



Advanced Web Technologies

HbbTV and Smart TV

Dr. Louay Bassbouss | Open Distributed Systems | lecture winter term 2023/24

Schedule

No	Week	Date	Topic
1	42	16.10.2023	Introduction and Framework
2	43	23.10.2023	Web Technologies Basics & Media Entertainment for the Web
3	44	30.10.2023	Foundations of Media Streaming
4	45	06.11.2023	Advanced Media Streaming
5	46	13.11.2023	Multiscreen Technologies and Standards
6	47	20.11.2023	Context-Aware Media Streaming & Encoding
7	48	27.11.2023	Dynamic Advertisement
8	49	04.12.2023	Media Players - dash.js, Exoplayer
9	50	11.12.2023	HbbTV and Smart TV
	51	18.12.2023	Holiday break
	52	25.12.2023	Holiday break
	1	01.01.2024	Holiday break
10	2	08.01.2024	Media Delivery in 5G Networks (1)
11	3	15.01.2024	Media Delivery in 5G Networks (2)
12	4	22.01.2024	Interoperable Web-supported Learning Technologies
13	5	29.01.2024	Securing Content-Provenance and Authenticity
14	6	05.02.2024	Metaverse Platforms and Technologies
15	7	12.02.2024	Exercise and Test Preparation
16	8	19.02.2024	Written Test (60min) first slot (details will be announced during the semester)

HBBTV INTRODUCTION

HBBTV INTRODUCTION

1. What is HbbTV?
2. How it Works?
3. Real World HbbTV Apps
4. History and Evolution of the Versions

WHAT MAKES YOUR TV SMART?

Set Top Boxes etc.



*www.google.com



*www.amazon.com



*www.apple.com



*www.gizmodo.com.au

Smart TV Sticks



*www.microsoft.com



*www.amazon.com



*www.google.com



*www.roku.com

Game Consoles



*www.sony.com



*www.microsoft.com



*www.nintendo.com

Smart TVs



*www.samsung.com



*www.lg.com

WHAT MAKES YOUR TV SMART? – HBBTV!

Connected TV platforms are different!!!

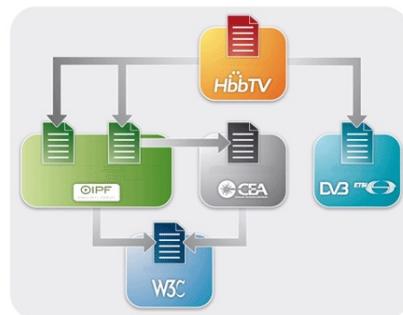


Expensive for content providers to deploy their services to all TV platforms



HbbTV draws from other open standards

→ write your app ones & run everywhere

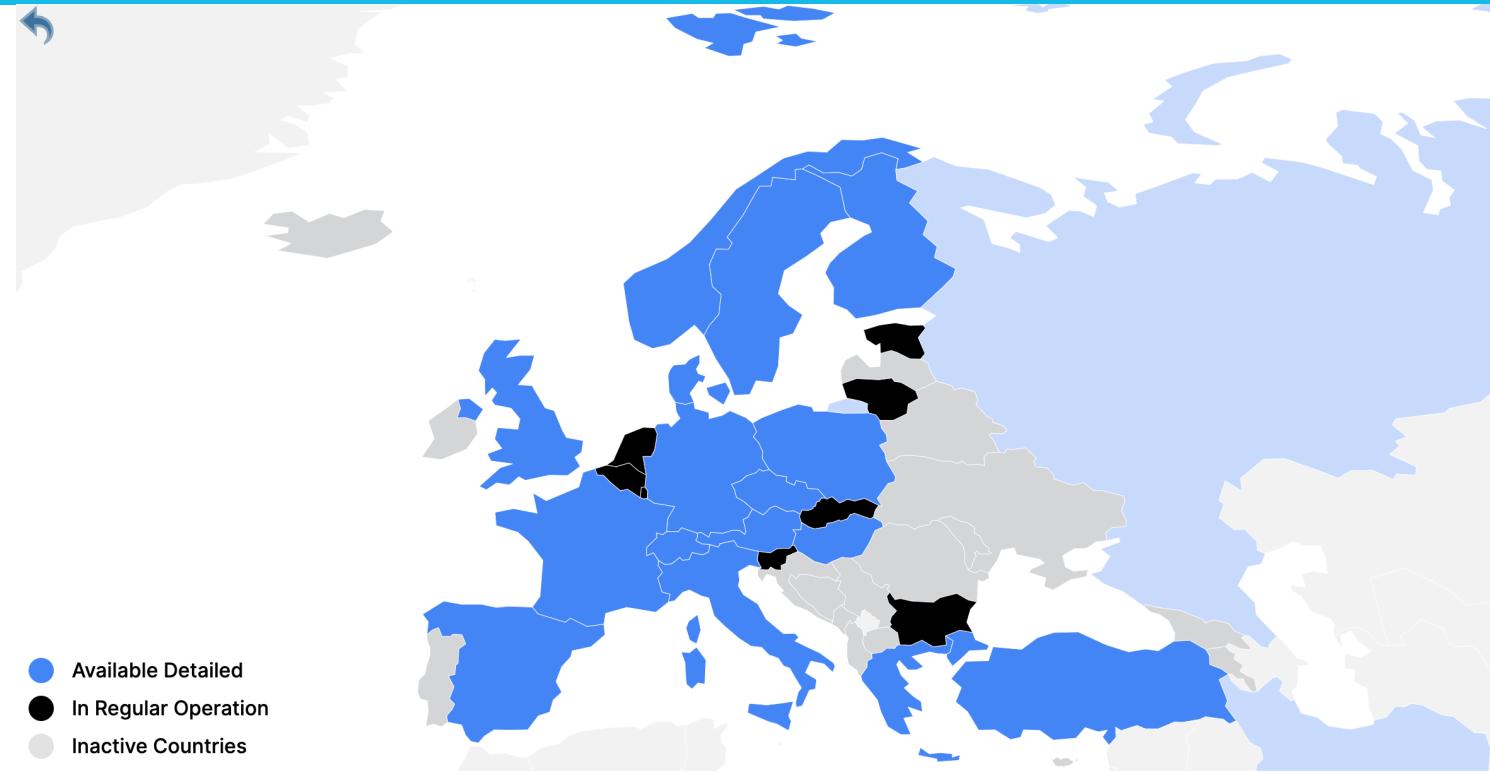


WHAT IS HbbTV?

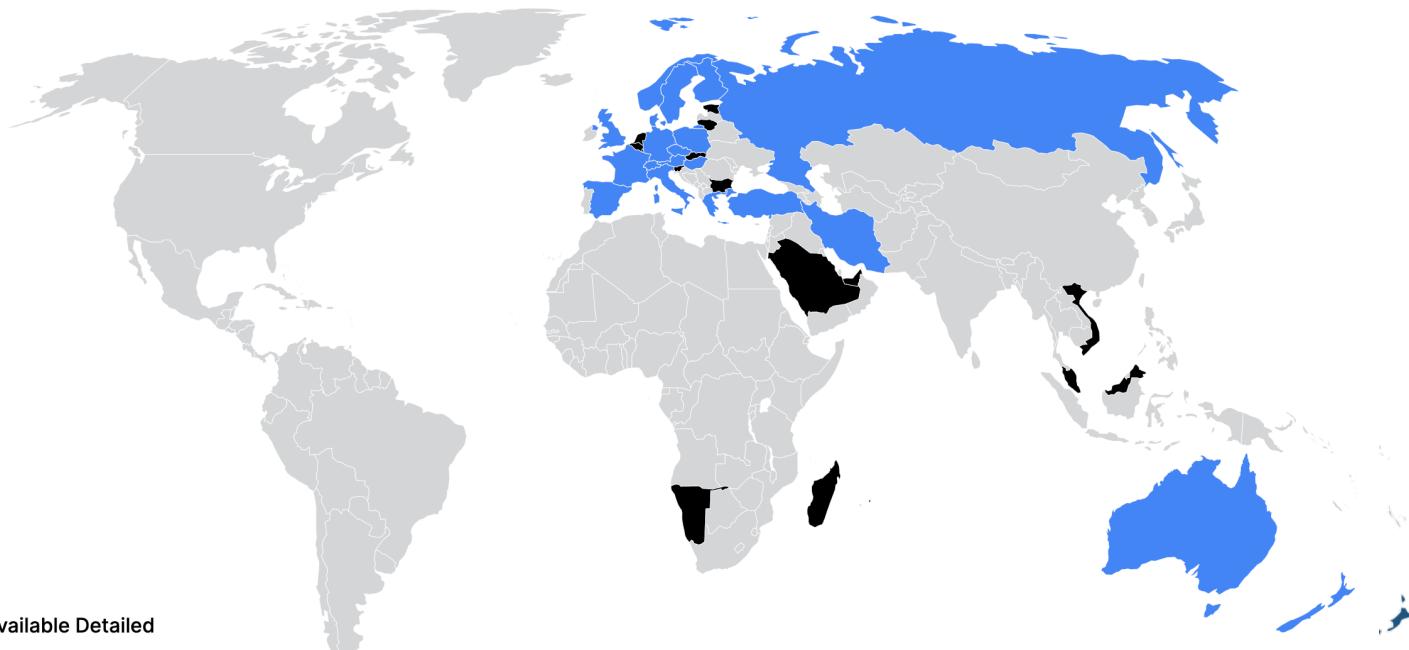
- HbbTV stands for **Hybrid broadcast broadband TV**
- Is an industry standard ([ETSI TS 102 796](#)) for the delivery of **broadcast TV** and **broadband interactive services** to consumers through connected TVs and Set-top boxes
- The HbbTV specification includes elements from other standards like **OIPF, CEA, DVB, MPEG-DASH and W3C**
- Currently more than **300 HbbTV Apps** deployed in **35 countries** for around **44Mln powered devices** and **120Mln Homes Reach** (source: <https://www.hbbtv.org/>)



HBBTV DEPLOYMENT IN EUROPE - 2023



HBBTV DEPLOYMENT WORLDWIDE - 2023



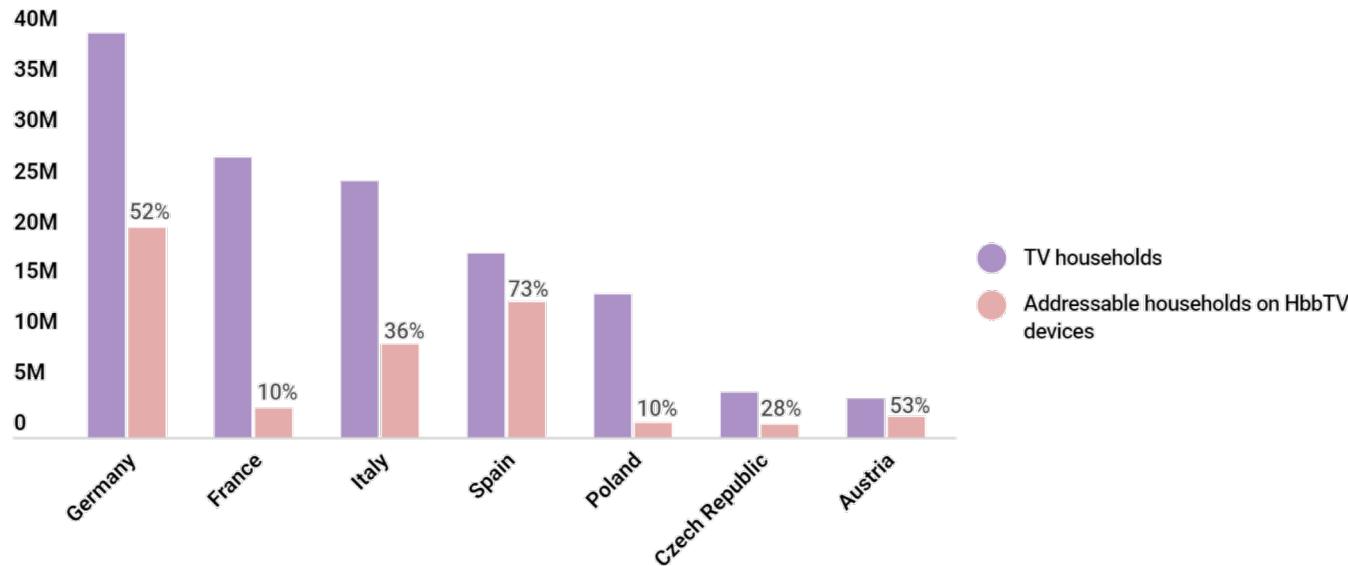
- Available Detailed
- In Regular Operation
- Inactive Countries

source: <https://www.hbbtv.org/deployments/>

SMART TV / HBBTV GLOBAL SALES (W.O. NORTH AMERICA)

