Test Setup Specification Backend

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Executive Summary

In this document, we describe the specific technical process for deploying applications to devices in a broadcast television context. This includes different delivery mechanisms, and the role that various elements within the broadcast signal play in the process.

Following this, we describe in detail the specification of two particular trials conducted within the scope of MPAT. This includes the details of the broadcast signal used, as well as a description of the infrastructure used to support the delivery of the application.

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1 Introduction

In this document, we outline further technical details in regards to the numerous pilots that are in conduction for the purposes of MPAT. The document begins within an introduction to some of the fundamentals of digital broadcast television, the technologies behind this, and finishes with an overview of the devices and equipment necessary to realise large-scale production-quality playout.

1.1 Fundamentals of Digital TV Technology

Digital TV is typically broadcast using signals containing MPEG-2 data. Each frequency carries a single *transport stream* or *multiplex*. Each stream can carry a finite amount of data, normally around 25-40 megabits/second, dependent on the transmission medium. Each of these streams is then further broken down into a number into a number of smaller, sub-streams, known as *elementary streams.* Each of these carries only one type of data (whether that be audio, video or data), and are identified using a unique *packet identifier* (PID).

To enable the reliable transmission of these streams, information is segmented into a *packetised elementary stream* (PES), and then further into a set of *transport packets.* These are small enough so that powerful error correction techniques can be used to ensure that data is received in a timely and ordered fashion. So that the receiver can correctly decode and reassemble each of these, an additional elementary stream is added, known as *program association table* (PAT)*.* This has a fixed PID of 0, so that the decoder can always identify it in a transport stream.

The PAT describes a number of *services* or *programs,* which are collections of elementary streams that belong together. For example, this may be the video and audio streams for a single television channel. These services are then broken down further into *events*, which are analogous to fixed periods of time within that stream, such as a running TV show.

Multiple services can also be grouped logically together into *bouquets*, which typically define a set of channels offered by a single broadcaster. They can also be used to separate groups into bundles based upon genre and content, such as sport and movies.

Digital broadcast television also has the concept of *networks*, which represent transport streams that are broadcast by the same entity. This distinction is necessary, because the broadcaster (channel programmer) is not always the same organisation as the network (infrastructure) operator.

1.2 Service Information

As mentioned previously, the program association table (PAT) is used to describe the other elementary streams within the transport stream. It does this by providing pointers to other packet identifiers (PIDs), each of which contains a *program map table (PMT)* for the individual services in the transport stream.

These tables describe in more details how a service should be put together and reassembled on client devices. This includes outlining all other elementary streams in a service, as well as their type: this table points directly to audio, video or data streams. It also contains the clock reference to be used for synchronisation and to ensure correct ordering during reassembly.

A third table is also in use in all MPEG-compliant transport streams: a *conditional access table (CAT) i*s used to determine the permitted access types that are in use within a stream, and also the methods used to decode them. Together, these tables together make up the *service information (SI).*

1.3 HbbTV Application Signaling

One method of delivering TV applications to end-user devices is to include these as an elementary stream, with the type set to *data.* This type of delivery is possible with the use of *DSM-CC,* which is a standard for data streams. The specification includes *object carousels*, which are used to deliver MHP and OCAP-based applications, as well as those based on the HbbTV specification.

In brief, this technique works by delivering the application data over a number of cycles. As the application will be part of the broadcast signal, it will be delivered repeatedly over the air (hence the carousel name). This gives clients access to the application regardless of the time that they access the service.

Applications are then described through the use of an *application information table (AIT)*, which is an additional table type similar to the PAT, PMT and CAT described in the previous section. In the same way that the PAT table can include pointers to PMT entries, the PMT can also include entries to AIT records (identified by a unique PID).

These AIT records describe all of the information relating to a single specific application. This includes the name, an identifier, the way that the application is launched (autostart, present, teletext), and a set of features that should be present on the device before the application can successfully start. These records also described the way in which the application should be delivered, such as the DSM-CC object carousel outlined previously.

However, HbbTV applications also support an alternative method of delivery, namely that over *IP (Internet protocol).* This is possible due to the connected nature of HbbTV-compatible devices, whom in all likelihood, have access to the Internet. In this case, the AIT will also contain a web-based URL, pointing to the application that should be fetched by the device when the application is launched. The device will then retrieve this from the web server and present it on the end-device.

