IPTV vs Internet TV
Understanding how Video Delivery in Unmanaged Networks differs from that in Managed Networks

SMPTE Boot Camp VI – Toronto – June 2014
Louis Sebastiani, IPTV Project Director
Agenda

1. Video delivery in managed and unmanaged networks
   a) Differences between Cable TV / IPTV / ATSC and Over-the-Top delivery (OTT) using the Internet
   b) Difference between MPEG-2 Transport Stream delivery and HTTP streaming
2. Adaptive Bit Rate streaming technology overview
3. Microsoft Smooth Streaming and Apple HLS examples
4. Comparing HTTP streaming technologies
5. Multiscreen video delivery from the Cable/Telco operator’s perspective
6. Overview of the multiscreen video delivery ecosystem (from content to consumer devices)
7. Live Demo – Booth 77
1. Video Delivery on Managed and Unmanaged Networks

MPEG-TS over **Managed** Networks

Cable TV / IPTV / Satellite / ATSC

Internet

Over-The-Top Delivery (OTT)

Delivery of video over **Un-Managed** Networks

Rogers Cable, Bell, Shaw, Videotron, COGECO, eastlink, TVA, City, GlobalTV, makes you think, Netflix, YouTube, Hulu, Apple, Incospec.
1. Video Delivery on Managed and Unmanaged Networks

**Difference between Managed and Unmanaged Networks**

- **Managed Network (HFC, DSL, FTTH, Satellite)**
  - Bandwidth is controlled and constant
  - Jitter is controlled
  - Network Engineering allows stable conditions (QoS is assured)
  - MPEG-TS is the preferred mechanism to deliver video (QAM, IPTV, Satellite, ATSC).
  - Because MPEG-TS requires stable network conditions and no packet loss: need Managed Network

- **Unmanaged Network (Internet)**
  - Bandwidth varies / Conditions are not stable
  - Quality of Service is not guaranteed ("Best Effort")
  - MPEG-TS (alone) is not a good solution…
  - So, need to use IP video streaming techniques… to deliver video over-the-top (OTT)
1. Video Delivery on Managed and Unmanaged Networks

MPEG-2-TS on Managed Network

IP Video Streaming (unmanaged)

MPEG-2 TS

0110011010110101001101

(or)

ASI

QPSK/8PSK (Satellite)

QAM (Cable)

GPON/EPON (FTTH)

DSL (Telco)

ATSC/8VSB (Broadcast)

“Direct” Connection from Headend to Customer

“Packet-Switched” Best Effort Network

TCP/IP
1. Video Delivery on Managed and Unmanaged Networks

MPEG-2-TS on Managed Network. An example with QAM and IPTV.

MPEG Transport Stream

| 188 bytes | 188 bytes | 188 bytes | 188 bytes | 188 bytes | 188 bytes | 188 bytes |

Header 4 bytes

184 bytes payload (Video, Audio, Metadata)

Sync Byte 0x47

Frame Type

I B B P B ... I

Frame Number

IPTV

Private Network

100 Mbps

IP Multicast

100 Mbps

IGMP switch

100 Mbps

100 Mbps

100 Mbps

100 Mbps

100 Mbps

100 Mbps

100 Mbps

100 Mbps

Note: Only four (0, 6, 1 and 7) out of the eight possible modulation states (0-7) are shown in this illustration.
1. Video Delivery on Managed and Unmanaged Networks

MPEG-2-TS on Managed Network. An example with Ethernet.

MPEG-2 TS

<table>
<thead>
<tr>
<th>188 bytes</th>
<th>188 bytes</th>
<th>188 bytes</th>
<th>188 bytes</th>
<th>188 bytes</th>
<th>188 bytes</th>
<th>188 bytes</th>
<th>188 bytes</th>
</tr>
</thead>
</table>

4 bytes header 184 bytes payload (Video, Audio, Metadata)

MPEG Transport Stream encapsulated in IP packet

Private Network

IP Multicast

IGMP switch

100 Mbps
1. Video Delivery on Managed and Unmanaged Networks

What is OTT Video Streaming?