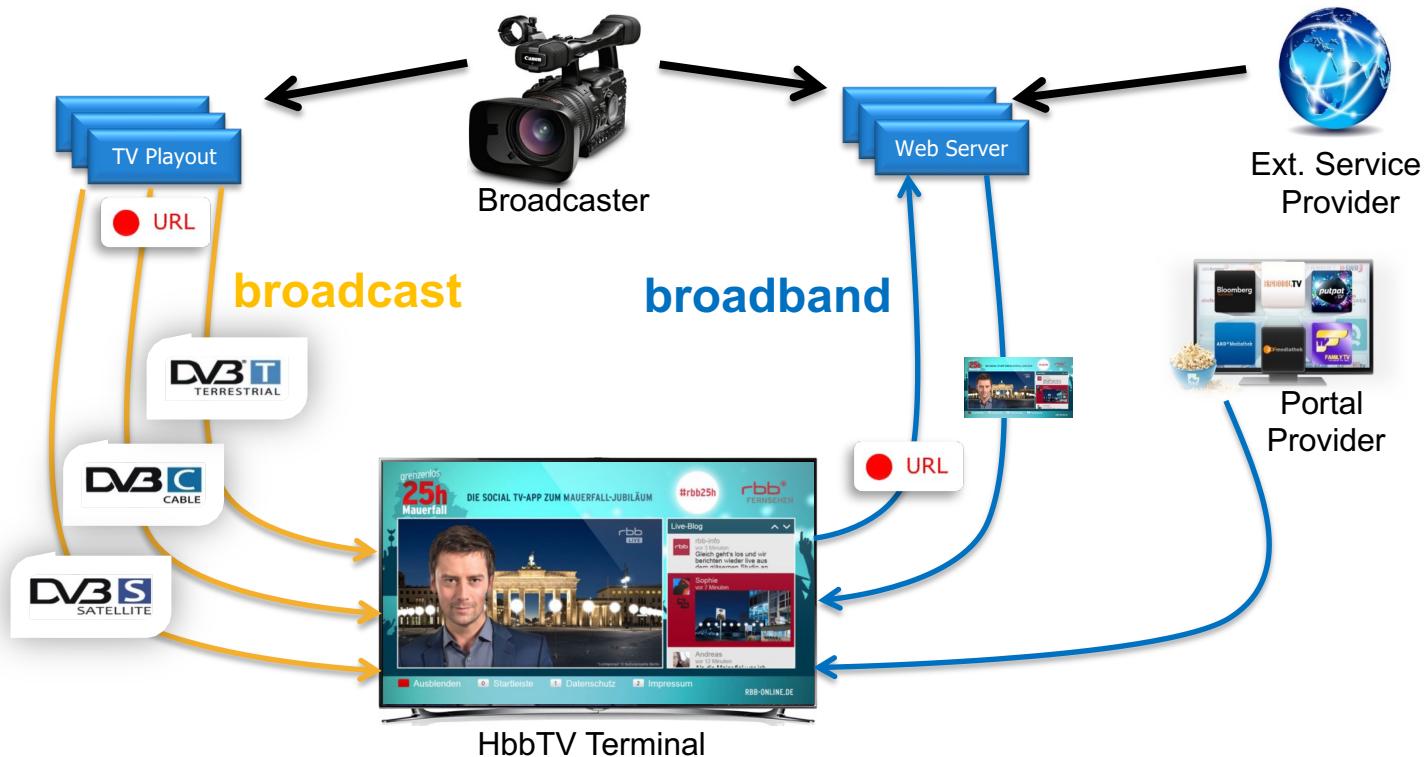
Addressable households on HbbTV connected devices

Countries with active HbbTV advertising offers, 2022



Source: Dataxis[®]

HOW IT WORKS?



HbbTV – APPLICATION TYPES

Broadcast-related vs. Broadcast-independent

Source: <http://www.netrange.com/>



Source: <http://www.yozzo.com/>



– Broadcast-independent application

- not associated with any broadcast service
- downloaded via broadband and accesses all of its associated data via broadband

– Broadcast-related application

- associated with one or more broadcast services or one or more broadcast events within a service
- may be launched automatically ("autostart") or explicitly upon user request.
- may be downloaded broadband or broadcast and may access its data via either

Real world HbbTV Apps

The image displays six screenshots of HbbTV applications for different broadcasters:

- ARD:** Shows a main menu with thumbnails for "Tatort: Das Monster von Kassel", "SERIEN", "FILME NACH GENRE", and "Charité - 2. Staffel". A search bar and navigation icons are at the top.
- ZDF:** Displays a media library section titled "Neu in der Mediathek" with a thumbnail for "Halgrímur 'Der Adler'" and other program cards like "Gesellschaft XY" and "Coca-Cola und der vermüllte Planet".
- Arte:** Shows a grid of program cards for May 13-19, including "360° Geo Reportage - Valparaíso, die Stadt der Aufzüge", "Ein Jahr in Kanadas Wildnis - Winter", and "Stadt Land Kunst - Fès / Kolumbien / San Francisco".
- TVP:** Features a "Przegapile w TV?" section with thumbnails for "Na dobre i na zle", "NAJSYBNALE", and "K". It also shows a "PROGRAMM JETZT" grid for Thursday, May 16.
- VOX:** Shows a "PROGRAMM JETZT" grid for Thursday, May 16, with programs like "Verkag mich doch!" and "vox nachrich". A "PROGRAMM 300" section is also visible.
- QVC:** Shows a woman drinking coffee in a kitchen setting, with the QVC logo in the bottom left. Navigation buttons like "KUNDEN EMPFEHLUNGEN", "SENDUNG VERPASST", "TAGESANGEBOT", "ÜBER UNS", and "DATENSCHUTZ" are at the bottom.



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Honig Senf
Dressing

250ml
ca. 0,95€



ARD® Buffet



Das Erste

Startleiste anzeigen

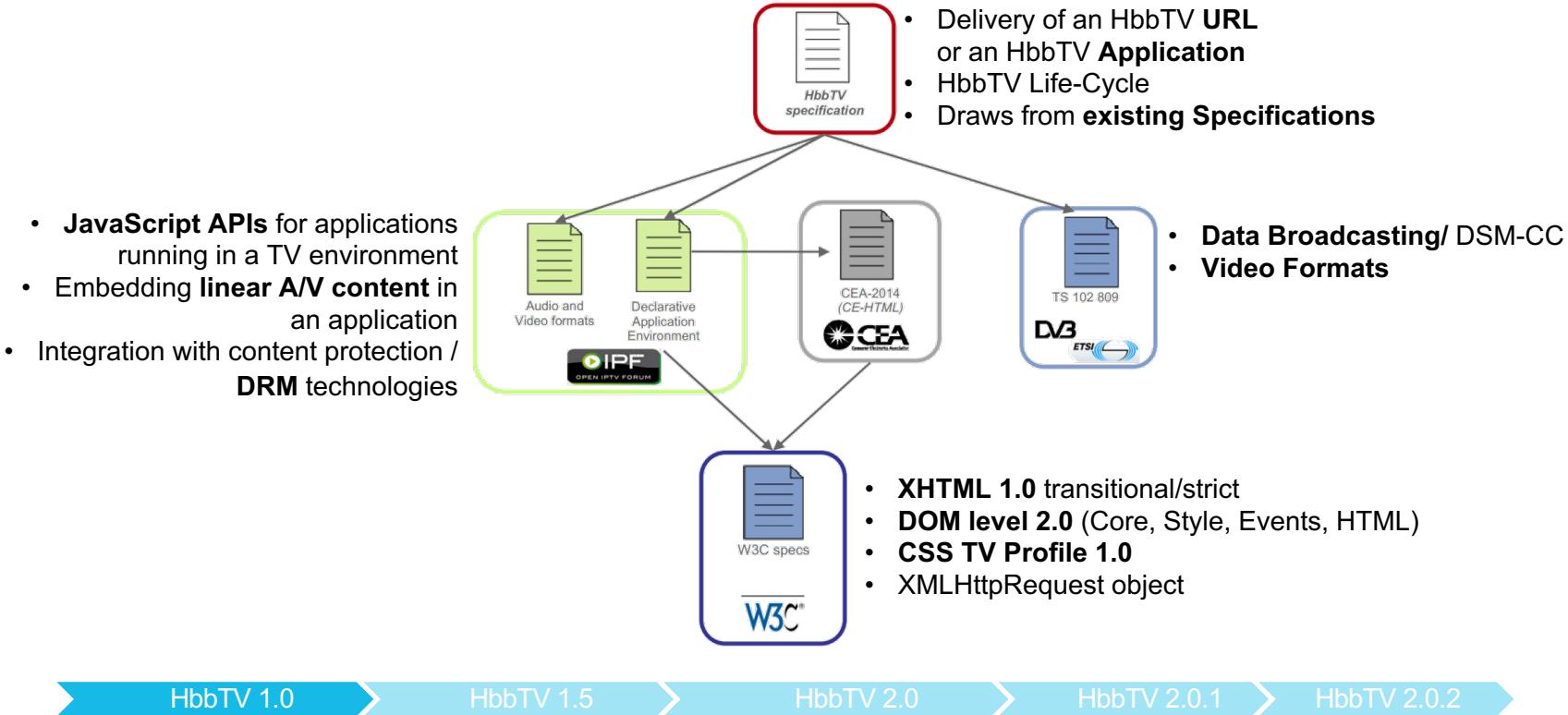
Datenschutzhinweise

HbbTV VERSION HISTORY

Informal Name	Formal Name	Year
HbbTV 1.0	ETSI TS 102 796 V1.1.1	2010
HbbTV 1.5	ETSI TS 102 796 V1.2.1	2012
HbbTV 2.0 HbbTV 2.0.1 HbbTV 2.0.2 HbbTV 2.0.3 HbbTV 2.0.4	(deprecated) ETSI TS 102 796 V1.3.1 ETSI TS 102 796 V1.4.1 ETSI TS 102 796 V1.5.1 ETSI TS 102 796 V1.6.1 ETSI TS 102 796 V1.7.1	2015 2016 2018 2020 2023

source: <https://www.hbbtv.org/>

HbbTV 1.0



HbbTV 1.0

HbbTV 1.5

HbbTV 2.0

HbbTV 2.0.1

HbbTV 2.0.2

HbbTV 1.0 – W3C XHTML (HTML4)

Document Object Model (DOM) Level 2, part of CEA 2014, is used by HbbTV 1.0

The following **properties** shall be supported on the window object:

- document, frames, history, innerHeight, innerWidth, location, id, name, navigator, oipfObjectFactory, onkeypress, onkeydown, onkeyup, parent, self, top, window, XMLHttpRequest



The following **methods** shall be supported on the window object:

- close(), debug(), setTimeout(), setInterval(), clearTimeout(), clearInterval(), addEventListener(), removeEventListener()

CSS TV Profile 1.0, part of CEA 2014, specifies a profile of the **Cascading Style Sheets level 2 (CSS2)**

→ All other methods and properties are not included.

