Multimedia Technologies and Converged Services

as. mag. Jože Guna
Contents

- What is *Multimedia*?
- Multimedia elements
- Multimedia services
- Distribution platforms
  - Broadcasting
  - IPTV
  - OTT
- End-user terminals and home network
- User eXperience
Big picture

Introduction to MM systems and services
- overview
- terminology
- short history of multimedia

MM elements and properties
- text, audio, pictures, video, 3DTV content
- content compression, standard [file] formats
- bandwidth requirements

Converged MM services and delivery methods
- SmartLiving home MM services
- SmartGrid services
- SmartTransport services
- SmartHealth services

Delivery methods: broadcast, multicast, unicast, radio broadcast

(Radio) broadcast services
- Broadcast
- Controlled

IPTV/VOD
- Multicast/Unicast
- Controlled

OTT
- Unicast
- Open

Transport networks, DVB/GoS

Terminal equipment
- Home network

Applications & Services

UX

www.itfe.org, Laboratorij za telekomunikacije
How it all began?

- **Telegraph - Samuel Morse (1843)**
  - 1861 W-E USA connection

- **Telephone – A.G. Bell (1876)**

  - 1901 wireless transmission over Atlantic

- **Radio – from 1919 onward**
  - USA 1920, France, UK 1922, Germany, Chech Republic, Austria 1923
  - SHS: Beograd 1924, Zagreb 1926, Ljubljana 1928
  - Propaganda tool
A short history of multimedia

- **Television**
  - Radio with pictures
  - BBC 1936 – first regular transmission
  - CNN: 1. july 1980
  - MTV: 1. august 1981

- **Advances in late 90ties and in 21st century**
  - Satellite TV, digital broadcasting, EPG
  - Internet and converged multimedia services -> OTT
  - Global media market
  - Social networks

www.itfe.org, Laboratorij za telekomunikacije
Multimedia and social aspects

- Socio/cultural aspects
  - “too much” free time
  - TV as the free time and energy black hole
  - e.g. one weekend of TV commercials in USA eq. 100 million hours!!

- Estimated effort for the WHOLE Wikipedia project eq. 100 million hours

- Big things can be achieved with only little effort (on a mass scale 😊)

But, what is Multimedia?

- “Multimedia (Lat. Multum + Medium) is media that utilizes a combination of different content forms. The term is used in contrast to media which only utilize traditional forms of printed or hand-produced text and still graphics. In general, multimedia includes a combination of text, audio, still images, animation, video, and interactivity content forms.” Wiki

- Multimedia elements
Interactivity

INTERACTIVITY
Multimedia elements - sound

- Mono, stereo, surround...
- Various sources and playback devices
- (Analog) and digital formats
  - wav, flac, mp3, aac, dts, ...
- A long history from wax cylinders (1877), vinyl records and compact cassettes to CDs and flash based media devices
- Today: HiFi surround sound (e.g. UHDV – 22.2 channel)
Multimedia elements - pictures

- **Properties**
  - Resolution
  - Colour space/depth

- **Digital formats**
  - Bitmap
    - gif, png, jpg, bmp, tiff, raw, etc.
  - Vector
    - svg, etc.

- **Almost unlimited editing possibilities… 😊**
Multimedia elements - video

- Video (lat. “videre” - to see)
  - “pictures in motion”
    - At least 24 fps
- (Analog) and digital formats
  - MPEG 2, MPEG 4avc, H.265
- Short history
  - 1860: animations - mutoskop
  - 1878: sequence of still photographs – horse races
  - 1936: first regular TV programme - BBC
  - 1951: first live transmission – HarryTruman speech
- Today – HDTV and beyond, OTT
Multimedia elements – 3D

- What is 3D?
- Virtual 3D
  - Stereoscopic vision
    - Uses glasses
  - Autostereoscopic vision
    - Without additional devices
- Real 3D displays
  - Holography
  - Volumetric displays
- A looooooooot of data!

Real 3DTV?

http://en.wikipedia.org/wiki/3D_display
Multimedia content compression

- **Lossless**
  - All information is retained

- **Lossy**
  - Information is irrevocably lost in the process

The balance between compressed content data size and quality...