For the purpose of this presentation:
- A toolkit of different technologies
- Making Use of the Public Internet and its Standard Protocols
- To deliver multimedia content
- Either Live or On-Demand
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3. Microsoft Smooth Streaming and Apple HLS examples

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2. Adaptive Bit Rate streaming technology overview

IP Stack – Standard Protocols “Key Words”

Network Topology

Data Flow

2. Adaptive Bit Rate streaming technology overview

An example with MPEG-TS
2. Adaptive Bit Rate streaming technology overview

Video Streaming Protocols

- All streaming protocols are in the application layer
- Clients and servers exchange messages in a request-response messaging pattern
- Streaming Protocols use the layers below to transport content
2. Adaptive Bit Rate streaming technology overview

Video Streaming Protocols Evolution

1. Progressive Download uses HTTP (e.g., YouTube)
2. RTSP/RTMP Streaming
   - RTMP (Flash Players)
   - RTSP (QuickTime, Android)
3. Adaptive HTTP Streaming
   - Microsoft Smooth Streaming
   - Apple HLS
   - Flash HDS
2. Adaptive Bit Rate streaming technology overview

Progressive Download principles

Progressive Download is supported by:
- Flash,
- HTML5 browsers,
- the iPad/iPhone and
- every regular webhoster supports downloads,
- as does every Content Delivery Network (CDN)

Youtube used to be Progressive Download

Features and Characteristics
- Simplest to implement
- HTTP protocol (using TCP/IP)
- When hit “Play” – the media player starts downloading the file until the whole file is received.
- Playback as soon as enough data in buffer
- Trick play (seeking in the video) if system is provisioned for pseudo-streaming

Downsides
- A lot of bandwidth is wasted for data downloaded but unwatched
- Inhability to change the video quality at mid-stream
  - Full screen looks bad (even if would have the bandwidth for a higher resolution); or
  - Playback stutters upon network congestion
- Not possible to do live streaming

Conclusion
- Good solution for short clips and when no live streaming
- Simple to implement
- Alternate solutions...
  - RTMP/RTSP streaming
  - Adaptive HTTP streaming

Info from [http://www.longtailvideo.com/blog/19578/what-is-video-streaming](http://www.longtailvideo.com/blog/19578/what-is-video-streaming)
2. Adaptive Bit Rate streaming technology overview

RTMP/RTSP Streaming principles

RTMP (Real Time Messaging Protocol) is what Flash uses

RTSP was developed by the Multiparty Multimedia Session Control Working Group (MMUSIC WG) and published as RFC2326 in 1998

RTMP (Flash) is the most widely used streaming protocol

Almost all PCs have flash players
* Not supported by iPhones / iPads

Hulu uses RTMP Streaming

Features and Characteristics
- RTMP/RTSP are “Stateful” protocol (vs HTTP which is a “Stateless” protocol)
- Requires a dedicated Streaming Server.
- The media player initiates a communication with a Streaming Servers
- Uses RTP/UDP streaming with a remote control protocol (TCP/IP to maintain end-to-end connection)
- RTMP uses port 1935; RTSP uses port 554

Downsides
- RTP(UDP) has no retransmit capability so packet loss will result in issues
- RTMP/RTSP packets may be blocked by certain firewalls (because of ports 1935/554)
- RTMP packets can’t leverage standard HTTP caching mechanisms
- The required server may also limit scalability as compared to HTTP-based streaming, since there are many more HTTP servers than RTMP.

Conclusion
- RTMP distribution is still widely and beneficially used by many websites today.
- However, at this point if you’re considering implementing a streaming technology, the overwhelming sentiment is to deliver via HTTP.
- For adaptive delivery to Apple devices (and Android 3.0 and higher ?), HLS is your only option.