HbbTV 1.0

HbbTV 1.5

HbbTV 2.0

HbbTV 2.0.1

HbbTV 2.0.2

HbbTV 1.0 – USER INPUT → KEY-EVENTS

Button	Key Event	Status
4 arrow buttons (up, down, left, right)	VK_UP, VK_DOWN, VK_LEFT, VK_RIGHT	Mandatory
ENTER or OK button	VK_ENTER	Mandatory
BACK button	VK_BACK	Mandatory
Number keys	VK_0 to VK_9 inclusive	Mandatory
Play, stop, pause	VK_STOP and either VK_PLAY and VK_PAUSE or VK_PLAY_PAUSE	Mandatory
Fast forward and fast rewind	VK_FAST_FWD VK_REWIND	Mandatory
TEXT or TXT or comparable button	Not available to applications	Mandatory
2 program selection buttons (e.g. P+ and P-)	Not available to applications	Optional
WEBTV or comparable button	Not available to applications	Optional
EXIT or TV or comparable button	Not available to applications	Optional



HbbTV 1.0

HbbTV 1.5

HbbTV 2.0

HbbTV 2.0.1

HbbTV 2.0.2

HbbTV 1.0 – OPEN IPTV FORUM

```
<div style="visibility: hidden; display: none;">  
  
    <!-- OIPF Application Manager -->  
  
    <object type="application/oipfApplicationManager" id="oipfAppMan"> </object>  
  
    <!-- OIPF Configuration -->  
  
    <object type="application/oipfConfiguration" id="oipfConfig"> </object>  
  
</div>
```

System Format	Video Format	Audio Format	MIME Type
TS	25 Hz H.264/AVC SDTV (max. 720 × 576) 25 Hz H.264/AVC HDTV (max. 1920x1080)	HEAAC, E-AC3 (when supported by broadcast channel)	video/mpeg
MP4	25 Hz H.264/AVC SDTV (max. 720 × 576) 25 Hz H.264/AVC HDTV (max. 1920x1080)	HEAAC, E-AC3 (when supported by broadcast channel)	video/mp4



Maximum only one: a broadcast or a broadband video at the same time!

HbbTV 1.0

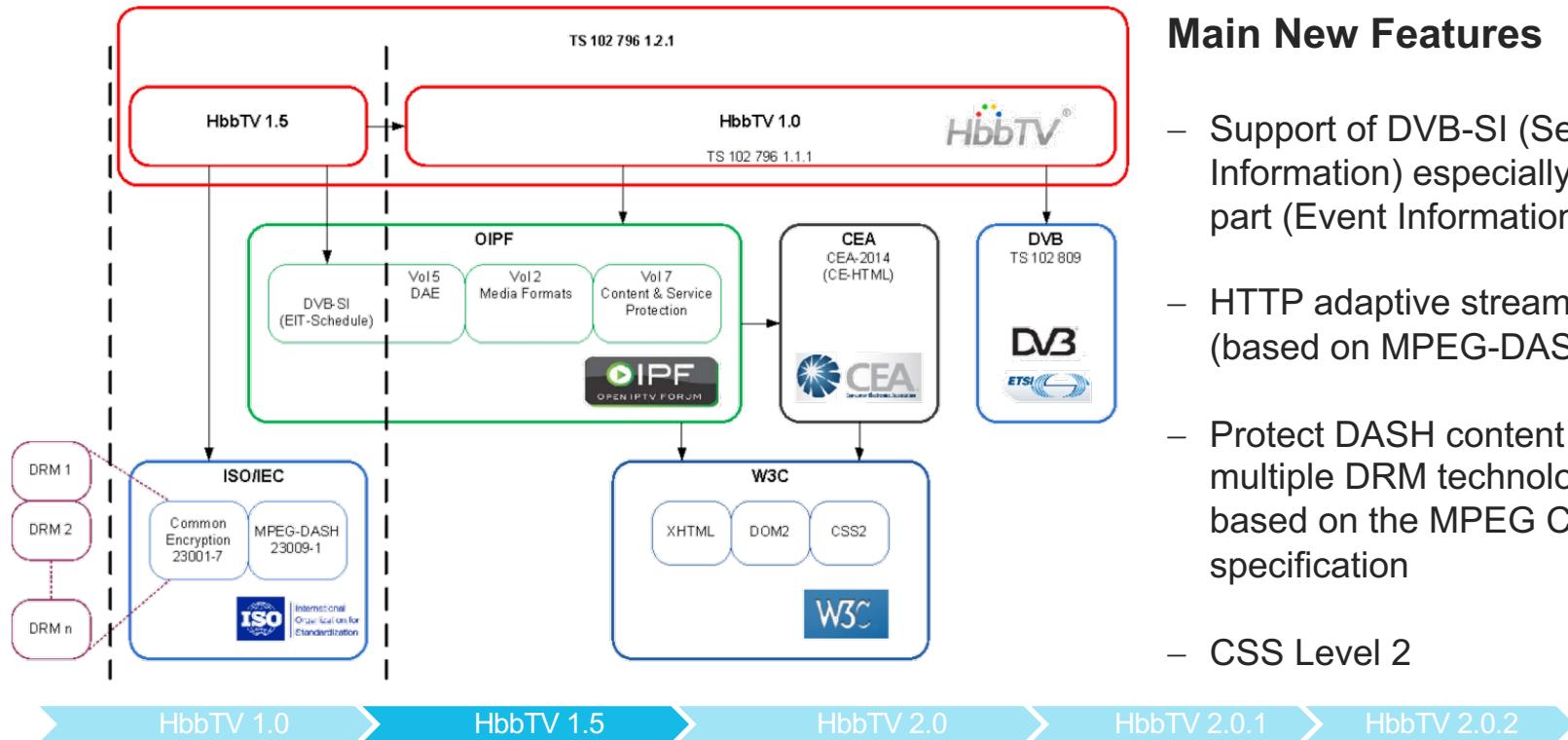
HbbTV 1.5

HbbTV 2.0

HbbTV 2.0.1

HbbTV 2.0.2

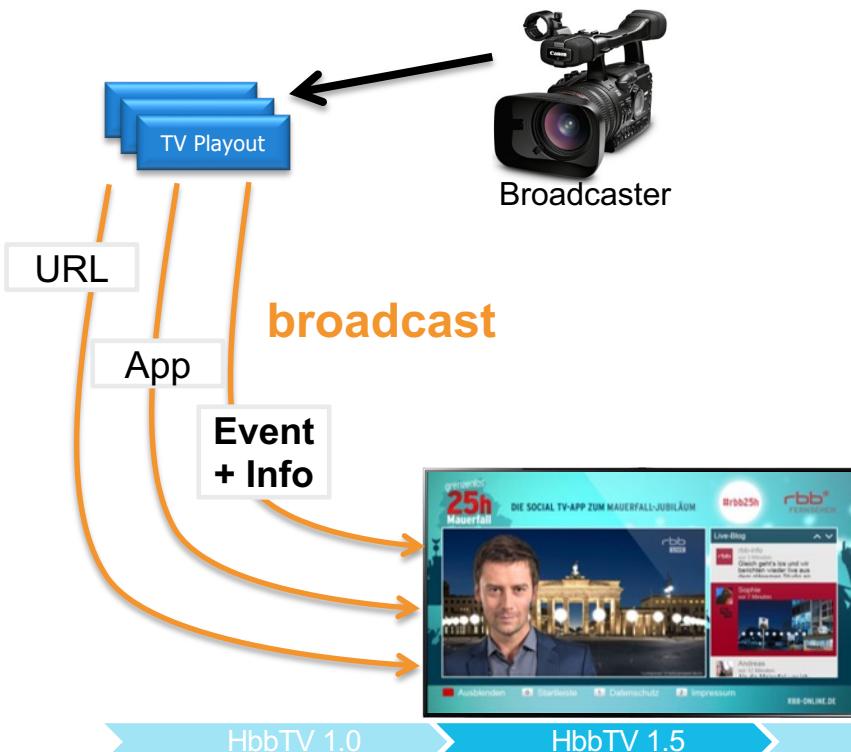
HbbTV 1.5 = HbbTV 1.0 + NEW FEATURES



Main New Features

- Support of DVB-SI (Service Information) especially EIT part (Event Information Table)
- HTTP adaptive streaming (based on MPEG-DASH)
- Protect DASH content with multiple DRM technologies based on the MPEG CENC specification
- CSS Level 2

HbbTV 1.5 – DVB-SI



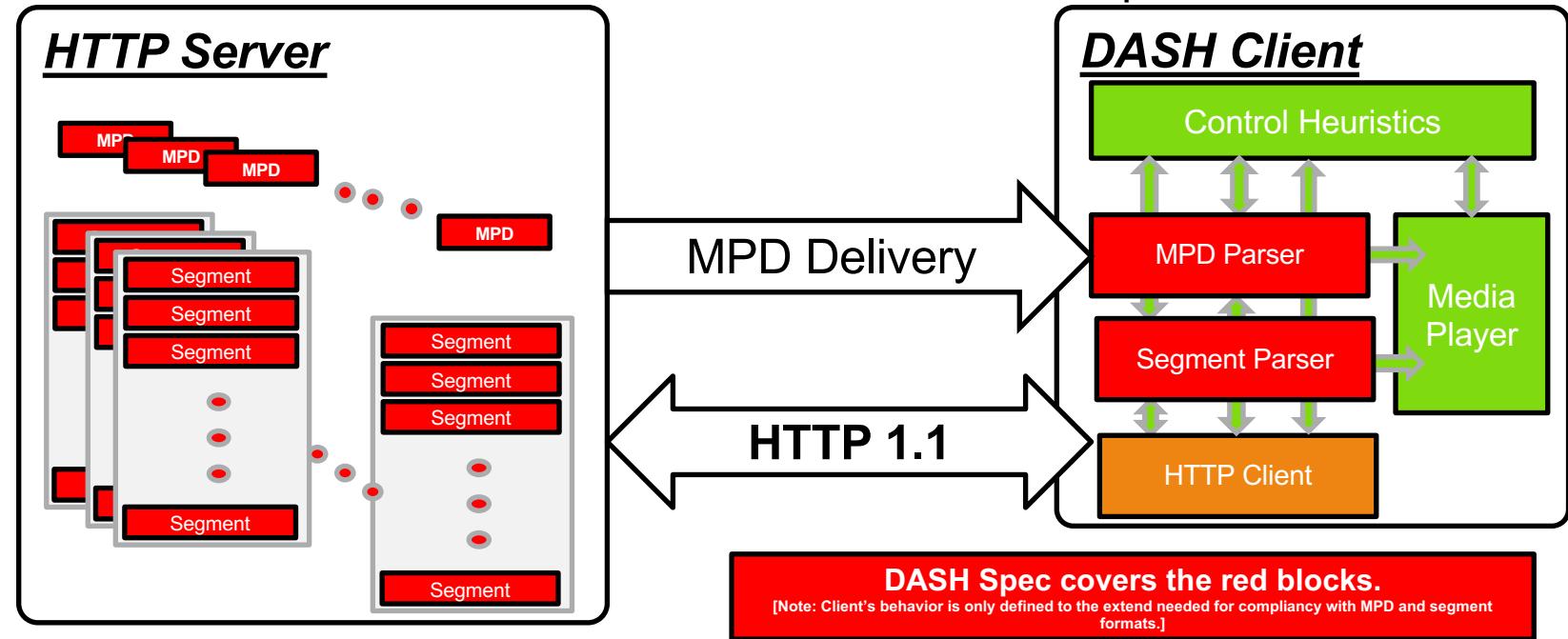
Digital Video Broadcasting – Service Information

