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D5.2: Large-Scale FMI Experiment Design in Broadcast, Gaming and Transmedia

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This deliverable describes the design and evaluation of experiments to demonstrate the potential of the FLAME ecosystem. This document is produced within the context of the activities related to WP5: Future Media Internet (FMI) Experimentation and Infrastructure Replication. The aim is to design, implement and conduct a series of pioneering FMI experiments in a range of vertical areas and expand experimental infrastructures through replication to cities around Europe. One of the objectives is to validate the FLAME Experimentation-as-a-Service (EaaS) proposition through a set of ground breaking FMI experiments in socio-economically important vertical sectors (Broadcast, Gaming and Transmedia) to ensure the FLAME ecosystem is ready for expansion in 3rd party project open calls.

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EXECUTIVE SUMMARY

The FLAME project is building new technical capabilities answering the ever-growing need for mobile applications supporting strong content exchanges and high quality of experience for the end users. In the deliverable "D3.1: FMI Vision Use Cases and Scenarios" [1], the FLAME consortium identified use cases that benefit from the FLAME platform. The selected use cases provide the basis to validate the FLAME Experimentation-as-a-Service proposition through a set of ground breaking Future Media Internet experiments in socio-economically important vertical sectors (Broadcast, Gaming and Transmedia) to ensure the FLAME ecosystem is ready for expansion in 3rd party project open calls. The goal of this deliverable "D5.2: Large-Scale FMI Experiment Design" is to describe the design and evaluation of experiments to demonstrate the potential of the FLAME ecosystem.

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ABBREVIATIONS

AAC	Advanced Audio Coding
AR	Augmented Reality
AWS	Amazon Web Services
CANVAS	Computer-Assisted Narrative Animation Synthesis
CCTV	Closed-Circuit Television
CDN	Content Delivery Network
CLMC	Cross-Layer Monitoring and Control
DASH	Dynamic Adaptive Streaming over HTTP
DB	Database
EaaS	Experimentation-as-a-Service
FLIPS	Flexible IP-based Services
FMI	Future Media Internet
HD	High Definition
HTTP	Hypertext Transfer Protocol
ICANVAS	Interactive Computer-Assisted Narrative Animation Synthesis
IP	Internet Protocol
KPI	Key Performance Indicator
LTE	Long-Term Evolution
MP4	MPEG Layer-4 Audio
MPEG	Moving Picture Experts Group
MR	Mixed Reality
NAP	Network Access Point
OTT	Over-the-Top
PIML	Personalisation, Interaction, Mobility and Localisation
PMM	Personalized Media Mobility
QoE	Quality of Experience

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QoS	Quality of Service
REST	Representational State Transfer
SME	Small and Medium-sized Enterprises
VoD	Video on Demand
WP	Work Package

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1 INTRODUCTION

This document is produced within the context of the activities related to WP5: Future Media Internet (FMI) Experimentation and Infrastructure Replication. The aim is to design, implement and conduct a series of pioneering FMI experiments in a range of vertical areas and expand experimental infrastructures through replication to cities around Europe. One of the objectives is to validate the FLAME Experimentation-as-a-Service (EaaS) proposition through a set of ground breaking FMI experiments in socio-economically important vertical sectors (Broadcast, Gaming and Transmedia) to ensure the FLAME ecosystem is ready for expansion in 3rd party project open calls.

The pioneering FMI use cases have been described in deliverable "D3.1: FMI Vision, Use Cases and Scenarios (v1.1)" [1] and have influenced the specification of FLAME as described in "D3.3: FLAME Platform Architecture and Infrastructure Specification (v1.1)" [2]. Section 2 of this document elaborates on the process of experimental design specification. The experiments are designed to use and evaluate FLAME's methodology and platform capabilities through experiments deployed at FLAME infrastructure locations.

Sections 3 and 4 describe two FMI validation experiment use cases within the broadcast vertical area. The two use cases explore the changing ways that consumers participate and access broadcast media on the move. The validation experiment "Participatory Media for Interactive Radio Communities" explores the role of an end user to generate media content and support the editorial process of live journalists. The validation experiment "Personalized Media Mobility in Urban Environment" explores adaptive follow-me streaming services across multiple devices and locations.