2. Adaptive Bit Rate streaming technology overview

Adaptive HTTP Streaming principles

Video is encoded in several resolutions to adapt for network conditions (different “Profiles”)

Clients play the video stream by requesting segments in a profile from a Web Server (via HTTP)

Adaptive delivery enables a client to “adapt” to fluctuating network conditions by selecting video segments from different profiles (Intelligence in client)

Objective: join the merits of RTMP/RTSP Streaming (bandwidth efficiency, quality switching) with those of Progressive Download (no special servers or protocol needed – simple HTTP). CDN Friendly.

Features and Characteristics
- Creation of fragments of encoded video (2 seconds or 10 seconds chunks) hosted on regular HTTP server
- HTTP is firewall friendly… (vs RTMP)
- Support for different resolutions – i.e. each fragment can be encoded in different quality levels
- IDR Frame alignment and equal duration of fragments to switch between resolutions during playback
- H.264 video Codec and AAC audio
  - Note: see upcoming slide for discussion on WebM and VP8

Downsides
- Requires more overhead because of TCP which requires acknowledgement (vs RTP/UDP transport)
- A lot of small files to manage (chunks)
- No Single and Widely used implementation
- Currently, some of the options are:
  - Apple HLS
  - Microsoft Smooth Streaming
  - Adobe HDS
- Lack of standardization, except effort from:
  - MPEG-DASH (MPEG consortium)

The list of available profiles is called a manifest file or playlist. This is used by the client to know what to expect and download

2. Adaptive Bit Rate streaming technology overview

Adaptive HTTP Streaming

- H.264 Encoder
- H.264 Multi Bit Rate Transport Streams
- Packaging / Segmenting
- + Playlist/Manifest File
- HTTP Server
- Managed Network or Delivery to CDN
- Adaptive Streaming Client

Client dynamically selects best size chunk according to network conditions

* For HDS, a Flash Media Server is required; For MSS, a IIS-7 Server is required

Creation of several bit rates/resolutions for delivery to different devices (STB, PC, Tablets, Phones, etc.)

Creation of small chunks (2 or 10 seconds) for each resolution and streaming format (HLS, HDS, MSS)

The video files are published over the Network like any other HTTP file for delivery on the Internet

The diagram illustrates the process from high-quality video input to adaptive streaming output, including encoding, packaging, and delivery to a client. The diagram also shows how the client dynamically selects the best bit rate according to network conditions.
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3. Microsoft Smooth Streaming – 320x180
3. Microsoft Smooth Streaming – 1024x576 (low res)

Player is still emptying buffer of 500 Kbps profile.
3. Microsoft Smooth Streaming – 1024x576 (high res)

Playout buffer matches “aimed” profile
3. Microsoft Smooth Streaming – 1024x576 (high res)
3. Microsoft Smooth Streaming – Manifest File
3. Adaptive Bit Rate Streaming - Recap

Adaptive HTTP Streaming

- H.264 Encoder
- H.264 Multi Bit Rate Transport Streams
- GOP aligned
- Packaging / Segmenting
  - Creation of several bit rates/resolutions for delivery to different devices (STB, PC, Tablets, Phones, etc.)
  - Creation of small chunks (2 or 10 seconds) for each resolution and streaming format (HLS, HDS, MSS)

- HTTP Server*
- Managed Network or Delivery to CDN
- Adaptive Streaming Client
- The video files are published over the Network like any other HTTP file for delivery on the Internet

* For HDS, a Flash Media Server is required; For MSS, an IIS-7 Server is required

Client dynamically selects best size chunk according to network conditions

- High Quality Video
- Video

WWW.INCOSPEC.COM
3. ABR Streaming - Group of Pictures (GOP)

High resolution

Medium resolution

Low resolution

GOP aligned. Switch from one profile to the other is done on Key Frames (I Frames)