- Compressed data
- Decompression
- Lossless
- Lossy
<table>
<thead>
<tr>
<th>Standard</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD PAL (i)</td>
<td>720×576, 25 fps (50 fields/s), 4:3 or 16:9</td>
</tr>
<tr>
<td>SD NTSC (i)</td>
<td>720×480, ~30 fps (~60 fields/s), 4:3 or 16:9</td>
</tr>
<tr>
<td>HDTV 720p50</td>
<td>1280×720, 50 fps, progressive; 16:9</td>
</tr>
<tr>
<td>HDTV 1080i50</td>
<td>1920×1080, 25 fps (50 fields/s), interlaced; 16:9</td>
</tr>
</tbody>
</table>
And beyond...

<table>
<thead>
<tr>
<th>Standard</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHDV</td>
<td>7680×4320, 60 fps, progressive</td>
</tr>
</tbody>
</table>

**Super Hi-Vision / Ultra High Definition Video (7680 x 4320)**
UHDV

- **Nippon NHK Ultra High Definition Television**
  - 16:9@7680x4320 pixel (33 megapixel)
  - 60 fps progressive
  - 22.2 audio system
    - 3 lower level
    - 10 medium level (ear height)
    - 9 upper level
    - 2 bass

- **Complete system for**
  - Capture,
  - Transmission,
  - Recording and editing.

- **Format**
  - uncompressed: 24 Gbit/s
  - compressed: MPEG2 600 Mbit/s; MPEG4 140 Mbit/s
Video resolution fidelity comparison

| 1080p (HD) | 1080i (HD) | 720p (HD) | 480p (ED) | 480i (SD) |

## Bandwidth requirements

<table>
<thead>
<tr>
<th>Service</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voice – GSM</td>
<td>13 kbit/s</td>
</tr>
<tr>
<td>Voice – ISDN</td>
<td>64 kbit/s</td>
</tr>
<tr>
<td>Streaming audio</td>
<td>20 kbit/s – 512 kbit/s</td>
</tr>
<tr>
<td>Streaming video – MPEG 2</td>
<td>4 – 8 Mbit/s</td>
</tr>
<tr>
<td>Streaming video – MPEG 4/AVC</td>
<td>1 – 3 Mbit/s</td>
</tr>
<tr>
<td>Internet video</td>
<td>~ 1 Mbit/s</td>
</tr>
<tr>
<td>HDTV</td>
<td>4 – 14 Mbit/s (MPEG 4)</td>
</tr>
<tr>
<td></td>
<td>18 - 25 Mbit/s (MPEG 2)</td>
</tr>
<tr>
<td>Videoconference, telepresence</td>
<td>384 kbit/s – 5 Mbit/s</td>
</tr>
</tbody>
</table>
Download

Downloading Video from A Web Server

HTTP server → Internet → PC

http://www.chickenfarm.com/video.asf

Media file downloaded via TCP/IP

Time

network bandwidth (>,<) content bandwidth
Progressive download

Network bandwidth > content bandwidth
Streaming Video from A Media Server

Video server

mms://wms.chickenfarm.com/video.asf

Internet

Client PC

Network bandwidth ~ content bandwidth
Services
xPlay?

Cable operators

1Play, 2Play, 3Play, 4Play...XPlay?

Mobile operators

TV

mobility

ISP

internet

voice

Telecoms

xPlay

www.itfe.org, Laboratorij za telekomunikacije
Business models

- Closed telco networks – IPTV
- “Over the top video”- internet TV
- Mobile TV
- Broadcasting
IPTV

- **IPTV (e.g. SiOL TV, T-2)**
  
  "IPTV is defined as multimedia services such as television/video/audio/text/graphics/data delivered over IP-based networks managed to support the required level of QoS/QoE, security, interactivity and reliability. “ ITU-T FG IPTV"

- **Internet TV (e.g. Youtube)**
  
  "Internet television (or Internet TV) is television distributed via the Internet. Internet television allows viewers to choose the show they want to watch from a library of shows. The primary models for Internet television are streaming Internet TV or selectable video on an Internet location, typically a website. It differs from IPTV in that IPTV offerings are typically offered on discrete service provider networks.” Wiki"
Typical IPTV services

- **Video services**
  - Linear TV
  - On demand services (VOD, AOD)
  - PVR services (local, network storage based)

- **Second screen services!!!**

- **Information services**
  - Electronic Programme/Service Guide
  - Presence
  - Instant messaging
  - WEB on TV
  - Domain specific (e.g. sports, music, weather,...)