Sections 5 and 6 describe two FMI validation experiment use cases within the gaming and transmedia vertical areas. The two use cases explore interactive media services for storytelling and gaming. The validation experiment "Collaborative Interactive Transmedia Narratives" explores how to embed imaginative content in real-world locations and how edge computing infrastructure and services routing can dynamically synthesize and deliver content directly to consumers. The validation experiment "Augmented Reality Location-based Gaming" explores how a large-scale location-based city-wide game may use advanced content delivery and communication tools to deliver an engaging game that transforms everyday objects and locations throughout a city into interactive, animated game characters and locations.

Section 7 elaborates on the influence of FMI experiment design on the creation of a 3rd party ecosystem through open calls for additional FMI use cases and infrastructure replication. The experiments described in this deliverable provide the hands on experience regarding infrastructure, platform and application capabilities. The knowledge gained by FLAME partners will be used to monitor, mentor and support 3rd party experiment projects.

The results of experiments described in this document will be reported on month 24 of the project in deliverable "D4.4: Insights from Broadcast, Gaming and Transmedia Experiments".

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2 DESIGN SPECIFICATION OVERVIEW

The design specification of validation experiments is intended to support the aim of FLAME to establish a Future Media Internet (FMI) ecosystem based on the Experimentation-as-a-Service paradigm that supports large-scale experimentation of novel FMI products and services. This ecosystem provides adaptive experimental infrastructures, encompassing compute and storage facilities and underlying software-enabled communication infrastructure.

The pioneering FMI use cases have been described in deliverable “D3.1: FMI Vision, Use Cases and Scenarios (v1.1)” [1]. The deliverable also introduced how the use cases are designed to capitalize on emerging trends in software defined infrastructure, mobile edge computing, flexible service provisioning and routing that will form an integral part of FLAME capabilities. Those capabilities have been elaborated in deliverable “D3.3: FLAME Platform Architecture and Infrastructure Specification (v1.1)” [2], providing a detail specification of interfaces and high level capabilities of service layer components of FLAME.

The experiment design specifications contained in this deliverable focus on the four validation experiment use cases. Experiment design is specified in a common way. First, the experiments and related media services are described. The KPIs are identified as a tool to evaluate the performance of the FLAME platform for the specific contexts. This provides the basis for executing experiments under repeatable, controlled conditions allowing for observation of both objective and subjective performance characteristics of the FLAME-enabled applications. Second, the main assets of FLAME offering compared to existing OTT solutions are detailed. This highlights the additional capabilities offered by the FLAME platform. Third, the experiments are presented in the context of the intended FLAME infrastructure location, including a description of how constraints of the physical location influences the design. Finally, expected outcomes are identified, presenting how these experiments can be used to validate the FLAME platform in specific contexts and inspire other actors to join the project.

The results of the validation experiments will be described in deliverable “D4.4: Insights from Broadcast, Gaming and Transmedia Experiments”. The activities leading up to the generation of these results will inform the evolution of the FLAME platform development and creation of the 3rd party ecosystem.

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3 PARTICIPATORY MEDIA FOR INTERACTIVE RADIO COMMUNITIES

The validation experiments that VRT wants to perform are situated on a technical level, user experience level and conceptual level. A broadcaster has a basic need for considerate amount of bandwidth at the lowest possible cost. An editorial room of a live radio show is interested in user generated content but shuns the extra effort to monitor incoming media. An end-user wants to generate media content to interact and co-create without having to worry about cost or upload and load times being a show stopper. And what is the role of a journalist, in the broadest sense of the word, in a smart city?

As part of a first experiment, VRT will deploy a media ingest service with object recognition capabilities. This will serve as a basis for many future narratives starting with a first trial during the FLAME Summer school.

What all scenarios will eventually have in common is the ingest and transfer of large files so in the end, we have got a clear view on several metrics concerning bandwidth and speed of media content and quality analysis.

3.1 EXPERIMENT DESIGN

3.1.1 FLAME capable 'urban journalist' experiment

VRT wants to emulate an urban journalist with an HD camera and evaluate to what extend the platform can replace a mobile production unit. This will be achieved by connecting a camera to a laptop or microcomputer that splices the incoming video stream and sends 1 second fragments to the deployed media ingest service. During the experiment, different input video formats will be tested.