1.4 Supporting Broadcast Infrastructure

There is significant infrastructure necessary to realise both broadcast and application delivery. In the case of broadcast, a number of encoders are used to correctly package audio and video signals into a suitable format, such as MPEG-2.

Together with compliant data streams and conditional access systems, these inputs are fed into a multiplexer, which muxes these inputs into a single output. These are then fed to a modulator, which converts the signal to an analog source, ready for transmission. This signal can then be broadcast over the chosen medium, such as a transmitter and antenna (for terrestrial or satellite), or a cable network. When received at the client side, it can be demodulated and reassembled to form a stream usable by the consumer device. This then provides all of the video, audio and data necessary to deliver a TV channel.

As mentioned previously, in cases where IP delivery is used for an application, the client device will make a request for an application from a remote location, defined in the URL. This will take the form of a

HTTP request for HTML content from a standard, commodity webserver. It is this set of HTML pages that together make a HbbTV application.

The advantage of using IP as a delivery technique is that many of the technologies that can be used to support modern websites, can also be applied to this domain. HTTP servers are easy to setup and maintain, and are a well understood system to deploy and manage.

Large-scale *content delivery networks (CDNs)* can also be employed in the delivery of these applications. These are used by many of the most visited and used websites and services on the web today. CDNs ensure that content is always available to the maximum amount of users, offering scalability and resiliency in the face of high load. They also ensure that a certain quality of experience is achieved, by placing this content close to the user (at least from a computer networking perspective). This minimises the risk of latency and congestion having an effect on the delivery of the application and the media objects contained within.

Similarly, web accelerators and load balancers can also be placed in the application delivery path (via the Internet) to ensure that the whole application is not only available, but delivered in an efficient and performant way. This is only possible due to the use of IP in this context; the same benefits cannot be realised with the use of DSM-CC object carousels. IP fundamentally allows for a much richer and complex application to be delivered without impacting the experience, whereas an object carousel enforces maximum size restrictions that can otherwise limit the creativity and possibilities for application developers.

2 Backend Specification

In the previous section, we described the infrastructure and technology behind the deployment of TV-based applications. In this section, we describe the specific details of the MPAT pilots to demonstrate the technical specification of the backend necessary to achieve the required technical outcome.

It is important to note that, despite the fact that much of this work was conducted specifically for the purposes of the pilot, it is nonetheless appropriate to a production environment. In fact, in all cases mentioned within this deliverable, the pilot applications were deployed and used in live, unrestricted environments, and were not presented in a constrained or restricted setup.

In the remainder of this section, we describe the technical specification of two pilots:

- A trial conducted by Mediaset, which measured the feasibility of deploying and using HbbTV applications in the Italian market, specifically in the advertisement of goods and services
- A trial conducted by RBB, used to provide a companion-application for a series of television shows, focusing on the formation of a music band, and designed specifically for younger audiences

2.1 Mediaset Technical Feasibility Trial

HbbTV is **not** commonplace amongst devices available in the Italian marketplace; some devices have compatibility, but this is not an advertised or explicit feature. The current situation is that the majority of applications deployed and available today in Italy are based upon the MHP standard.

This trial was designed to understand the migration path between existing TV applications and the new HbbTV standards. As such, it looked to understand how these two formats of applications can be delivered together; allowing devices to determine which application to load based upon their own capabilities.

The remainder of this subsection describes the detailed technical details of the trial, including the multiplex configuration, the infrastructure used to support the application delivery, and the analytics backend used to track consumption of the application in the wild.

2.1.1 Service Information Composition

This application was introduced into an existing Mediaset-operated multiplex, containing a number of individual services. The PMTs for a number of services were modified to point to AITs describing HbbTV applications, some of which were created through MPAT.

More specifically, the PMT of the *La5*[1] channel was modified to point to an AIT describing an MPAT application hosted on Internet-connected infrastructure. Similarly, the PMT of *TG-Com*[2] was also modified to point to the same application (using the same URL).

In both cases, the mode of launching was set to display a prompt, or call-to-arms, on the user's screen. By following the given instructions, users could then load the MPAT application, in this case an advertisement.

[1] La5: http://www.mediaset.it/la5/

[2] TG-Com: http://www.tgcom24.mediaset.it/

As mentioned previously, and in both cases, the application was delivered using IP, without any need for the DSM-CC object carousel.