EIT (Event Information Table) is part of DVB-SI specification

- Provides event information in chronological order
- E.g. is used for the **electronic program guide (EPG)**
- Classification of **Event Information Table (EIT)**
 - „0x4E“ actual TS, **present/following event** information
 - „0x4F“ other TS, present/following event information
 - „0x50“ to „0x5F“ actual TS, **event schedule** information
 - „0x60“ to „0x6F“ other TS, event schedule information

HbbTV 1.5 – MPEG DASH

MPEG DASH ISOBMFF Live Profile → urn:hbbtv:dash:profile:isofflive:2012



HbbTV 1.0

HbbTV 1.5

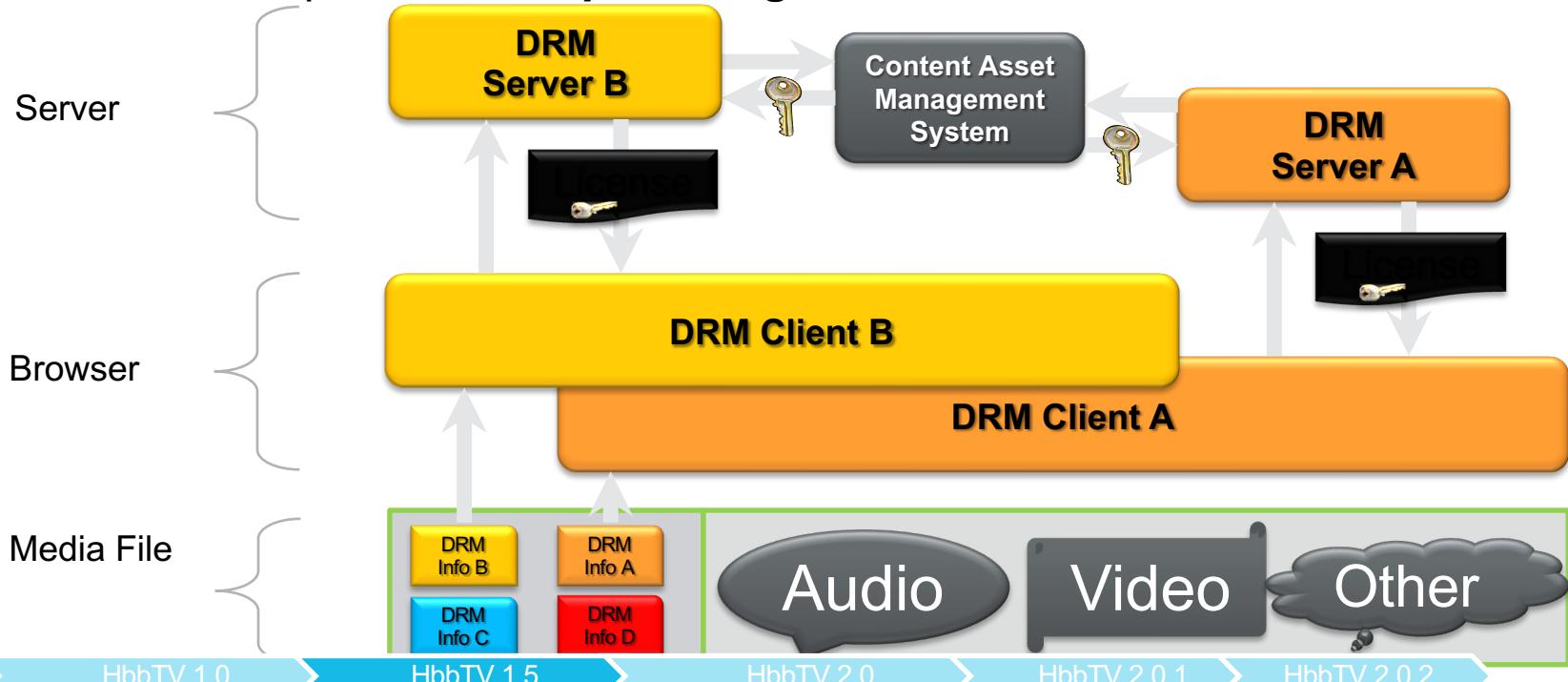
HbbTV 2.0

HbbTV 2.0.1

HbbTV 2.0.2

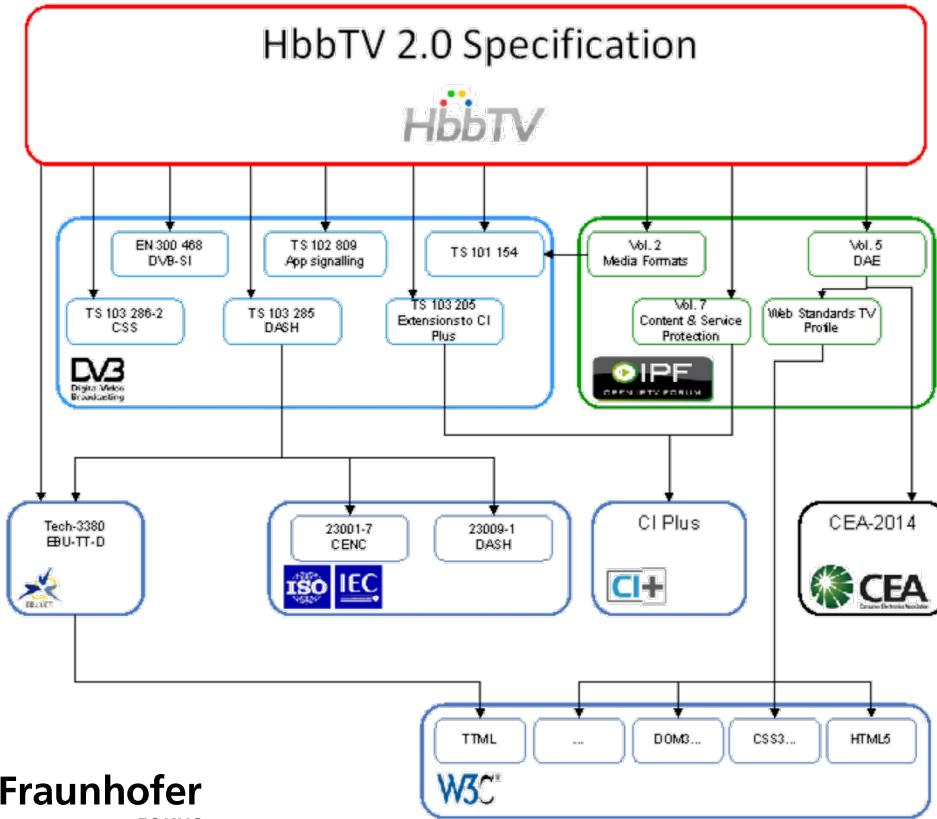
HbbTV 1.5 – MULTI DRM WITH COMMON ENCRYPTION

DRM license acquisition via **oipfDRMAgent API**



HBBTV 2 FEATURES & USE CASES

HbbTV 2.0 = HbbTV 1.5 + NEW FEATURES



Main New Features

- HTML5
- Companion Screens
- Multi-device and Multi-stream Synchronization
- DVB-DASH
- New Video Features: HEVC Support, multiple video objects, etc.

HbbTV 2.0 – NEW FEATURES



Second Screen

- Launch HbbTV App from Companion Screen
- Launch Companion Screen App (Web or Native) from HbbTV
- App2App Communication → WebSockets



Synchronization

- Media Stream Synchronization (Broadcast + Broadband or Broadband + Broadband)
- Inter-device Synchronization (Broadcast or Broadband on TV with second screen)



HTML5

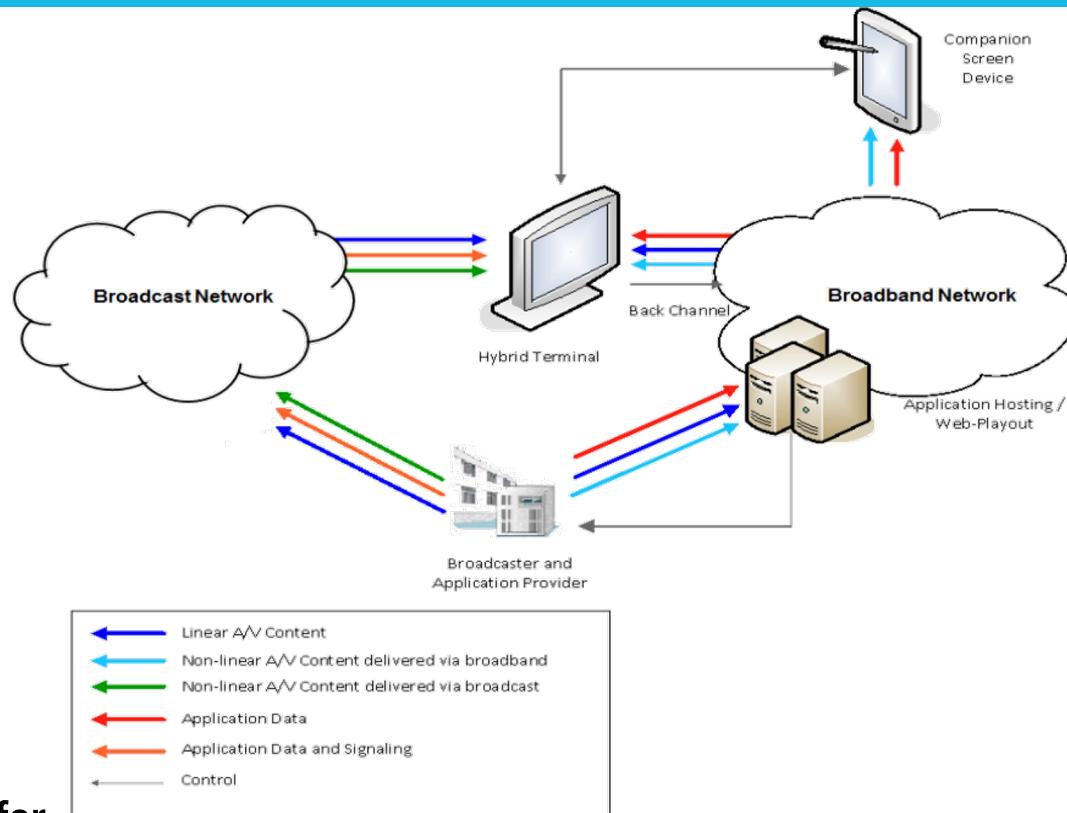
- DOM level 3, CSS level 3, Downloadable fonts
- Canvas 2D, Web Messaging, Web Workers, Server-Sent Events and Web Storage