Typically:
MPEG-2: 12-15 frames
MPEG-4: 60+ frames
3. Apple HLS analysis (Playlist - Manifest File)
3. Apple HLS analysis (Playlist - Manifest File)

```plaintext
#EXTM3U
#EXT-X-VERSION:1
## Created with Unified Streaming Platform (versinn=1.4.57)
#EXT-X-MEDIA-SEQUENCE:750
#EXT-X-ALLOW-CACHE:NO
#EXT-X-TARGETDURATION:5
#EXTINF:4, no desc
channel1-1-AAC-128K-fre%3D128000-
video%3D5000000-750.ts
#EXTINF:4, no desc
channel1-1-AAC-128K-fre%3D128000-
video%3D5000000-751.ts
#EXTINF:4, no desc
channel1-1-AAC-128K-fre%3D128000-
video%3D5000000-752.ts
#EXTINF:4, no desc
channel1-1-AAC-128K-fre%3D128000-
video%3D5000000-753.ts
#EXTINF:4, no desc
channel1-1-AAC-128K-fre%3D128000-
video%3D5000000-754.ts
#EXTINF:4, no desc
```

- Profile 5
- Manifest

**PROFILE DESCRIPTION**
1280x720

**PROFILE BPS**
5435680

**ACTUAL BPS**
5320400

**DOWNLOAD BPS**
29064664

**CHUNK LENGTH**
5.0 sec.

**DOWNLOAD TIME**
0.7 sec.

**CHUNK FILE**
channel1-1-AAC-128K-fre-128000-video-5000000-762.ts

**CHUNK SIZE**
2660200 bytes

**MANIFEST SIZE**
1200 Lyters

**SEQUENCE AGE**
0 sec.

**ENCRYPTION**
No

**LAST CHECKED**
Today 3:54:36 PM

INCONSPIC
From your content to its distribution, we deliver solutions...
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4. **Comparing HTTP streaming technologies**

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### 4. Comparing HTTP Streaming Technologies

- **HLS:** HTTP Live Streaming (Apple) 2009
- **MSS:** Smooth Streaming (Microsoft) 2009
- **HDS:** HTTP Dynamic Streaming (Flash) 2010

#### mpeg-DASH

- ISO Standard in order to provide a Universal Delivery Format

<table>
<thead>
<tr>
<th>Features</th>
<th>Apple HLS</th>
<th>Microsoft Smooth Streaming</th>
<th>Adobe HDS</th>
<th>mpeg-DASH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Codec Used</td>
<td>H.264</td>
<td>H.264, VC-1</td>
<td>H.264, VP-6</td>
<td>H.264 (or other MPEG codec family)</td>
</tr>
<tr>
<td>Open Standard</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Subtitle Support</td>
<td>Partial</td>
<td>Yes</td>
<td>Partial</td>
<td>Yes</td>
</tr>
<tr>
<td>Multiple Audio Support</td>
<td>V4 only</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Trick Mode Support</td>
<td>Partial</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CDN-Friendly</td>
<td>Requires Chunk Carriage Optimization</td>
<td>Requires specific IIS-7 origin server</td>
<td>Requires specific Flash Media Server(origin)</td>
<td>Yes</td>
</tr>
<tr>
<td>Common Encryption</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Summary of HTTP Protocol Differences.
4. Adaptive Bit Rate Streaming - Recap

Adaptive HTTP Streaming

Client dynamically selects best size chunk according to network conditions

* For HDS, a Flash Media Server is required; For MSS, an IIS-7 Server is required

- High Quality Video
- H.264 Encoder
- H.264 Multi Bit Rate Transport Streams
- GOP aligned
- Packaging / Segmenting
- Lower Bit Rate ----------- Higher Bit Rate
- + Playlist/Manifest File
- HTTP Server
- Managed Network or
- Delivery to CDN
- Adaptive Streaming Client
- The video files are published over the Network like any other HTTP file for delivery on the Internet
- Creation of small chunks (2 or 10 seconds) for each resolution and streaming format (HLS, HDS, MSS)
- Creation of several bit rates/resolutions for delivery to different devices (STB, PC, Tablets, Phones, etc.)
- The video files are published over the Network like any other HTTP file for delivery on the Internet
- Time
- High Bit Rate
- Network Congestion
- Low Bit Rate
4. Comparing HTTP Streaming Technologies

What about HTML5?