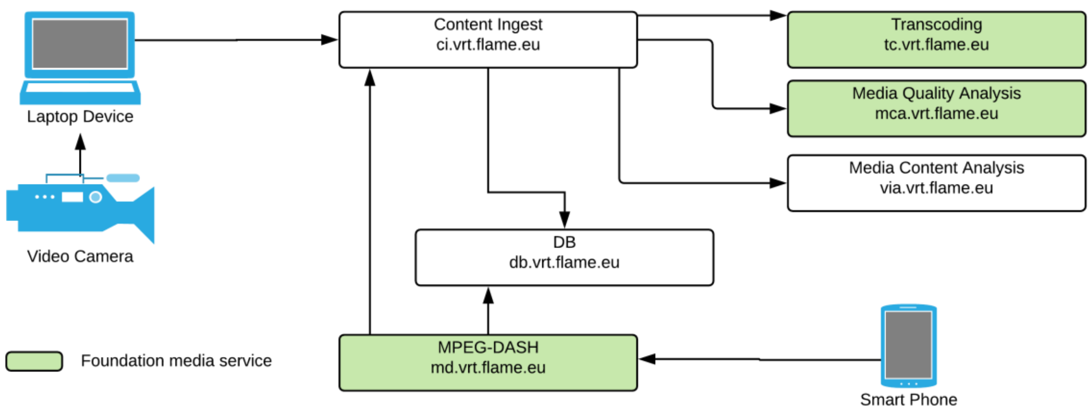

Figure 1: VRT media ingest and analysis

3.1.1.1 Media service design

The design started from the idea to emulate a stream by file upload through HTTP POST. A hardware module, which will be a laptop during the experiment, multiplexes the video and audio stream from the camera and splits it into 1 second sequences. The sequences are immediately offered to the

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service. If necessary, the module can perform lossless compression first before upload but as stated further in the experiment KPI's, we aim to upload raw HD video. Figure 1 shows the composition of the full media service that will be deployed. The ingested video is analysed on media quality, compression details and resolution and on content. This annotation data is stored in a database. The recorded streams are served through an MPEG-DASH service.

- **Content Ingest**. This component will accept a video file using the HTTP protocol via a REST API as input and will delegate it through the other components. It also functions as the main file storage location so it is not stateless.

- **Transcoding**. A service that does transcoding, transrating and conditioning of video files through HTTP using REST. This service that will transcode the video and audio to MP4 and AAC respectively and up to 3 different resolutions. This will enable the MPEG-DASH service to serve up to 3 different bitrates. These files are returned to the ingest component. A smaller video file can then be used to perform media content analysis.

- **Media Quality Analysis**. A stateless component that accepts a video file as input and performs objective video quality assessment. Information such as video codecs, framerate, resolution, audio codecs, and bitrate is returned as response.

- **Media Content Analysis**. Stateless component that will perform object detection. During the experiment, an already trained model will be used. The trained model will classify 80 different types of objects known as the common objects in context (COCO[1]) dataset. It will use the YOLO (You-Only-Look-Once) real-time object detection system. In the future, it should be possible to train new models depending on the requirements of the scenario.

- **DB**. A MongoDB service with replication capabilities.

- **MPEG-DASH**. 3 different bitrates are offered per stream. The user can choose from different streams based on source (e.g. Camera 1 feed) or content (e.g. bikes or cars).

[1] COCO – Common Objects in Context (http://cocodataset.org/#home)

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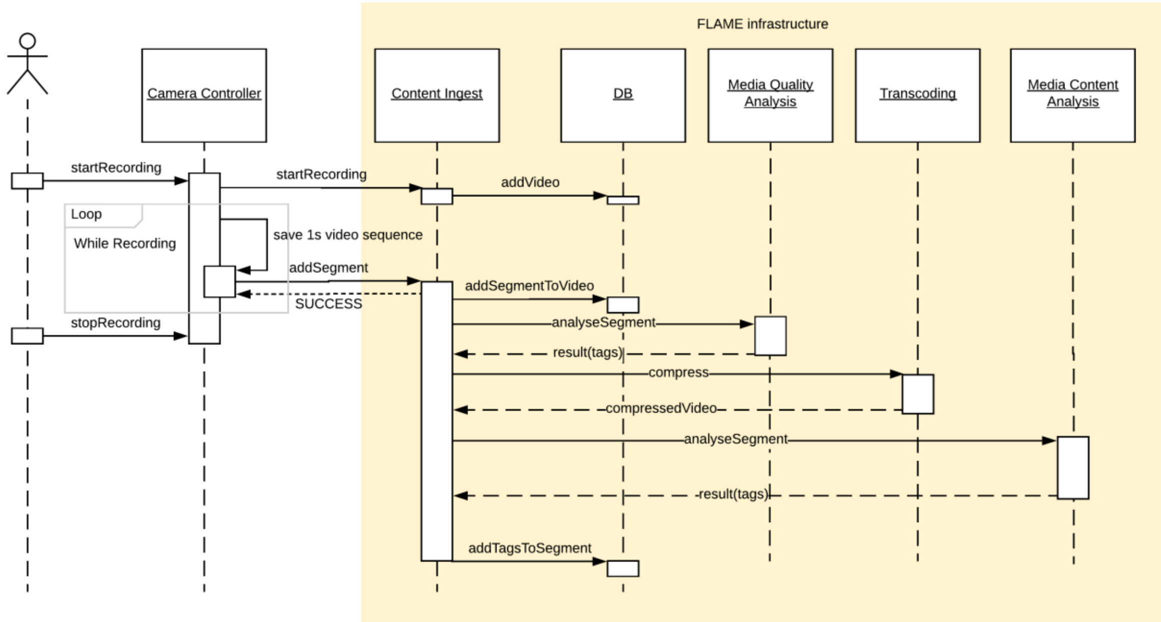