- **Other converged services**
  - Games on Demand
  - Social applications (FB, twitter)
  - eHealth applications
  - smartHome applications
Converged service example

- NEWS application

- Similarities
  - Same content
  - Same login

- Differences
  - Content quality
  - User interface and interactions
Naftni derivati od jutri na novem rekordu

Grička prihaja konec dolgega obdobja nestvarnosti
Stefan Dela Revija: priznanih 34 mio evrov terjatev
Povort osebnih stankov v vnad

Pošlji SMS z besedilom VIK NET 5 na številko 6767.

Anketa
Aš imate radi krofa?
O, da, želo
TV

Novice

Grčija pričakuje konec dolgega obdobja negotovosti
20.02.2012

Pred začetkom srečanja finančnih ministrov držav v območju evra je v Bruslju prevladoval optimizem, da bo

20.02.2012
Ustavite se. Vlak se ne more.

20.02.2012
Fitch nakazal znižanje nekaterih ocen

20.02.2012
Grčija pričakuje konec dolgega obdobja

20.02.2012
Naftni derivati od jutri na novem rekordu

20.02.2012
Odjem električne energije se
Mobile device
NGN IPTV

Messaging

Invitation

Settings

Presence
SmartHome services

INTELIGENTNI DOM
- napredna uporabniška oprema
- komunikacijske napeljave
- lokalno omrežje z dostopom do interneta
- možnost avtonomnega delovanja

ČENTRALNI STREŽNIK
- hramba podatkov
- avtentikacija in autorizacija
- posredovanje podatkov
- razreševanje sočasnih dostopov

STORITVENA LOGIKA
- uporabniški profil
- časovno programiranje
- video domofon
- navidezna prisotnost
- napredna multimedijska

UPORABNIKI
- razvrščanje v skupine
- dodeljevanje pravic
- dodeljevanje prioritet

UPORABNIŠKI VMESNIKI
- vmesnik IPTV
- spletni vmesnik
- mobilni spletni vmesnik
Home automation
Energy monitoring
Telemedicine

![Telemedicine Image]

www.lfte.org, Laboratorij za telekomunikacije
Distribution platform

Broadcasting
Broadcasting

“Broadcasting is the distribution of audio and video content to a dispersed audience via any audio or visual mass communications medium, but usually one using electromagnetic radiation (radio waves). The receiving parties may include the general public or a relatively large subset thereof.”

http://en.wikipedia.org/wiki/Broadcasting
Analog TV formats

- Phase Alternating Line (PAL)
- National Television System Committee (NTSC)
- Séquentiel couleur à mémoire (SECAM)

Vir: http://en.wikipedia.org/wiki/Pal
PAL format

- PAL - Phase Alternating Line
  - Automatic colour correction by phase reversal

- Main properties
  - 4:3 format
  - 625 lines; 576 visible lines
  - 50 fields/s; interlaced
  - 7/8 MHz per channel
BW and colour TV

- Various colour spaces
  - RGB vs. YUV
  - YUV – backward compatibility with BW TV
    - One luma (Y) and two chrominance (U,V) components
    - Luma component – backward compatibility
    - Human visual perception properties

\[
Y' = 0.299R + 0.587G + 0.114B \\
U = 0.492 (B - Y') \\
V = 0.877 (R - Y')
\]

http://lea.hamradio.si/~s51kq/V-CIV.HTM
Teletext

- Digital data transmission in analog video signal
  - Transmission using ”invisible TV lines”
  - PAL B bandwidth: 6.9375 Mbit/s

- Standard properties
  - 40 columns × 25 rows
  - ASCII characters
  - Limited effects (double size, transparency, etc.)
Digital radio

- Eureka 147
- Digital Audio Broadcasting (DAB)
  - Eureka 147
  - MPEG Audio Layer II (typical 192 kbit/s)
- DAB+
  - HE-AAC, typical 48-64 kbit/s)
- Digital Multimedia Broadcasting (DMB)

http://en.wikipedia.org/wiki/Digital_Audio_Broadcasting
Digital terrestrial television

Main DTT technologies

- DVB-T
- ATSC
- ISDB-T
- DTMB

Why go digital?