It is important to note that this was a live TV channel, using a production service and included within one of the Mediaset transmission bundles; no signal generation or emulation equipment was used, and as such, the users accessing the service were real viewers in their own homes.

2.1.2 Infrastructure

To support the delivery of this application to users that interacted with the TV, and subsequently launched the application, a single virtual machine was used. This was hosted in a datacentre owned and operated by Fincons, who were working as a technical partner for the purposes of this trial.

This virtual machine hosted an Apache web server, which handled the actual serving of web content to the connected HbbTV-compatible devices, and a MySQL database to support the running and operation of the service.

Given that this was anticipated to be a low-volume feasibility trial, the virtual machine specification was as follows:

Resource Type	***Amount***	***Tenancy***
CPU Clock	2.4Ghz	Shared
CPU Cores	2	Shared
RAM	4GB	Dedicated
Hard Disk	10GB	Dedicated

Table 1: Virtual Machine Specifications

The software configuration and versioning used in this trial was as follows:

Software Type	***Package***	***Version***
Operating System	CentOS Linux	7.2.1511
Scripting Language	PHP	5.6.19
Database	MySQL – MariaDB	15.1 – 5.5.47
Web Server	Apache	2.4.6

Table 2: Software Configuration

Given the scale of this trial, no caching or additional appliances were used to aid delivery. Despite this, the resource consumption and usage was monitored closely to ensure that the service was not overloaded or insufficient.

Note: As a result of this monitoring, it possible to report that the consumption never exceeded 50% during the duration of the trial. This is despite peaks of over 100 requests per second. More substantial reporting will be provided in a further deliverable.

2.1.3 Analytics

In order to monitor the usage of the application once deployed in the trial, an analytics platform was required to be used alongside the application itself. In this case, Google Analytics[3] was deployed. This involved including a small snippet of application code on the landing page of the application. Once the page was loaded, this code produced a callback to Google's infrastructure, which would automatically track that the application had been loaded.

A similar process was also used to monitor the loading of other pages and parts of the application; each with a unique ID, yet still utilising existing behaviour within Google's analytics platform. This was designed to track the loading of different pages, and examining those parts of the application visited most often. It is important to note that this technique does not provide any exact insight into how an application was used, nor how the user interacted with it - only that fact that the page was loaded by the client user.

This method of generating analytics relies solely on Google's infrastructure to realise the user counts and reporting of usage. It does not require the deployment of dedicated hardware or software solutions alongside the application, nor does it require any modification after the snippet has been included in the application code.

2.2 RBB Trial

A further trial was conducted by RBB. As with the previously describe configuration, this too was destined to run as part of a production service on an existing live TV channel.

2.2.1 Service Information Composition

The playout for this trial was realised through a partnership with ZDF, whom are responsible for the KiKA channel on which the application was deployed. However, this entity is nonetheless a separate organization to RBB, and as such, detailed playout information is not available.

2.2.2 Infrastructure

In much the same way as the Mediaset technical trial, the application delivered in the RBB trial uses virtualised computing infrastructure to deliver the application to Internet-connected devices. The web servers used to deploy this application were located within RBB's existing infrastructure provision, and as such, are deployed alongside other web services, such as their web presence.

It is important to note that, in the case of RBB, the German market is a much more mature environment for deployment and usage of HbbTV-based applications. As such, it is a well understood and common procedure to deploy and maintain application on-air. The MPAT application deployed as part of this trial

[3] Google Analytics: https://www.google.com/analytics

therefore coexisted alongside long-running and permanent services, deployed in the same, generic, manner.

2.2.3 Analytics

The RBB trial uses an alternative method of gather analytical data, namely Piwik[4]. This is an open source platform, and is self-hosted. This gives greater control and protection of the data collected through use of the platform, but does require additional overhead in terms of resource allocation and provision.

[4] Piwik: https://piwik.org/

Glossary

AIT	Application Information Table
PMT	Program Map Table
PAT	Program Application Table
SI	Service Information
PID	Packet Identifier

Partner Short Names

Short Name	Name
FRAUNHOFER	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. (DE)
IRT	Institut für Rundfunktechnik GmbH (DE)
RBB	Rundfunk Berlin-Brandenburg (DE)
ULANC	Lancaster University (UK)
MEDIASET	Reti Televisive Italiane S.p.A. (IT)
LEADIN	Leadin Oy (FI)
FINCONS	Fincons SpA (IT)
IMT	Institut Mines-Telecom (FR)

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