Figure 2: Sequence diagram of video ingest and analysis

3.1.1.2 Performance KPIs

The described experiment relies very much on the 1 second timeframe in which a single video sequence is ingested by the platform. We want to achieve a 'near' live experience for the media consumer. Every delay in the component chain will result in extra loading time or an end-of-stream. For all KPI's we will assume this one second timeframe. If all KPI's are reached, although this is not a requirement for this experiment, a multi-cam setup can be tested and evaluated.

- Ingest of 1 second raw (uncompressed) HD video
- Transcoding of 1 second raw HD video sequence into MP4/AAC and 3 different bitrates
- Object detection of 2 frames (the first and last frame) within a one second sequence.

These indicators will be measured during the first experiment using repeatable, machine based methods. During this lab test, the execution time of every service component will be measured and compared to the actual screen to screen latency.

3.1.2 Wall-of-moments

Wall-of-moments is a tool, or better yet, a toolset, that has been integrated into the mobile app of all the VRT radio brands. Listeners can send text, photo and video to the editorial rooms of the radio show. Editorial teams can send multicast messages to the listeners. The tool has already found its way into the daily production of the radio shows on two VRT radio brands targeting a younger audience.

It is proven to be a quite important extension to some radio shows and many variants of it have been developed to accommodate certain events. You might call it a continuously growing experiment enabler.

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The app is completely cloud based with services running in AWS and Google. A transcoding service that handles the uploaded video and some object classification. For FLAME, we would transfer both of the services to the edge. This is a perfect fit for our deployed media service from 3.1.1.1 as it is designed to handle file upload.

Because of the current capabilities we would use the wall-of-moments app to support two different trials: The flame summer school trial and the running event simulation.

3.1.2.1 FLAME Summer School trial: Urban Journalism

Journalism in the Future Smart City

In this chapter, we outline the activities of the participation of the VRT in the first FLAME summer school at Bristol UK, July 2018. In this summer school, VRT wants to explore new forms of journalism in this within the challenging context of the “Smart City Under Construction”. The future smart city is a city in transition to a more sustainable future. This city aims for a symbiotic life; wherein technology and social innovations empower each other. Therefore, this city gets the role of a social innovation platform. A platform that allows to explore new collaborations and construction of new relationships between researchers, citizens, entrepreneurs and the city council. In this context, VRT would like to explore the potential of new types of media, new types of formats, and new journalist practices.

TV for debate

Participants are divided in teams of 3-6 persons. Each team will play out the life of a TV studio. The TV Studio has to produce a reportage about Bristol in its transitions towards a smart city. The studio investigates future city challenges and works out several speculative design ideas (design for debate) in the context of their selected challenge for a specific neighbourhood in the city. With these design ideas at hand (physical and digital prototypes) a crew will collect in situ feedback via e.g. street interviews. A director, local in the town centre in an emulated OBV (Outside Broadcast Van) or in a classroom at the summer school premises (Broadcast Centre), will assist and direct the crew remotely. Live interactions are captured and can be used in the final edit of the reportage.

Each TV Studio reflects on the cost of their activities and the benefits of the used FLAME services. Each TV Studio also reflects on future services which FLAME could offer in the light of what has been experienced or in the light of future media practices. Two examples can be put forward to trigger the creative engineering process: “Smart Media File Transfer”, and “Virtual Life Stream (Smart) Director”. These services illustrate the potential benefits of the FLAME platform in order to improve current broadcast practices in the field in the area of cost reduction and creative support for creating new live event formats.