**Advantages**
- RF spectrum usage efficiency -> digital dividend
- More TV channels and better, enhanced services
- Better quality, HD
- Interactivity (real, local)

**Disadvantages**
- Non-gradient degradation of service dependent on SNR
- Longer zapping times in general
- Additional terminal equipment required
Digital vs. analog TV

- Perfect reproduction – in good SNR conditions!
- Digital signal coding – different video/audio artefacts

Digital:
- “black” picture
- compression artefacts

Analog:
- “snow”
- reflections, shadows
- geometry and colour distortions
Digital dividend

- RF spectrum released in process of DTT transition
- RF bands from 174 to 230 MHz (VHF) and from 470 to 862 MHz (UHF)
- A single analog RF bandwidth (8MHz) used for ONE analog TV programme can now be used as versatile digital broadcast channel
  - More TV channels
  - HD channels
  - Data services
- Spectrum reuse
  - More TV services
  - MobileTV
  - Mobile telephony services

Digi, a DTT logo in Slovenia.
**DVB-x (Digital Video Broadcasting)**

- A family of standards for digital video broadcast
- Standardization under JTC, ETSI, CENELEC and EBU
- Mainly focused on physical and transport layers
- Standard compression mechanisms
  - Video
    - MPEG-2
    - MPEG-4avc
  - Audio
    - MP3
    - AC-3
    - AAC
    - HE-AAC
- Return channel option (DVB-RCT)
- DVB transmission over IP networks (DVB-IPTV)
- Combination of broadcast and broadband networks (HBBTV)
  - Applications and data over DTT or internet
DVB-T/T2 (Terrestrial)

- **MPEG 2 TS**
- **OFDM modulation**
  - QPSK, 16QAM, 64QAM
  - FEC
  - 2k (1705) or 8k (6817)
  - guard interval (e.g. 1/4)
  - coding rate (e.g. 2/3)
  - 6, 7, or 8 MHz channel bandwidth
- **DVB-T/2 -> data bandwidth increase**
  - Better modulation parameters
  - cca. 30% in BW increase

---

Available bitrates (Mbit/s) for a DVB-T system in 8 MHz channels

<table>
<thead>
<tr>
<th>Modulation</th>
<th>Coding rate</th>
<th>1/4</th>
<th>1/8</th>
<th>1/16</th>
<th>1/32</th>
</tr>
</thead>
<tbody>
<tr>
<td>QPSK</td>
<td>1/2</td>
<td>4.976</td>
<td>5.529</td>
<td>5.855</td>
<td>6.032</td>
</tr>
<tr>
<td></td>
<td>2/3</td>
<td>6.635</td>
<td>7.373</td>
<td>7.806</td>
<td>8.043</td>
</tr>
<tr>
<td></td>
<td>5/6</td>
<td>8.294</td>
<td>9.216</td>
<td>9.758</td>
<td>10.083</td>
</tr>
<tr>
<td></td>
<td>7/8</td>
<td>8.709</td>
<td>9.676</td>
<td>10.246</td>
<td>10.556</td>
</tr>
<tr>
<td>16-QAM</td>
<td>1/2</td>
<td>9.953</td>
<td>11.059</td>
<td>11.709</td>
<td>12.064</td>
</tr>
<tr>
<td></td>
<td>2/3</td>
<td>13.271</td>
<td>14.745</td>
<td>15.612</td>
<td>16.086</td>
</tr>
<tr>
<td></td>
<td>5/6</td>
<td>16.588</td>
<td>18.431</td>
<td>19.516</td>
<td>20.107</td>
</tr>
<tr>
<td></td>
<td>7/8</td>
<td>17.418</td>
<td>19.353</td>
<td>20.491</td>
<td>21.112</td>
</tr>
<tr>
<td>64-QAM</td>
<td>1/2</td>
<td>14.929</td>
<td>16.588</td>
<td>17.564</td>
<td>18.096</td>
</tr>
<tr>
<td></td>
<td>2/3</td>
<td>19.906</td>
<td>22.118</td>
<td>23.419</td>
<td>24.128</td>
</tr>
<tr>
<td></td>
<td>3/4</td>
<td>22.394</td>
<td>24.882</td>
<td>26.346</td>
<td>27.144</td>
</tr>
</tbody>
</table>

Slovenia DTT -> Better modulation parameters

cca. 30% in BW increase

http://www.dvb.org/technology/fact_sheets/
DVB-T/T2

Single Frequency Network, SFN

DVB-T Single Frequency Network Architecture
DVB-S/S2 (Satellite)