• HTML5 is a markup language used for structuring and presenting content (Graphical User Interface)

• HTML5 is a new method for delivering instructions to Web-enabled devices about how to handle video and audio content.
  – Embed video directly in HTML5 web page with simple tag
  – No need for plug-in (example Flash or Microsoft Silverlight) to be installed

• Open standard allows interoperability between devices.
  – STB
  – Smart TVs
  – Tablets
  – Smart phones
  – Etc.

• Opens the door for “unified customer experience”
4. Comparing HTTP Streaming Technologies

The State of HTML5 support

2. Media Formats

Until recently, the biggest challenge with HTML5 video was the split support for audio/video formats. Some browsers supported MP4, others supported WebM. Firefox resolved this issue by rolling out MP4 support to Windows & Android. Firefox is still working on Mac support, at which point MP4 will be ubiquitous.

On the mobile side, MP4 has always played across devices. Android 4 did introduce support for WebM video. It mostly uses software decoding instead of hardware routines though, meaning lower performance and shorter battery life.

<table>
<thead>
<tr>
<th>BROWSER/DEVICE</th>
<th>VIDEO FORMATS</th>
<th>AUDIO FORMATS</th>
<th>MULTIPLE SOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chrome</td>
<td>MP4, WebM</td>
<td>AAC, MP3, Vorbis</td>
<td>✔</td>
</tr>
<tr>
<td>Firefox</td>
<td>MP4, WebM</td>
<td>AAC, MP3, Vorbis</td>
<td>✔</td>
</tr>
<tr>
<td>Internet Explorer</td>
<td>MP4</td>
<td>AAC, MP3</td>
<td>✔</td>
</tr>
<tr>
<td>Safari</td>
<td>MP4</td>
<td>AAC, MP3</td>
<td>✔</td>
</tr>
<tr>
<td>iOS</td>
<td>MP4</td>
<td>AAC, MP3</td>
<td>✔</td>
</tr>
<tr>
<td>Android</td>
<td>MP4</td>
<td>AAC, MP3</td>
<td>✔</td>
</tr>
</tbody>
</table>

Note that just about any mobile phone can play MP4 video through a built-in media player. Offering an MP4 download link therefore enables playback on older mobile platforms.

4. Comparing HTTP Streaming Technologies

The State of HTML5 support

Adaptive streaming is a core component of online video. It enables buffer control (less waste of bandwidth), fast seeking (to not-yet-downloaded parts), quality adjustment (important for mobile) and live streaming (possibly with DVR).

The Media Source Extension is a brand-new API for building adaptive streaming players. Only Chrome supports it yet (plus IE11 on Win6), but all 4 browser vendors are working on it. On the mobile side, adaptive streaming (HLS) is built into the <video> element on both iOS and Android (beware, buggy).

<table>
<thead>
<tr>
<th>BROWSER/DEVICE</th>
<th>MEDIA SOURCE API</th>
<th>BUILT-IN HLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chrome</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Firefox</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Internet Explorer</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Safari</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>iOS</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Android</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note that every HTML5 browser already supports seeking to not-yet-downloaded portions of the video by using HTTP 1.1 range-requests. Flash players could not do that.

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5. Multiscreen Video Delivery from the Cable/Telco Operator’s perspective

So why should I care?

- Because anyone can now reach the customers using the Internet (OTT delivery)
- Because we are at a new Product cycle in the video delivery (and many different ways to skin the cat…)
- New Players are proposing new Business Models
- New Technologies/Players means change in the equilibrium…

* Need to understand what the customer wants (need)
* Need to understand which technologies are available to answer the need
* SWOT analysis to maintain $ margins
* Need to choose a strategy
5. Multiscreen Video Delivery from the Cable/Telco Operator’s perspective

The Marketing Mix (4P’s)