Festival of the Future City

Participants are asked to create a common statement, assembling their experiences and insights. Participants are invited to post their statement at the upcoming “Festival of the Future City October 2019, Bristol UK”. If more time is needed to finalize this post, the summer school organization will setup an agenda allowing the participants to further develop and finalize.

3.1.2.2 Running event simulation

The main features needed for the running case are:

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- **Personalization**: All participants are identified by scanning the number they are wearing in an object detection service. At the end of the event, each contestant is given a link where they can watch a montage of their personal run.
- **Interactivity**: Spectators can choose who they want to follow and are given updates on where their friend or family member is running.
- **Mobility**: These functions should be enabled along the complete course of the run.
- **Localization**: Passing certain points can trigger certain events, e.g. showing live video on a public screen along the course, or sending notifications to spectators further on the track.

<u>Simulation</u>

When we do experiments with the wall-of-moments we normally do this during an event of radio or television show. This means that we are or can be involved during every step of the (pre-)production. Plus, there is a connection with the targeted audience already. The audience trusts the radio brand and is also critical. There is an involvement and interest in interactivity that we don't need to enforce on to the participants, which is an enormous advantage. In Bristol, or Barcelona, however, there is no such liaison so as far as the trial goes, we will have to simulate everything. This is why, instead of really attending a running event, we want to try out the features needed by using them in a game.

- **Personalization**: Each contestant has a number on them that is registered within the game. The number is tied to a historical figure from Bristol together with some background information. Nobody knows who she/he is. Scanning the number of a contestant will reveal her/his identity. The goal is to 'capture' somebody at the correct location.
- **Interactivity**: By scanning, information about the character is revealed.
- **Mobility**: It is a game where people will be moving around different areas in the city. The services should be available in every zone.
- **Localization**: The game has also information stored about specific locations. Each location is matched to one historical figure. Capturing the contestant at the right location is key. The FLAME API should be able to tell the location of the uploaded video.

3.1.3 Future experiment: live journalism

The scenario of the urban journalist is an actual use case that has been adapted to fit the FLAME platform. The goal is to explore to which extend of the FLAME platform could stand in for a mobile production unit. You could argue that this is a form of edge computing already. The unit receives all local streams, performs quality analysis and chooses which stream to forward to the studio. This reduces bandwidth (cost) as only one stream is sent but still comes at the price of deploying the unit.

A main selling point for a broadcaster would be to have this same functionality at lower cost. The first requirement of the platform would be to be able to handle the same flow from figure 1 with streams instead of file upload. Keeping a steady data flow is more important than reliable delivery. Some advanced media quality analysis like shakiness detection and sound analysis work better on streams.

Of course FLAME can handle all protocols over IP but is limited in replication functionality when it comes to the typical protocols used for streaming like UDP. There are also no foundation media services currently in the pipeline that will make use of streams.

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3.1.4 Experiment and trial summary

Table 1: VRT Experiment and Trial Summary

Scenario #	Scale	Key demonstration points
1	**Experiment** *Lab*	**FLAME capable 'urban journalist' experiment**
2	**Small Trial** *5-10 users*	**Summer School Trial**
3	**Small Trial** *5-10 users*	**Running event simulation**
Optional	**Experiment** *Lab*	**Future Experiment: Live journalism** Focus on end-to-end live streaming services

3.2 EXPLOITATION OF FLAME METHODOLOGY AND PLATFORM CAPABILITIES

The experiments focus on the possibility of getting the video in the edge and performing on-the-fly operations on it. The FLAME platform provides the necessary future media services to perform transcoding, transrating, media quality analysis and storage of video files and meta-data. The Wall-of-moments scenarios; Urban Journalism and the running event simulation, can benefit heavily from the quick service provisioning and video conditioning the platform offers.

Aforementioned scenarios are file based over HTTP just like the current media services that will be deployed. However, many of the real-world use cases for live journalism implicate setting up a live video stream. VRT wants to explore the road of stream capable services together with the future media service providers. Part of the validation experiment is to test the FLAME platform capabilities and to envisage future improvements.

3.3 DEPLOYMENT AT FLAME INFRASTRUCTURE

3.3.1 Physical

The FLAME infrastructure, mapped on the physical city infrastructure, led to the development of the game scenario in 3.1.2.2. Because there is no overlap between NAPs the city is divided into zones. This directly had impact on the idea of mapping historical information to the NAPs.