- **DVB-S**
  - Digital satellite broadcast
  - MPEG-2 TS

- **DVB-S2**
  - Digital bandwidth increase (cca. 30%)
  - Compatible with DVB-S

- **UHDV- 2xDVB-S2 transponders used for transmission**

<table>
<thead>
<tr>
<th>Satellite EIRP (dBW)</th>
<th>51</th>
<th>53.7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System</strong></td>
<td>DVB-S</td>
<td>DVB-S2</td>
</tr>
<tr>
<td><strong>Modulation &amp; Coding</strong></td>
<td>QPSK 2/3</td>
<td>QPSK 3/4</td>
</tr>
<tr>
<td><strong>Symbol Rate (Mbaud)</strong></td>
<td>27.5 ($\alpha = 0.35$)</td>
<td>30.9 ($\alpha = 0.0$)</td>
</tr>
<tr>
<td><strong>C/N (in 27.5MHz) (dB)</strong></td>
<td>5.1</td>
<td>5.1</td>
</tr>
<tr>
<td><strong>Useful Bitrate (Mbit/s)</strong></td>
<td>33.8</td>
<td>46 (gain = 36%)</td>
</tr>
<tr>
<td><strong>Number of SDTV Programmes</strong></td>
<td>7 MPEG-2 15 AVC</td>
<td>10 MPEG-2 21 AVC</td>
</tr>
<tr>
<td><strong>Number of HDTV Programmes</strong></td>
<td>1-2 MPEG-2 3-4 AVC</td>
<td>2 MPEG-2 5 AVC</td>
</tr>
</tbody>
</table>

Vir: [http://www.dvb.org/technology/fact_sheets/](http://www.dvb.org/technology/fact_sheets/)
DVB-C/C2 (Cable)

- Digitalni broadcast over cable networks
- **DVB-C**
  - **Bandwidth increase due to better modulation parameters**

<table>
<thead>
<tr>
<th>Modulation</th>
<th>Bandwidth (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16QAM</td>
<td>6.41 12.82 19.23 25.64 32.05</td>
</tr>
<tr>
<td>32QAM</td>
<td>8.01 16.03 24.04 32.05 40.07</td>
</tr>
<tr>
<td>64QAM</td>
<td>9.62 19.23 28.85 38.47 48.08</td>
</tr>
<tr>
<td>128QAM</td>
<td>11.22 22.44 33.66 44.88 56.10</td>
</tr>
<tr>
<td>256QAM</td>
<td>12.82 25.64 38.47 51.29 64.11</td>
</tr>
</tbody>
</table>

Bandwidth per DVB-C channel (Mbit/s)

<table>
<thead>
<tr>
<th>Input Interface</th>
<th>DVB-C</th>
<th>DVB-C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modes</td>
<td>Single Transport Stream (TS)</td>
<td>Multiple Transport Stream and Generic Stream Encapsulation (GSE)</td>
</tr>
<tr>
<td>Constant Coding &amp; Modulation</td>
<td>Variable Coding &amp; Modulation and Adaptive Coding &amp; Modulation</td>
<td></td>
</tr>
<tr>
<td>FEC</td>
<td>Reed Solomon (RS)</td>
<td>LDPC + BCH or RS</td>
</tr>
<tr>
<td>Interleaving</td>
<td>Bit-Interleaving</td>
<td>Bit- Time- and Frequency-Interleaving</td>
</tr>
<tr>
<td>Pilots</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Modulation</td>
<td>Single carrier QAM</td>
<td>COFDM or single carrier QAM</td>
</tr>
<tr>
<td>Modulation Schemes</td>
<td>16- to 256-QAM</td>
<td>16- to 4096-QAM</td>
</tr>
</tbody>
</table>

http://www.dvb.org/technology/fact_sheets/
ATSC (Advanced Television Systems Committee)

- Terrestrial (ATSC-T) or cable (ATSC-C) broadcast

- Main properties
  - 6 MHz bandwidth per channel
  - VSB (vestigial sideband modulation) and 256 QAM modulation
  - Digital bandwidth
    - 19.39 Mbit/s ATSC-T
    - 38.78 Mbit/s ATSC-C
  - MPEG-2 TS, MPEG-2 video, AC3 audio
**ISDB (Integrated Services Digital Broadcasting)**

- **Standards**
  - ISDB-T
  - ISDB-S
  - ISDB-C

- **Main properties**
  - 5.6 Mhz bandwidth per channel
  - OFDM modulation
  - 19 Mbit/s (ISDB-T, 64QAM-OFDM)
  - SFN
  - MPEG-2 audio/video, MPEG-4avc, JPEG (MHEG apps)