New Video Features

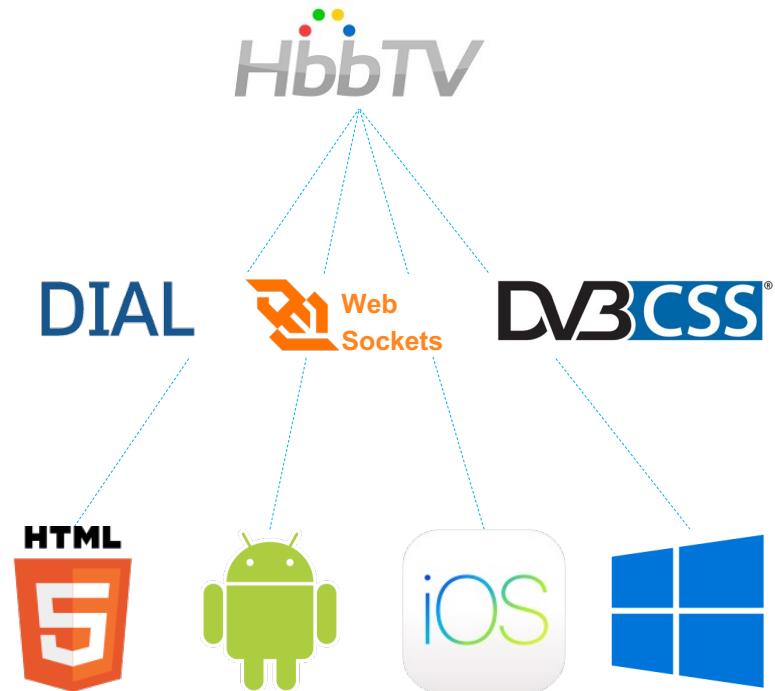
- HEVC Support (UHD)
- Adaptive Streaming (DVB-DASH) → HTML5 Video Element
- Subtitles (EBU-TT-D)

COMPANION SCREEN AND SYNCHRONIZATION - OVERVIEW



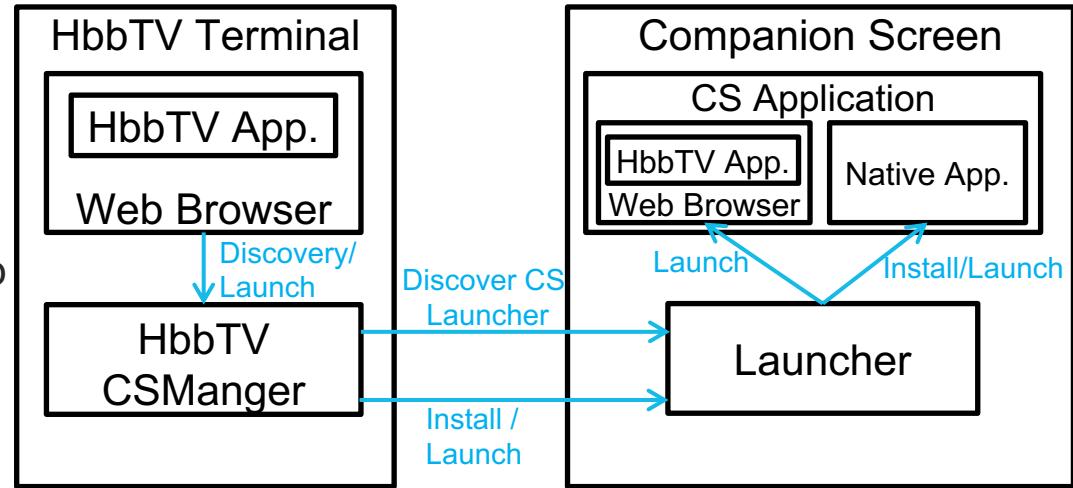
COMPANION SCREEN AND SYNCHRONIZATION - FEATURES

- Launch HbbTV App from CS App
 - Technologies: DIAL (SSDP Discovery)
- Communication between HbbTV and CS Apps
 - Technologies: WebSockets
- Launch CS App from HbbTV App
 - Technologies: Proprietary
- Multi Device Synchronization
 - Technologies: DVB-CSS



LAUNCHING A COMPANION SCREEN APPLICATION

- The HbbTV App uses the HbbTVCSManager interface to discover CS devices with a running Launcher and to install or Launch native or web CS Apps
- Communication protocol between HbbTVCSManager and Launcher is not part of the HbbTV Spec
- The HbbTV App obtains platform information, including the OS that the Companion Screen is running.



http://hbbtv.org/pages/about_hbbtv/HbbTV_specification_2_0.pdf

Intro

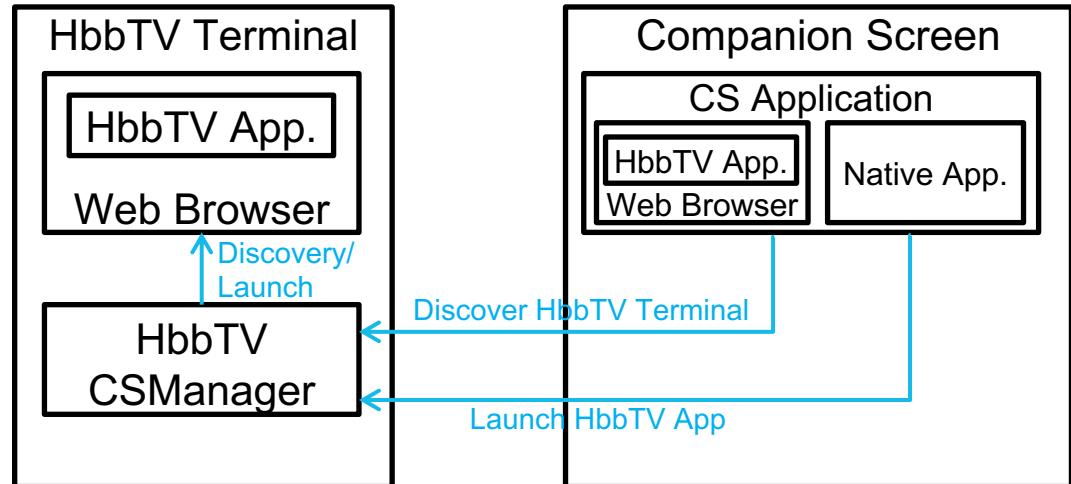
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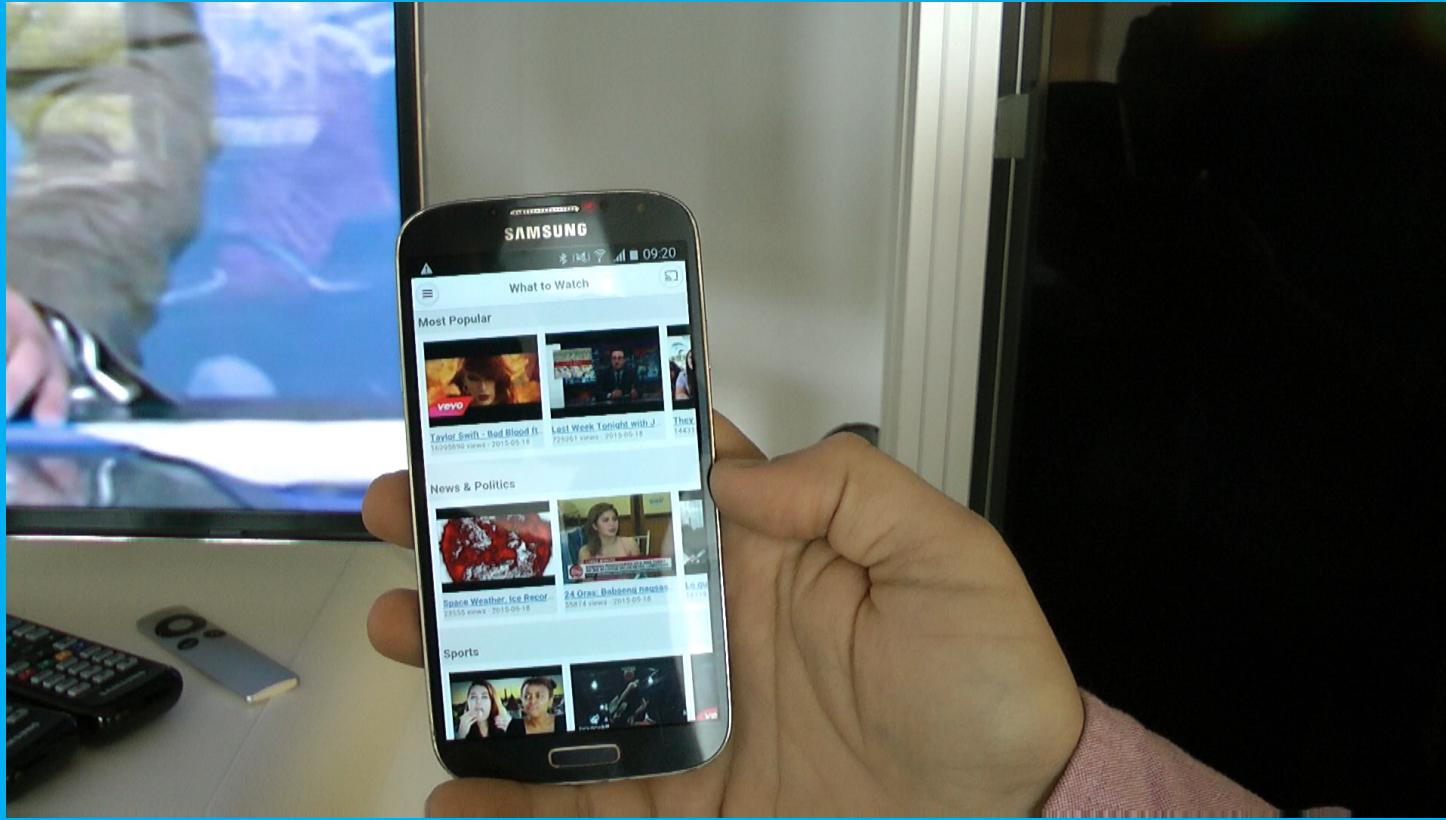


LAUNCHING AN HBBTV APPLICATION

- Launch Broadcast independent HbbTV App
- HbbTV Terminal exposes itself as DIAL App “HbbTV”
- Companion Screen App discovers (using SSDP) available DIAL servers and checks if “HbbTV” is available
- Companion Screen App launches the HbbTV App by sending HTTP POST request to the DIAL Endpoint
- The body of the HTTP POST request is an XML that contains information about the HbbTV App to launch