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In the scenario of urban journalism, this lack of coverage overlap could become an issue when an interesting story subject is moving out of Wi-Fi or LTE range. This fact should be made clear to the students during the summer school trial.

In addition to the Wi-Fi and LTE coverage there is the possibility of accessing the network through cable, with consent of the City Council. This could prove an interesting advantage in future scenarios, when professional journalists need to perform a live stand-up and network reliability is of the most importance.

3.3.2 Technical

The following functions will be deployed at Bristol. They will be offered as a Docker container or VM image

- **Content Ingest** (Java based REST-server)
  - Virtual machine characteristics:
    - Processors: 2vCPU Intel type, 2.4 GHz or better
    - Memory: minimum 4GB RAM
    - Storage: minimum 200 GB
    - OS: at least Ubuntu 16.04 LTS

  Summary: High network bandwidth demand, low delay variation, low end-to-end latency, low computational.

- **Media Content Analysis** (Python - Tensorflow)
  - Virtual machine characteristics:
    - Processors: 4vCPU Intel type, 2.4 GHz or better
    - Memory: minimum 8GB RAM
    - Storage: 8 GB for image
    - OS: at least Ubuntu 16.04 LTS

  Summary: High network bandwidth demand, low delay variation, low end-to-end latency, high computational demand.

- **Transcoding, Transrating and Conditioning**
    - Provided by ATOS
    - VM specifications not yet known

  Summary: High network bandwidth demand, low delay variation, low end-to-end latency, high computational demand.

- **Media Quality Analysis**
    - Provided by ATOS
    - VM specifications not yet known

  Summary: High network bandwidth demand, low delay variation, low end-to-end latency.

- **Database** (Mongo DB)
    - Provided by ATOS
    - Docker image. Specifications not yet known

  Summary: Low network bandwidth demand, medium end-to-end latency, low computational.

- **MPEG-DASH**
    - Provided by ATOS

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- VM specifications not yet known

Summary: High network bandwidth demand, low end-to-end latency, low computational.

3.4 EXPECTED OUTCOMES

Live broadcasting over IP has been a challenge for a while. It is hard to have reliability, (bandwidth) cost and latency meet in the middle. The experiments conceptually focus on both sides of the news delivery process:

- Ingest of content: where traditionally ultra-low latency beats cost
- Broadcast content: where cost beats latency

Upon the traditional chain of content delivery, we want to experiment with a complete media analytics chain.

- **Technical outcome**
    - Experiment if FLAME can offer a possible solution in the IP latency debate.
    - Better understanding of media services and how they add to the screen to screen delays.
    - Low latency on multi-cam live stream
        - Instigate the debate on enabling services with a streaming protocol (UDP, RTP, WebRTC, etc.)
- **Business outcome**
    - Validate the use of media analytic services in the edge.
    - Better control of media transport based on accurate cost prediction.
    - Lower production cost: from journalist to editorial room.
    - Lower broadcast cost: from editorial room to public.

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4 PERSONALIZED MEDIA MOBILITY

This experiment focuses on the Personalisation, Interaction, Mobility and Localisation (PIML) aspects of the media distribution in the Smart City. In particular, we are building a platform and experiments to evaluate how media service providers can serve users on the go within the Smart City taking benefit of some key FLAME platform services like:

- Intelligent service endpoint management
- Dynamic service routing to direct traffic to the most appropriate local service instance
- Reduction of network traffic through localizing traffic wherever possible, also addressing the aforementioned latency reduction.

The PMM experiment aims to validate how FLAME can allow to go beyond the traditional content delivery network (CDN) architectures currently available for media distribution over IP, and test a PMM service over the FLAME platform deployed in Barcelona (Spain) to evaluate which surrogate functions for media distribution can be better used to serve various endpoints in the FLAME-empowered Smart City.

In our PMM experiment, end-users can get access to their personal contents and interact with the origin media server from anywhere. On top of the FLAME platform we will manage to have media distribution service chains automatically deployed and adjusted while users move in the Smart City and reach areas covered by FLAME network access points.

4.1 EXPERIMENT DESIGN

The main goal of the PMM experiment is to test an adaptive follow-me media streaming services across multiple devices and locations in the Smart City.

This goal translates into investigating how the FLAME platform can impact on personalized media distribution with a specific interest in four main aspects:

- FLAME platform mechanisms for intelligent service endpoint management
- Dynamic service routing to direct traffic to the most appropriate local service instance
- Support for cross-layer optimizations and reduction of network traffic through localization of traffic wherever possible
- Support of fully secured surrogate media distribution service endpoints

A detailed description of the experiment rationale, narrative storylines, stakeholders and requirements has been provided in Deliverable D3.1: FMI Vision, Use Cases and Scenarios (v1.1) [1].