- **IP broadband return channel support** -> interactive apps

- **EPG**
Alternative technologies

- MMDS (Multichannel Multipoint Distribution Service)
- “wireless cable” aka. DOCSIS+
- Triple play services
- Slovenija
  - UPC – Lastovka TV
  - Globtel AIR

http://www.air-tv.net/
Distribution platform

IPTV
High-level basic architecture

- **Head-End**
  - Services, users, terminal equipment management
  - IPTV services and applications hosting (including GUI)
  - DRM/CA
  - billing

- **Customer Premises**
  - IPTV terminal equipment and home network devices

- **Transport Network**
Vertical IPTV architecture

- **Headend**
  - Servers
  - Encoders
  - Management

- **Terminals**
  - STB
  - Smart TV
  - PC
  - Game console
  - Mobile phone
  - Tablet
IPTV protocols

- Live services
  - IP multicast
    - IGMP
- On demand services
  - Session control
    - RTSP
    - SIP
    - HTTP
  - Data transfer (audio, video)
    - RTP/RTCP
    - SRTP/SRTCP
    - TCP/UDP
    - HTTP/TCP
- Personalization
  - UNICAST!
IPTV middleware

- Defines key IPTV system features and elements
- Provides
  - Service, content, user, portal and server management functionalities
  - Billing
  - Service creation
  - Content protection
- User portal and GUI
Content protection

- Digital Rights Management (DRM)
- Conditional Access System (CA)
NGN IPTV
Why NGN?

- Standard platform for data, voice and multimedia services
- Network independent
- Open application interfaces
- IPTV is “just another service” (IMS)
- Standardization and interoperability
- Generalization leads to COMPLEXITY
- User expectations are on par with traditional TV experience (and rightly so)
Next Generation Networks / IMS

**Aplikacije**

- IPTV subsystem

**Drugi podsistemi**

- UPSF/HSS
- PSTN/ISDN emulacija

**Podsistem za priključitev omrežij (NASS)**

**Podsistem za krmiljenje virov in dostopa (RACS)**

**Prenosne funkcije**

**TISPAN NGN**

**IPTV subsystem**

- Applications
- Other Subsystems
- PSTN/ISDN emul. Subsystem
- Core IMS
- User profiles
- Network Attachment Subsystem
- Resource and Admission Control Subsystem
- Transport processing functions
High-level architecture

- **IPTV domains (ITU-T IPTV GSI)**
  - **Content Provider (CP)**
    - Content/rights Owner
  - **Service Provider (SP)**
    - Head-End
    - DRM/CAS
    - Content Processing/Serving
  - **Network Provider (NP)**
    - (Content) Delivery
  - **End-User – Consumer (EU)**
    - Home Network
    - Terminal Equipment
...in greater detail
NGN IPTV standardization effort

- ITU-T IPTV Global Standards Initiative
- ETSI TISPAN
  - IPTV as NGN subsystem
- ATIS IIF
- OPEN IPTV forum
- DVB konsortium (DVP-IPI)
- OMA BCAST
- CableLabs
- DLNA/UPnP

<table>
<thead>
<tr>
<th>ORGANIZATION</th>
<th>KEY DOCUMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITU-T IPTV GSI</td>
<td>T-PROC-IPTVFG-2008 (Focus Group Proceedings)</td>
</tr>
</tbody>
</table>
| ETSI TISPAN        | ETSI TS 182 027 (IPTV functions supported by the IMS subsystem)  
                    | ETSI TS 182 028 (Dedicated subsystem for IPTV functions)  |
| ATIS IIF           | ATIS-0800007 (IPTV High Level Architecture)             
                    | ATIS-0800002 (IPTV Architecture Requirements)            |
| Open IPTV Forum    | Functional Architecture                                |
                    | Service and platform Requirements                      |
OPEN IPTV Forum

- “End2End” IPTV standardization
- Main goal → Interoperability

http://www.oipf.tv/
OPEN IPTV Forum partners
Distribution platform

OTT
Functionalities

- **Content and services**
  - Anywhere at any device (smart phone, tablet, smartTV, PC…)
  - Anytime (timeshifting and PVR services)

- **2nd screen (Second screen) is the holy grail of converged applications concept**

- **Applications using multiple devices**
  - Control
  - Enhanced experience with specialized content and interaction modalities per device

- **Interactivity and Ux are of paramount importance**
  - Voting
  - Chat
  - Additional info
  - Games and entertainment
  - …
iTV broadcast platforms

