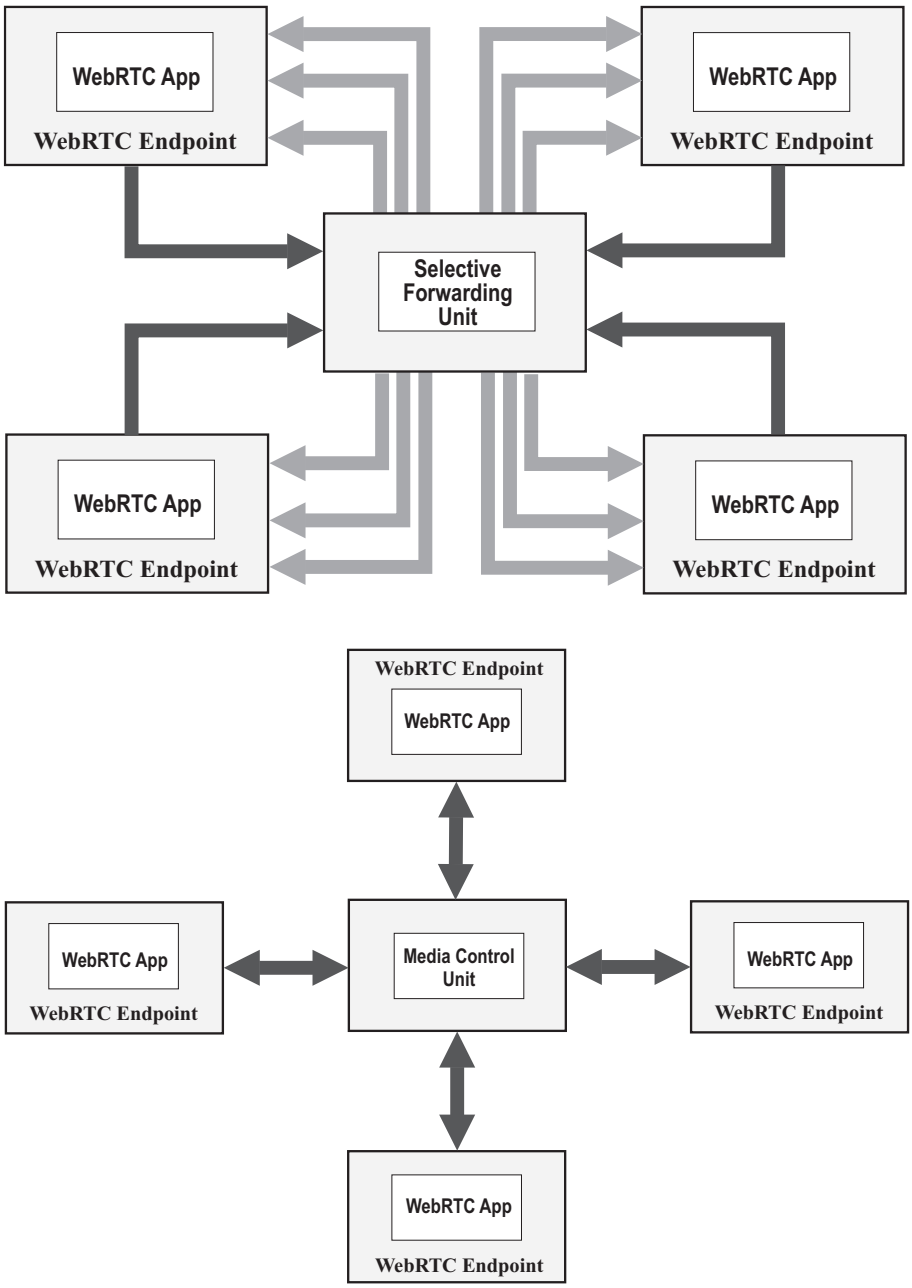

Fig. 13 - Selective Forwarding Unit and Media Control Unit

7.2 Summary

With WebRTC, web developers can natively access mic/video camera and set up direct browser-to-browser connections. They are able to send real-time content & normal data without worrying about signal processing, codecs, security, and bandwidth management.