Starting from that standpoint, the PMM experiment has been designed to cover incrementally up to three scenarios to be deployed in the City of Barcelona with increasing system complexity and number of involved end-users:

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- **Scenario 1: PMM distribution in walking areas in Barcelona**, i.e. my screen & preferences follow me from home to my smart hand-held devices to continue media consumption while walking in the Smart City

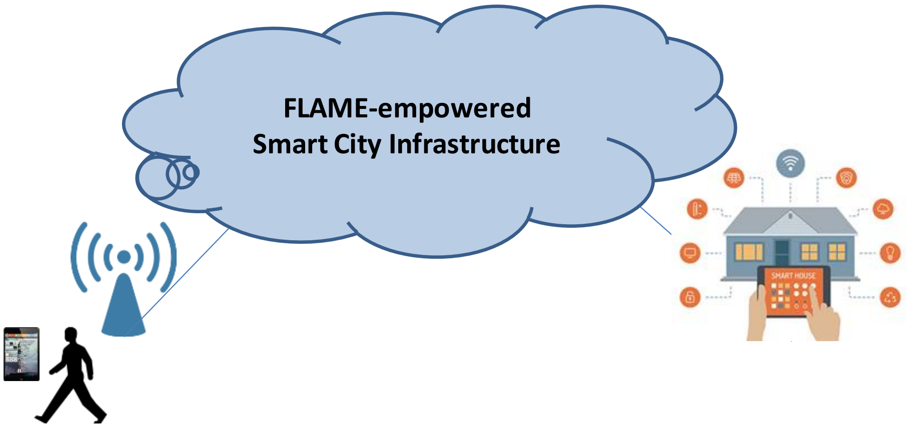

Figure 3: PMM Experiment Scenario 1 -Distribution of personal media in walking areas in Barcelona

- **Scenario 2: PMM on aggregation areas of the Smart City**, i.e. my media follow me also in aggregation area (e.g. shop, cafeteria, and mall), and surrogate functions for media distribution are allocated in edge nodes for more users.

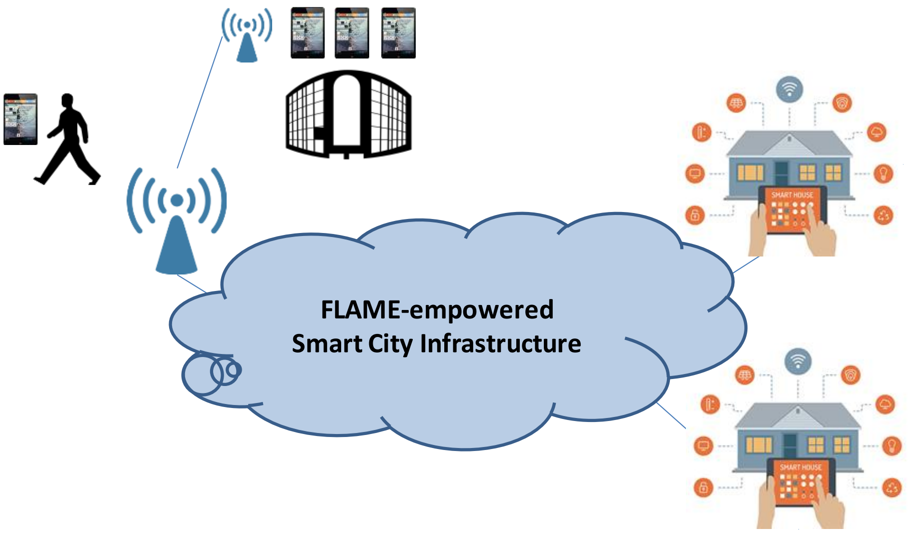

Figure 4: PMM Experiment Scenario 2 -Distribution of personal media in aggregation areas of the Smart City

- **Scenario 3: PMM in digital signage posts**, i.e. access to media contents from large public events in the Smart City at digital signage posts and swipe them in the personal device.