- Platforms
  - Proprietary
    - OpenTV, MediaHighway, Microsoft TV, Liberate, PowerTV, NDS Core
  - Open
    - MHEG, MHP, OCAP, ACAP, ARIB B23, Java TV, HbbTV

- Broadcast distribution channel
  - UK “red button”
  - Apps are closely related to specific TV channel and show
Hybrid Broadcast Broadband TV

- **Broadcast channel**
  - Radio and TV signal
  - App data distribution
  - Local interactivity

- **Broadband channel**
  - On-demand audio/video
  - App data distribution
  - Real interactivity

Two worlds combined
(Transport) networks
Network & services architecture

- Generatorji vsebin in storitev
- Dostop
  - Mobilne tehnologije
  - Brežične tehnologije
  - Fiksne tehnologije
  - Radiodifuzija
- Jedro
  - Hrbtenično omrežje
- Omrežje
- Načrtovanje in upravljanje

- Ponudniki vsebin in storitev
  - Govor
  - Video
  - Podatki

www.itfe.org, Laboratorij za telekomunikacije
Network classification

- **By range**
  - PAN – Personal Area Network
  - LAN – Local Area Network
  - CAN – Campus Area Network
  - MAN – Metropolitan Area Network
  - WAN – Wide Area Network

- **Wired and wireless**

- Internetwork – two or more networks connected (by common network layer technology)
  - internet = internetwork
  - intranet
  - extranet
  - THE Internet

http://en.wikipedia.org/wiki/Internet
How big is THE Internet? (AS)

http://bgp.potaroo.net/
Modern network concept

- A three-layered model
  - Application layer
  - Service control layer
  - Transport layer

- Transport layer
  - Backbone (core)
  - Distribution (metro)
  - Access

- STANDARDIZATION
- INTEROPERABILITY
- Edge devices
  - Functionalities
  - Expandability
  - Price considerations

Diagram:

- Application layer
- Service control layer
- Transport layer (IP/MPLS)
- Access: xDSL, ETTH, ETTB, FR/ATM, DOCSIS, WLAN, WiMAX
- Transport layer: HSDPA, UMTS, GPRS
Access technologies

- Call services
  - PSTN
  - ISDN

- Broadband access
  - xDSL
  - Cable (DOCSIS)
  - FTTx
  - WLAN

- Mobile access
  - GPRS/UMTS/HxPA
  - LTE
Broadcast, multicast, unicast

- **Broadcast**: Information is sent to all devices in the network simultaneously.
- **Multicast**: Information is sent to multiple devices in the network, but not all devices will receive it.
- **Unicast**: Information is sent to a single device in the network.

Wikipedia
End-user (terminal) equipment
User eXperience

„Everything is an Interface …“
JG.
Modern end-user equipment

- PC
- Video game console
- Multimedia extender (HTPC)
- IPTV Set-top-box
- SmartTV
- Tablet PC
- Smartphone

performance

mobility

wired

wireless
Home (multimedia) network

- Lots of devices -> a mess
  - Home gateway/router
  - Service terminal equipment
- Easy setup and content sharing?
- Technologies
  - DLNA/UPnP
  - AirPlay
  - Miracast
DLNA/UPnP

- Digital Living Network Alliance
  - A vision of multiple multimedia connected devices
  - Content and service sharing
- Universal Plug and Play
  - Underlying technology (protocol suite)
  - IP network based
- Simplicity is of key importance

http://www.dlna.org/
User eXperience - Ux

- User interface
  - HW UI (e.g. remote control)
  - SW UI (e.g. portal)
- User interaction (HCI)
- User experience, usability aspects (QoE, Ux)
Trends

- User interface, design, interaction modalities and experience as whole are of key importance
- Good Ux can be the tipping factor of success
Interaction modalities

- **Traditional**
  - PC mouse and keyboard combo
  - Remote control
  - 3D mouse

- **Touch modality**

- **Voice control modality**

- **Gesture based modality**
Interaction modalities

- Eye gaze
- Brain control
- 2nd screen
User experience vs. Usability

- User experience describes a person's perceptions and responses that result from the use or anticipated use of a product, system or service. (ISO)
- The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. (ISO)
- Of course, perfectly usable devices or services can still be completely useless 😊
In broad terms, user-centered design (UCD) is a type of design and a process in which the needs, wants, and limitations of end users of a product are given extensive attention at each stage of the design process.
QoE and QoS
(an IPTV example)
QoE and QoS