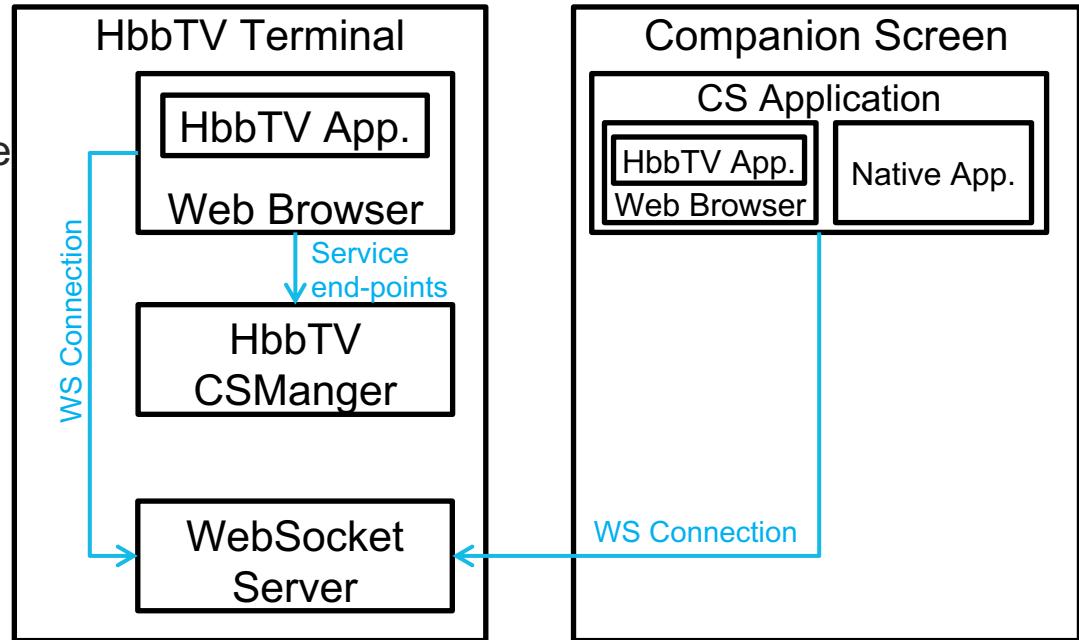


http://hbbtv.org/pages/about_hbbtv/HbbTV_specification_2_0.pdf



APPLICATION TO APPLICATION COMMUNICATION

- The HbbTV Terminal runs a Websocket Server
- App2App end-point contains the address of the WS Server
- The HbbTV App requests the App2App end-point from the HbbTVCSManager
- The CS App gets the App2App end-point after DIAL App Launch
- The HbbTV and CS Apps establish WS connections
- The Websocket Server acts as relay and pairs the WS connections on the same channel



http://hbbtv.org/pages/about_hbbtv/HbbTV_specification_2_0.pdf

USAGE OF HBBTV 2 CS APIs

HbbTV App

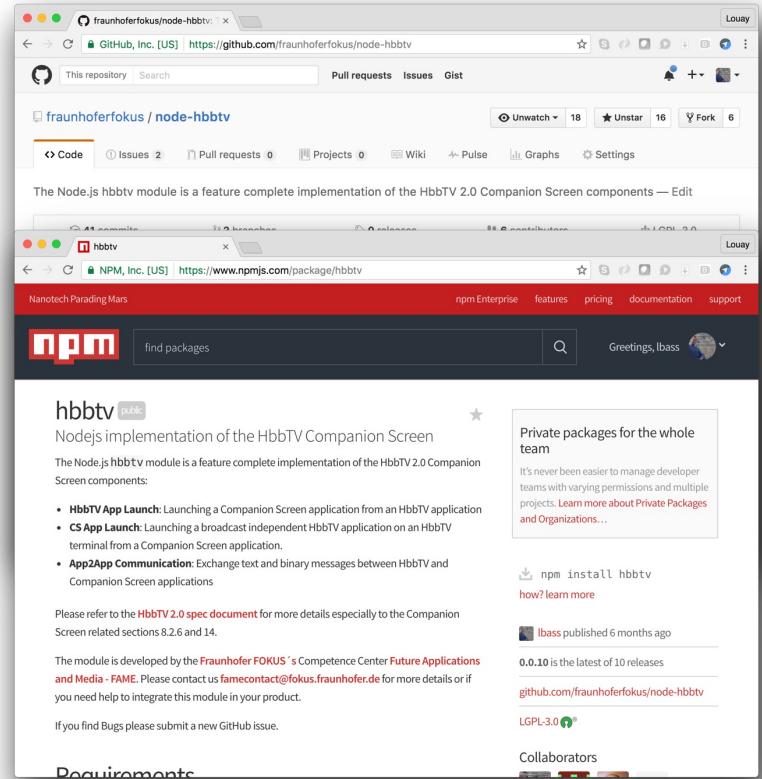
- Use *HbbTVCSManager* embedded object to discover CS Launchers, other HbbTV Terminals or launch CS App
 - *discoverCSLaunchers(function onCSDiscovery)*
 - *discoverTerminals(function onTerminalDiscovery)*
 - *launchCSApp(Number enum id, String payload, function onCSLaunch)*
- Use *MediaSynchroniser* embedded object for Multi-stream or Multi-Device Synchronization.
 - *initMediaSynchroniser(video, timeline)* → Master
 - *initSlaveMediaSynchroniser(cssCiiUrl)* → Slave
 - *enableInterDeviceSync()*
- Use W3C WebSockets API for App2App Com.
 - *new WebSocket(app2appLocalUrl);*

CS App

- Native App:
 - Use *DIAL* Client Lib for target Platform (Android, iOS, ...) and launch App with identifier “*HbbTV*” (*POST* request contains *XML AIT* describing the target HbbTV App)
 - Use *WebSocket* Lib for target platform and connect to *app2appRemoteUrl*
 - Use DVB-CSS Client Lib for target platform and connect to *cssCiiUrl* of master Terminal
- Web App:
 - **DIAL not supported (Discovery requires *UDP*)**
 - Use *W3C WebSockets API* for App2App com.
 - ***DVB-WC (Wall Clock)* requires also *UDP***

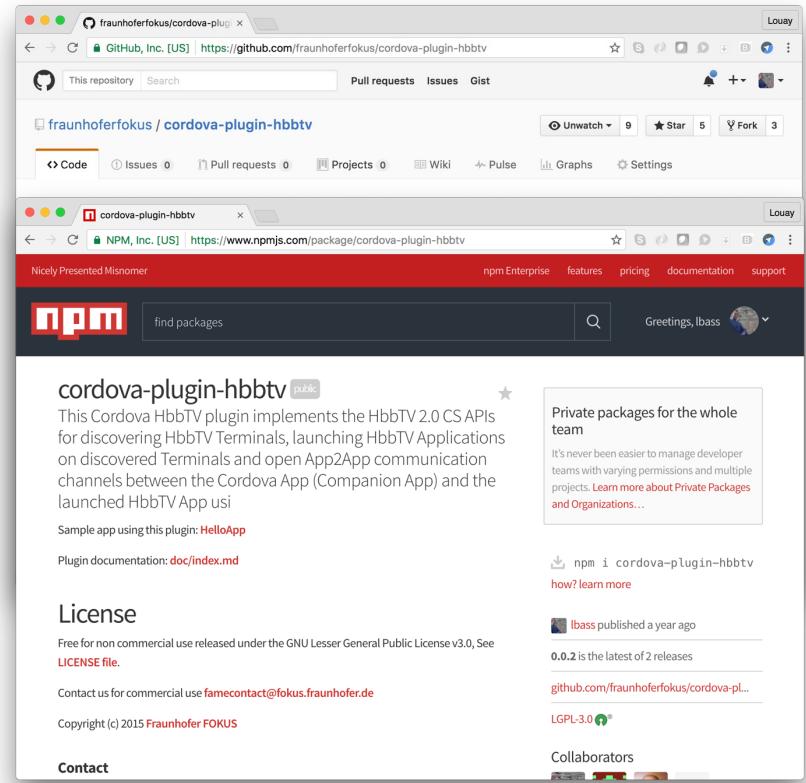
HbbTV CS OPEN SOURCE IMPLEMENTATION (TERMINAL)

- HbbTV CS Implementation as Node.js Module:
 - github: <https://github.com/fraunhoferfokus/node-hbbtv>
 - npm: <https://www.npmjs.com/package/hbbtv>
- Uses Fraunhofer Open Source DIAL and SSDP Node Modules:
 - DIAL: <https://github.com/fraunhoferfokus/peer-dial>
 - SSDP: <https://github.com/fraunhoferfokus/peer-ssdp>
- CLI with two modes:
 - Terminal mode: \$ hbbtv -m terminal -p 8080
 - Terminal-mode components: DIAL Server/Client, App2App Server, DVB-CSS Server/Client (Client for Slave Terminal)
 - CS mode: \$ hbbtv -m cs -p 8090
 - CS-mode components: CSLauncher, DIAL Client, DVB-CSS Client
- Can be used with any User Agent (e.g. Firefox with FireHbbTV Add-On)



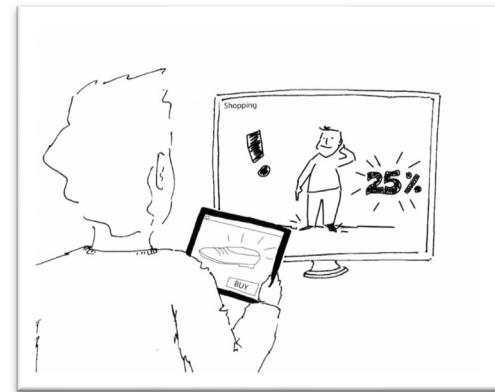
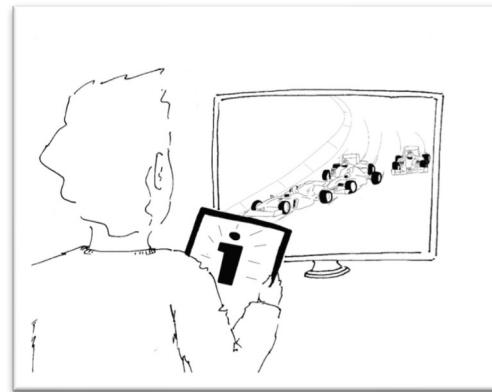
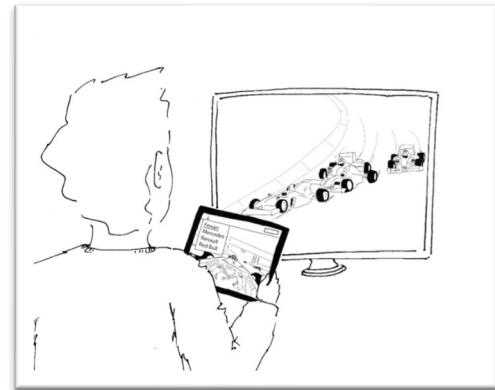
HbbTV CS OPEN SOURCE IMPLEMENTATION (CORDOVA)

- HbbTV CS Implementation of CS components as Cordova Plugin:
 - github: <https://github.com/fraunhoferfokus/cordova-plugin-hbbtv>
 - npm: <https://www.npmjs.com/package/cordova-plugin-hbbtv>
- Supported Platforms: Android, iOS (coming soon)
- Components:
 - DIAL Client (includes SSDP Client)
 - Helpers for XML AIT POST requests