<table>
<thead>
<tr>
<th><strong>Product</strong></th>
<th><strong>Price</strong></th>
<th><strong>Promotion</strong></th>
<th><strong>Place</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Consumer’s Need</strong></td>
<td><strong>“Cost”</strong></td>
<td><strong>Communication</strong></td>
<td>*<strong>Convenience Ease of:</strong></td>
</tr>
<tr>
<td>- Live Video</td>
<td>- Many factors affect cost… including the consumer’s cost to change products/services</td>
<td>- Advertising</td>
<td>- Buying the product</td>
</tr>
<tr>
<td>- On-Demand Content</td>
<td></td>
<td>- Special Promotions</td>
<td>- Finding the product</td>
</tr>
<tr>
<td>- Time Shift</td>
<td></td>
<td>- Communication Channel</td>
<td>- Finding information on the product</td>
</tr>
<tr>
<td>- Catch-up TV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Multiscreen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Every product as a life cycle (growth, maturity, decline)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This is what Cable/Telcos have done. By aggregating content, they have made the multimedia viewing experience **easier** for the consumer.

Now, the Cable/Telcos need to adapt to the change in demand of the consumers (new Product)…. 
5. Multiscreen Video Delivery from the Cable/Telco Operator’s perspective

Blockbuster vs Netflix example…

• Blockbuster failed to adapt to customer needs
• Stopped providing value to customers

• Does this mean to jump in TV everywhere and multiscreen delivery with your eyes closed?
5. Multiscreen Video Delivery from the Cable/Telco Operator’s perspective

Cable/Telco Operator SWOT analysis…

**Strengths**
- Familiar with video delivery
- Already have relationship with Content Providers
- Already have relationship with Customers

**Weaknesses**
- Footprint of cable/telco operator limited to network coverage territory
- Need to learn new technologies (resistance to change)
- TV everywhere/Multiscreen may be a defensive move

**Opportunities**
- Offer customers a better user experience
- Reduce Churn
- Differentiate vs competing offerings

**Threats**
- Content Providers, Consumer Electronics Manufacturers and new Aggregators can offer TV services directly to consumers OTT

*HEVC should provide 40-50% reduction in bitrate vs H.264*
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6. **Overview of the multiscreen video delivery ecosystem (from content to consumer devices)**

7. Live Demo – Booth 77
6. Overview of the multiscreen video delivery ecosystem

Integration & Professional Services
Consultancy and System Design, Training, Support, Installation and Configuration

- Antenna System
  - Satellite
  - Terrestrial

- Receiving Decoding
  - IRDs
  - DVB-S/T/C

- Video Processing
  - Encoding
  - Transcoding
  - Transrating

- Content Encryption & DRM

- Service Delivery Platform (Middleware)

- Content on Demand
  - Recording
  - Timeshift
  - NPVR
  - LPVR

- CPE, STB & Multiscreen Devices

Managed Network

Internet

Un-Managed Network

IPTV Monitoring Systems

BSS / OSS

www.incospec.com
6. Overview of the multiscreen video delivery ecosystem

TV Everywhere challenges…

- **Authentication**
  - This is the biggest hurdle to adoption of TV everywhere – needs to be simple for all users
- **High reliability live streaming**
- **Multiplicity of devices and streaming formats makes the headend more complicated…**
  - iPads, iPhones, Android, XBOX, PCs, Connected TVs, STB, etc…
- **Security**
  - Complexity of Digital Rights Management
- **Advertising**
- **Measurement**
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7. Live Demo – Booth 77
7. Live Demo (Block Diagram) with Test Equipment
## Our Markets

<table>
<thead>
<tr>
<th>IPTV</th>
<th>Satellite</th>
<th>Fiber Transport</th>
<th>Cable TV and RF distribution</th>
<th>TV and FM Broadcast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Our Know-How

- MPEG-2/4 Compression and test equipment
- DTV headend (live), VOD, EPG (guide), PVR
- DTV, IPTV and OTT delivery

- PSIP / PSI-SI (Metadata and Guide)
- Digital TV headend design
- RF distribution (QPSK, QAM, 8VSB)
- Carrier Ethernet / DWDM solutions
- RF Test and Measurement
- CATV Network Powering
- Wireless Point-to-Point and Multipoint
- HFC and PON distribution design
- Network Management
- L-Band Signal Management and transport
Implementing Second Screen Services Using Adaptive Bitrate Streaming Techniques

Thank you / Merci

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