Quality of Experience

Objective
- Quality of Service
  - Service matrix
  - Transport matrix

Subjective
- Human factors
  - Emotions
  - Price
  - User experience
QoE and QoS properties

- Two aspects – objective and subjective
  - Quality of Experience (QoE)
    - Holistic user experience
    - Closely related to the system’s ability to satisfy the users’ needs and expectations
    - Technology independent
  - Quality of Service (QoS)
    - Provides objective network quality performance factors
    - QoS mechanisms for network traffic prioritization and congestion management
    - Technology dependent (especially the transport layer)

Influential factors – video

- Compression used (MPEG-2, MPEG-4avc, VC-1 ...)
- Signal preprocessing, noise reduction
- Compression parameters
  - Resolution (SD, HD, UHDV)
  - Temporal resolution (fps)
  - Bandwidth required
  - Content dynamics
  - Special parameters (CBR, VBR, GOP, prediction precision, kvantization matrix...)
- Source material quality (“garbage in garbage out”)

www.itfe.org, Laboratorij za telekomunikacije
Influential factors – audio

- Compression used (MP3, AAC, AC3 ...)
- Signal preprocessing, noise reduction
- Compression parameters
  - Number of channels
    - mono/stereo
    - surround (5.1, 6.1, 7.1, 8.1, 22.2 ...)
  - Sampling frequency (8 khz, 16 khz, 44.1 khz, 48 khz, 96 khz, 192 khz)
  - quantization (8 bit, 16 bit, 24 bit)
  - Bandwidth required
  - Compression specifics (CBR, VBR)
- Source material quality (“garbage in garbage out”)

www.itfe.org, Laboratorij za telekomunikacije 97
### Recommendation – SD linear TV

<table>
<thead>
<tr>
<th>Video Codec Standard</th>
<th>Minimum Bit Rate (video only)</th>
<th>Pre-processing Enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPEG-2 – Main profile at Main level (MP@ML)</td>
<td>2.5 Mbit/s CBR</td>
<td>Yes (if available)</td>
</tr>
<tr>
<td>MPEG-4 AVC (Main profile at Level 3.0)</td>
<td>1.75 Mbit/s CBR</td>
<td>Yes (if available)</td>
</tr>
<tr>
<td>SMPTE VC-1</td>
<td>1.75 Mbit/s CBR</td>
<td>Yes (if available)</td>
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<td>AVS</td>
<td>1.75 Mbit/s CBR</td>
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<thead>
<tr>
<th>Audio Codec Standard</th>
<th>Number of Channels</th>
<th>Minimum Bit Rate (kbit/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPEG Layer II</td>
<td>Mono or stereo</td>
<td>128 for stereo</td>
</tr>
<tr>
<td>Dolby Digital (AC-3)</td>
<td>5.1 if available, else left/right stereo pair</td>
<td>384 for 5.1/128 for stereo</td>
</tr>
<tr>
<td>AAC</td>
<td>Stereo</td>
<td>96 for stereo</td>
</tr>
<tr>
<td>MP3 (MPEG-1, Layer 3)</td>
<td>Stereo</td>
<td>128</td>
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**ITU-T T-PROC-IPTVF-2008**
# Recommendation – SD VoD

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<td>MPEG-2 – Main profile at Main level (MP@ML)</td>
<td>3.18 Mbit/s CBR</td>
<td>Yes (if available)</td>
</tr>
<tr>
<td>MPEG-4 AVC (Main profile at Level 3)</td>
<td>2.1 Mbit/s CBR</td>
<td>Yes (if available)</td>
</tr>
<tr>
<td>SMPTE VC-1</td>
<td>2.1 Mbit/s CBR</td>
<td>Yes (if available)</td>
</tr>
<tr>
<td>AVS</td>
<td>2.1 Mbits/s CBR</td>
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<tbody>
<tr>
<td>MPEG-2 – Main profile at Main level (MP@ML)</td>
<td>15 Mbit/s CBR</td>
<td>Yes (if available)</td>
</tr>
<tr>
<td>MPEG-4 AVC (Main profile at Level 4)</td>
<td>10 Mbit/s CBR</td>
<td>Yes (if available)</td>
</tr>
<tr>
<td>SMPTE VC-1</td>
<td>10 Mbit/s CBR</td>
<td>Yes (if available)</td>
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<tr>
<td>AVS</td>
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QoS impact on QoE at IPTV

- MPEG – 2 example

Single B-frame IP packet loss

Single I-frame IP packet loss

TR-126, Broadband forum
Conclusions...