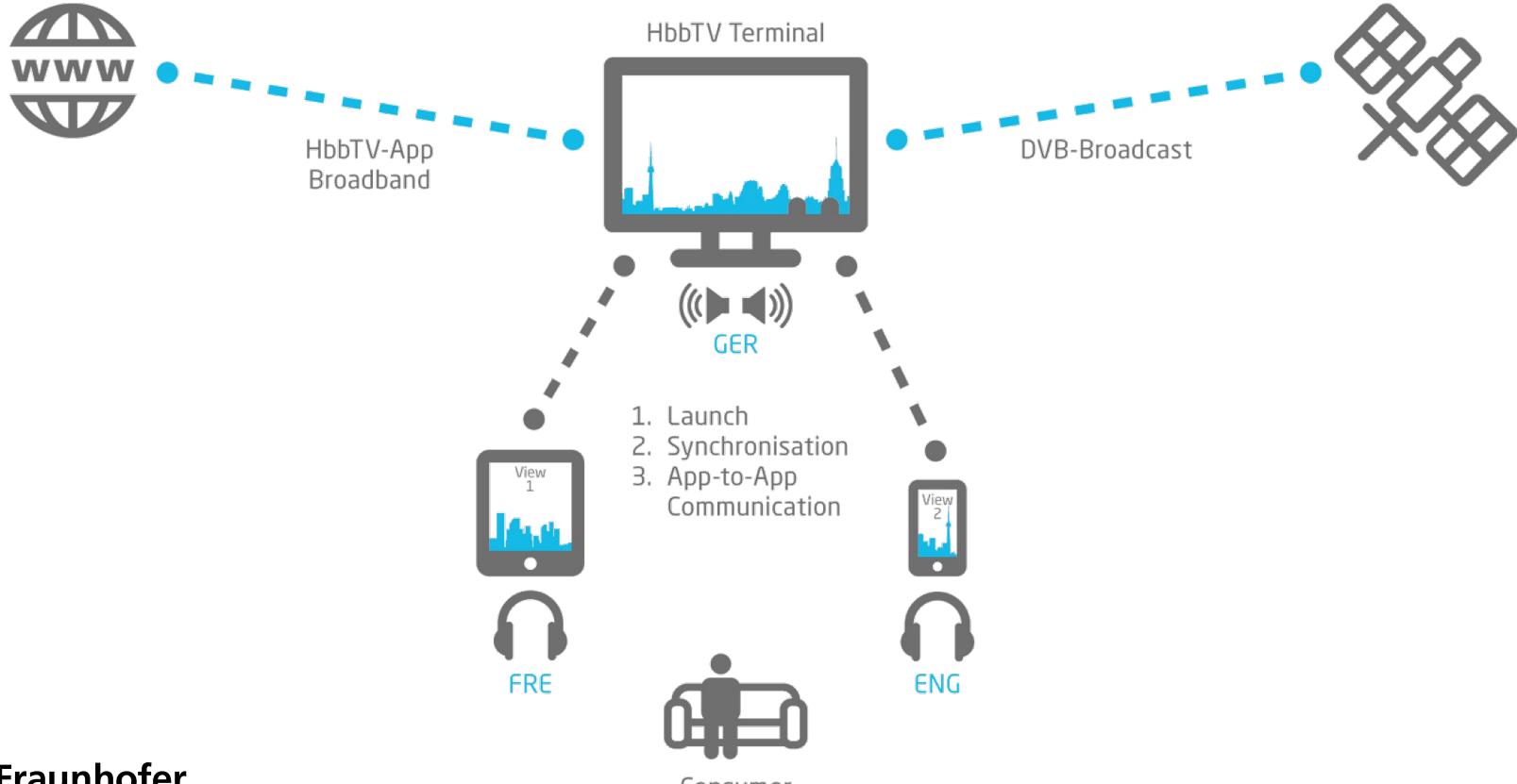


HBBTV 2 COMPANION SCREEN USE CASES

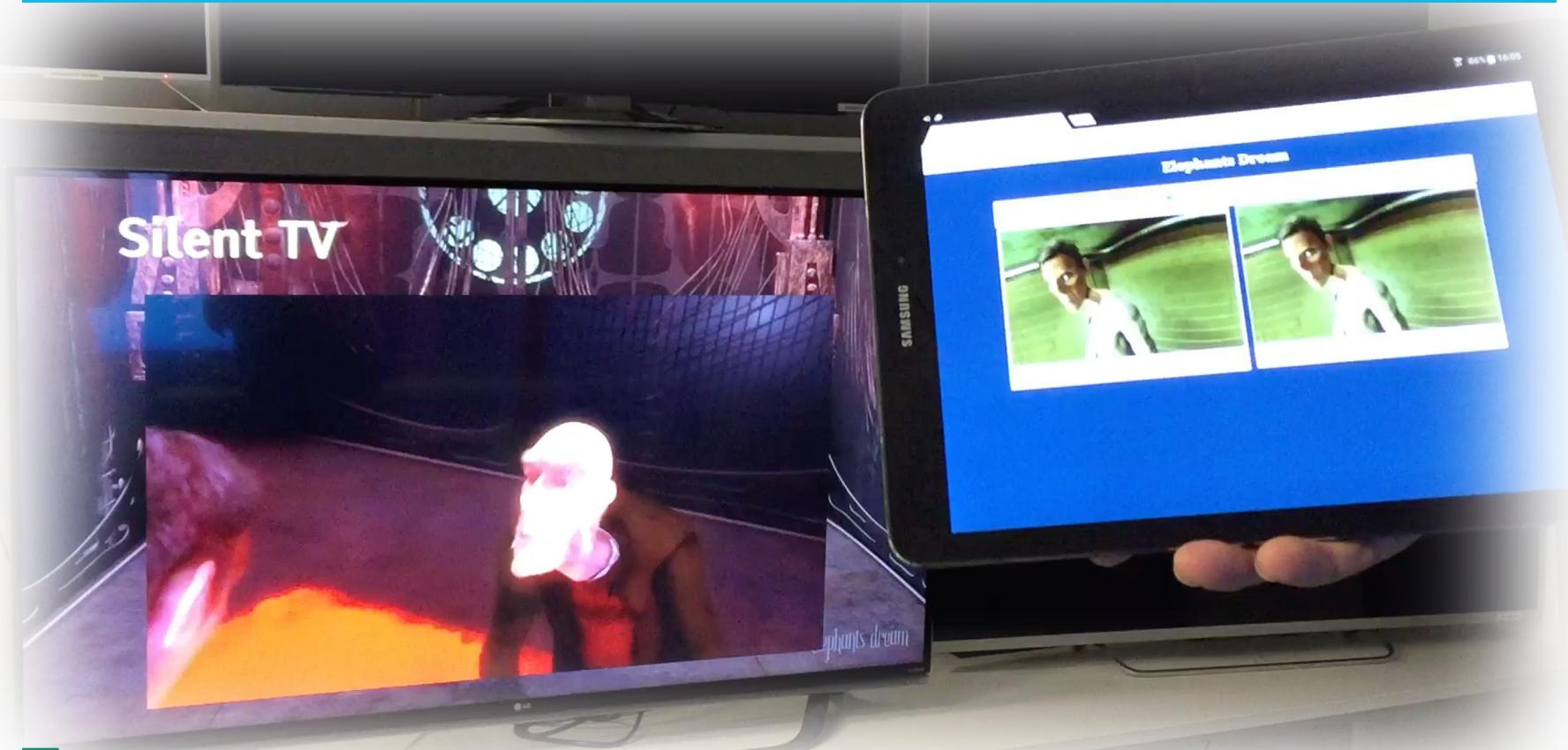
- Cast Media to Broadcaster's HbbTV Application
- Show additional Content on Companion Screens
- Multiple Camera Perspectives
- Personalized Audio Tracks on Companion Screens
- Multi-User Support
 - Multiplayer Games
 - Quizzes
 - ...
- Multiscreen Advertisement



DEMO: PERSONALIZED VIDEO AND AUDIO STREAMS ON CS



DEMO: SILENT VIDEO ON TV IN SYNC WITH AUDIO ON CS



NEW HTML5 FEATURES/APIS (1/4)

– Most relevant new Features/APIs

- **DOM level 3:** DOM Core interfaces and exceptions extended, new Types and Interfaces introduced, XPath supported, etc. ([changes to DOM level 2](#))

```
var paragraphCount = document.evaluate( 'count(//p)', document, null, XPathResult.ANY_TYPE, null );
var iterator = document.evaluate( '//p', document, null, XPathResult.UNORDERED_NODE_ITERATOR_TYPE, null );
var firstParagraph = document.evaluate('p', document, null, XPathResult.FIRST_ORDERED_NODE_TYPE, null );
```

- **CSS level 3:** introduction of modules, new CSS selectors and pseudo-classes, new properties like *border-radius*, RGBA color with opacity, ...

```
p[title^="foo"] { // match <p> elements with title value starting with foo
    transform: rotate(180deg); // rotate element for 180°
    background: rgba(217, 127, 185, 0.5); // background opacity is 50%
}
```

- **Downloadable fonts:** Web Open Font Format (WOFF) supported

```
@font-face {
    font-family: "Open Sans";
    src: url("/fonts/OpenSans-Regular-webfont.woff") format("woff");
}
```

NEW HTML5 FEATURES/APIS (2/4)

- **Web Sockets:** Bidirectional Communication between Client/HbbTV Terminal and Server. No need for XHR polling anymore.

```
var socket = new WebSocket('ws://example.com'); // Create WebSocket connection.  
socket.addEventListener('open', function (event) { // Connection opened  
    socket.send('Hello Server!'); // Send message to server  
});  
socket.addEventListener('message', function (event) { // Listen for messages from Server  
    console.log('Message from server ', event.data); // Display message  
});
```

- **Canvas 2D:** provides objects, methods, and properties to draw and manipulate graphics on a canvas drawing surface.

```
<canvas id="myCanvas" width="200" height="200"></canvas>  
var c = document.getElementById('myCanvas');  
var ctx = c.getContext('2d');  
ctx.moveTo(0, 0);  
ctx.lineTo(200, 200);  
ctx.stroke();  
ctx.font = '30px Arial';  
ctx.fillText('Hello World', 10, 20);
```

NEW HTML5 FEATURES/APIS (3/4)

- **Web Messaging**: defines a mechanism for communicating between browsing contexts in HTML documents. Browsing context is for example `<iframe>`

```
<!-- http://domain1.com/index.html -->
<iframe src="http://domain2.com/iframe.html"></iframe>

var iframe = document.getElementsByTagName('iframe')[0];
iframe.contentWindow.postMessage('Say Hello',
  'http://domain2.com');
```

```
<!-- http://domain2.com/iframe.html -->
window.addEventListener('message', function(event){
  if (event.origin == 'http://domain2.com') {
    console.log(event.data);
    event.source.postMessage('Hello', event.origin);
  }
});
```

- **Web Storage**: defines APIs for persistent data storage of key-value pair data in Web clients. **localStorage** API stores data with no expiration date while **sessionStorage** API expires when the browser is closed (TV turned off?).

```
localStorage.setItem('myKey', 'my value');
var value = localStorage.getItem('myKey');
localStorage.removeItem('myKey');
localStorage.clear();

sessionStorage.setItem('myKey', 'my value');
```

NEW HTML5 FEATURES/APIS (4/4)

- **Web Workers:** provides an API to run JavaScript in the background (new thread), without affecting the performance of the page/ avoids page to becomes unresponsive.

```
<!-- index.html -->
var worker = new Worker('worker.js');
worker.onmessage = function(event){
  console.log('got result', event.data);
  worker.terminate();
};
worker.postMessage('do job');
```

```
<!-- worker.js -->
onmessage = function(event){
  if (event.data == 'do job') {
    var result = runMyJob(); // perform complex job
    postMessage(result);
    close(); // workers can close themself
  }
};
```

- **Server-Sent Events:** enables servers to push data (UTF-8) to Web pages over HTTP or (using dedicated server-push protocols) using ***text/event-stream*** MIME type.

```
<!-- Client -->
var source = new EventSource('update.php');
source.onmessage = function(event){
  console.log('got update', event.data);
};
```

```
<!-- Server sends data in following format -->
data: This is the first message.
```

```
data: This is the second message, it
data: has two lines.
```

```
data: This is the third message.
```

NEW VIDEO FEATURES

- **High Efficiency Video Coding HEVC (or H.265) Support**
 - Defines how **HEVC** video codec can be used via broadband
 - HEVC can be used for **UHD** content and to enable **HD** content to be delivered using less bandwidth (around **50%**) than the Advanced Video Coding **AVC** (or H.264) for the same quality
 - HEVC supports resolution up to **8K UHD** (or 8192×4320 pixels).
- **Support of multiple HTML5 Video Elements**
 - HbbTV 2.0 supports HTML5 Media Elements: <**video**> and <**audio**>
 - *“The terminal shall support the existence within the same DOM of at least **one** HTML5 media element that is **playing** together with **at least two** HTML5 media elements in a **paused** state”*
 - can be used to seamlessly insert adverts at the start, middle and end of VoD content.

NEW VIDEO FEATURES

– DVB-DASH

- HbbTV 1.5 includes a simple profile of MPEG DASH which is being used successfully today
- HbbTV 2.0 extends it to add extra features using the work completed in July 2014 in the DVB project: **DVB DASH** profile → **urn:dvb:dash:profile:dvb-dash:2014**
- It is subset of MPEG-DASH optimized for the needs of the DVB community
- specifies both the On Demand and Live profile of MPEG-DASH
- Includes support for HEVC and UHD

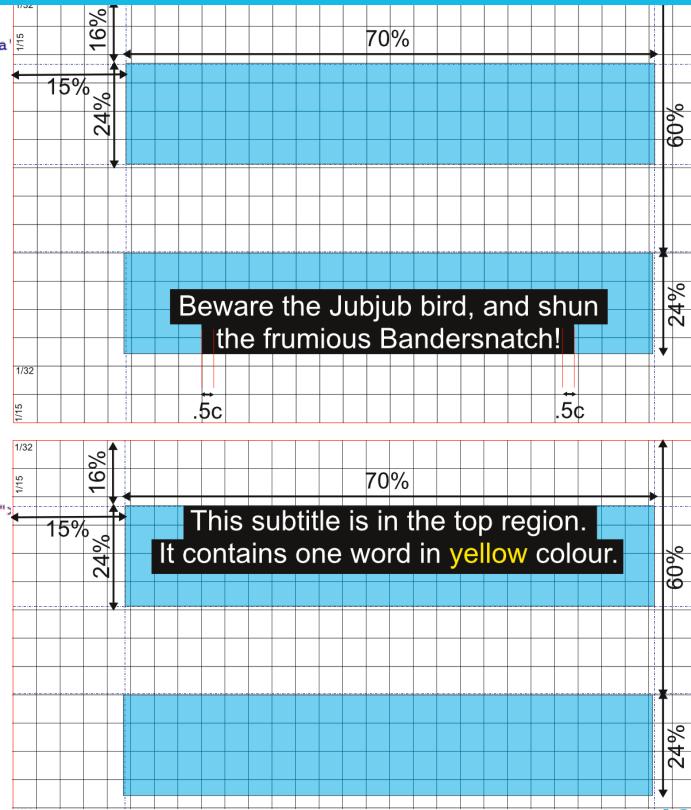
– Subtitles

- HbbTV 2.0 adds support for subtitles for broadband content using the EBU profile EBU-TT-D (Timed Text Part D) of W3C TTML (Timed Text Markup Language).

EBU-TT-D EXAMPLE

```
<tt xmlns="http://www.w3.org/ns/ttml" xmlns:ttp="http://www.w3.org/ns/ttml#parameter"
  xmlns:tts="http://www.w3.org/ns/ttml#styling" xmlns:ebutts="urn:ebu:tt:style" xmlns:ebuttm="urn:ebu:tt:metadata"
  ttp:timeBase="media" ttp:cellResolution="32 15" xml:lang="en">
  <head>
    <metadata>...</metadata>
    <!---->
    <styling>
      <style xml:id="paragraphStyle" tts:fontFamily="proportionalSansSerif" tts:fontSize="100%"
        tts:lineHeight="120%" tts:textAlign="center" tts:wrapOption="noWrap" ebutts:multiRowAlign="center"
        ebutts:linePadding="0.5c"/>
      <style xml:id="spanStyle" tts:color="#FFFFFF" tts:backgroundColor="#000000"/>
      <style xml:id="yellowStyle" tts:color="#FFFF00" tts:backgroundColor="#000000"/>
    </styling>
    <!---->
    <layout>
      <region xml:id="topRegion" tts:origin="15% 16%" tts:extent="70% 24%" tts:displayAlign="before"
        tts:writingMode="lrtb" tts:overflow="visible"/>
      <region xml:id="bottomRegion" tts:origin="15% 60%" tts:extent="70% 24%" tts:displayAlign="after"
        tts:writingMode="lrtb" tts:overflow="visible"/>
    </layout>
  </head>
  <body>
    <!---->
    <div>
      <!---->
      <p xml:id="subtitle1" region="bottomRegion" style="paragraphStyle" begin="00:00:10.000" end="00:00:20.000">
        <!---->
        <span style="spanStyle">Beware the Jubjub bird, and shun</span>
        <br/>
        <span style="spanStyle">The frumious Bandersnatch!</span>
      </p>
      <p xml:id="subtitle2" region="topRegion" style="paragraphStyle" begin="00:00:30.000" end="00:00:31.000">
        <span style="spanStyle">This subtitle is in the top region.</span>
        <br/>
        <span style="spanStyle">it contains one word in</span>
        <span style="yellowStyle">yellow</span>
        <span style="spanStyle">colour.</span>
      </p>
    </div>
  </body>
</tt>
```

source: <http://bbc.github.io/subtitle-guidelines/#EBU-TT-D-file>



NEW VIDEO FEATURES

– Access Broadcast Time

- Important for accurate audience tracking in current program
- Uses The **MediaSynchronizer** API with TEMI-timeline

```
if(oipf0bjectFactory.isObjectSupported("MediaSynchroniser")){
    var timeline = 'urn:dvb:css:timeline:temi:8:1';
    var broadcast0bj = document.createElement("object");
    broadcast0bj.type = "video/broadcast";
    document.body.appendChild(broadcast0bj);
    broadcast0bj.bindToCurrentChannel();
    var synchronizer = oipf0bjectFactory.createMediaSynchroniser();
    synchronizer.initMediaSynchroniser(broadcast, timeline);
    var currenTime = ms.currenTime;
}
```

HBBTV 2.0.1 = HBBTV 2.0 + BUG FIXING + NEW FEATURES

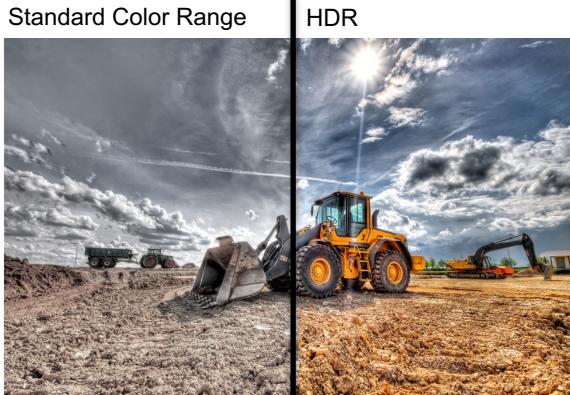
- The ~~HbbTV 2.0~~-specification has been deprecated and is not available anymore
- It has been replaced by HbbTV 2.0.1
- Changes to HbbTV 2.0
 - Bug fixes in the spec
 - More clarifications and exact formulations
 - Additional Features for Role-Out in Italy and UK
 - Monitoring AIT/DSM-CC while IP AV Content is played
 - Use “Audio from Memory” via WebAudio API
 - Details for using higher display resolution
 - Prevention of Zapping-Banner
 - Clear-Key from W3C EME API shall be supported for content delivered by MPEG DASH

HbbTV 2.0.2 = HbbTV 2.0.1 + NEW FEATURES

- Integration of HbbTV with
 - High Dynamic Range (**HDR**) video → both PQ10 and HLG10
 - PQ10: 10-bit Perceptual Quantizer
 - HLG: 10-bit Hybrid Log Gamma (Backward compatible with SDR)
 - High Frame Rate (**HFR**) video → 100Hz or 120Hz
 - Next Generation Audio (**NGA**) → Both AC-4 and MPEG-H audio
 - **AC-4**: audio compression technology developed Dolby (50% better compression).
 - **MPEG-H**: Support immersive Audio, higher Order Ambisonics (HOA), ...
 - **HbbTV doesn't require any of these → Up to national, broadcaster or operator specs to require them**
- Updated DVB-DASH → describes how to include HDR, HFR and NGA in manifest
- Fixes for bugs in HbbTV 2.0.1 found in development of apps, TVs, STBs and test cases

CURRENT TV TRENDS – HDR, HFR & UHD

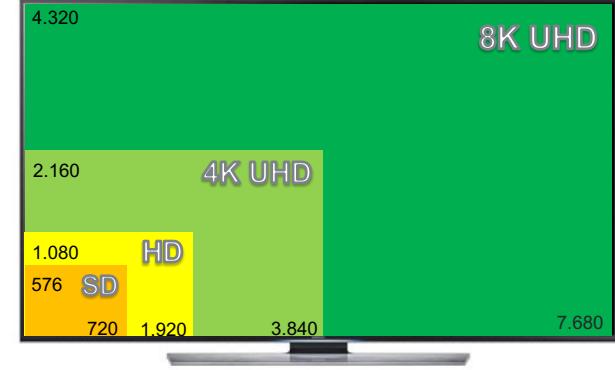
Standard Color Range



= 8 bit per channel: 16.7 m colors

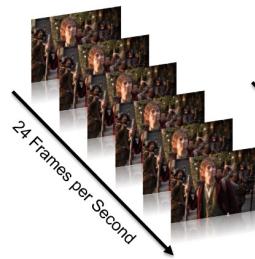
HDR

* <https://www.entain.de>



\geq 10 bit per channel: 69.8 bn colors

High Dynamic Range



24 Frames per Second

High Frame Rate

48 Frames per Second



48 Frames per Second
(in 3D: 24 FPS_per_Eye)

HBBTV 2.0.3 = HBBTV 2.0.2 + NEW FEATURES + DEPRECATIONS

- New Features added to 2.0.3
 - W3C Media Source Extensions API
 - Service Workers
 - HTTP/2 Support
 - TLS updated to version 1.3
 - navigator.cookieEnabled
 - CMAF Support
 - Low Latency DASH
 - ...
- Removed Features
 - App Launch on companion screen
 - CI+ host player mode
 - Teletext Subtitles in OTT content
 - ...

HBBTV 2.0.4 = HBBTV 2.0.3 + NEW FEATURES + DEPRECATIONS

New Features

- Accessibility integration: query if accessibility feature is supported
- DVB-I integration: Use Broadcast Object to play DVB-I DASH Stream
- Voice assistant integration: use of voice input in HbbTV app for selected media playback features (Play/Pause/...)
- Smaller additions
 - Audio mixing enhancements
 - Allow analytics reporting on exit from an HbbTV app via W3C Beacon API
 - Web platform update from 2018 to 2021

Deprecations

- Partial deprecation of A/V control object: Properties on AVComponent which have no equivalent on HTML5 *Track
- Streaming with MPEG-2 TS as the system format
- Native on-screen keyboard



THANK YOU FOR YOUR ATTENTION