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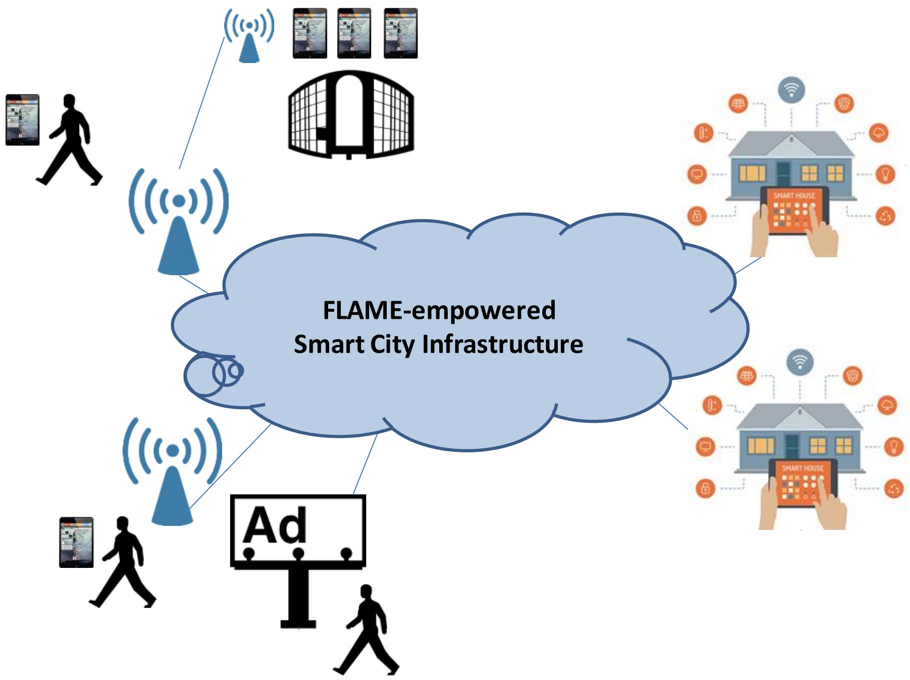

Figure 5: PMM Experiment Scenario 3 -Distribution of public media contents in digital signage posts in the Smart City

The planned experiment size and key demonstration steps are described in the following **Error! Reference source not found.** for the three scenarios.

Table 2: Characteristics of the PMM experiment scenarios

Experiment scenario #	Scale	Key demonstration points
1	**Very Small** *1-5 users*	**"My screen follows me" from home to smart hand-held devices in the Smart city** • User swipes media from a fixed video/audio device at home to personal mobile devices (e.g. tablets, smartphones) and move within the FLAME urban area • The OTT application is capable to invoke the FLAME platform APIs to instantiate content caches and media service chains to continue streaming on the move • *[Complimentary] My preferences follow me*: I can resume my playlist (music or video) from where I paused while I'm on the move
2	**Small** *10-50 users*	**"My screen follows me" from home to public aggregation areas in the Smart City** • User swipes media from a fixed video/audio device at home to

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		personal mobile devices (e.g. tablets, smartphones) and move within the FLAME urban area • User uses public transportation or is in an aggregation area (e.g. shop, cafeteria, mall) and FLAME content caches and service chains are re-allocated to serve him/her
3	**Live in public event** *50+ users*	**"The Congress Eye"** • Delegates can consume video streaming (live and recorded) from various sources (cameras) at the Congress centre on their personal devices while moving in the Smart City • The same library is available at digital signage posts installed at public places in the Smart City • Digital signage posts can be used for location-based services to citizens and delegates

The successful execution of the scenario #1 and scenario #2 will represent a minimal target for achieving a significant validation of the PMM experiment in the City of Barcelona.

4.1.1 PIML aspects under evaluation

As reported in D3.1, the PIML aspects of particular interest during the execution of this PMM experiment can be summarised in:

- **Personalisation.** The user can select the personal devices through which he can consume the media while moving within the urban area and activate by swiping on the remote control the join of the media stream over the selected device. In case of CCTV streaming, the user can select the camera from which to stream and remotely control zoom, pan/tilt etc. to implement a personal view of specific zones under control and record
- **Interactivity.** The user can manage personal contents and configure preferences for the service e.g. to access live CCTV contents from video-surveillance cameras and tilt, pan, zoom-in/out, to stream specific formats, etc.
- **Mobility.** While the user moves from one cell/network access point to another one, the media delivery service chains need to be dynamically re-adapted to continue streaming the selected media with the committed QoS/QoE levels.
- **Localisation.** The location information exposed by the FLAME platform (e.g. user attached to a specific network access point, in a specific city zone, etc.) can be used to infer a derivative proximity information, and e.g. generate location-based services for e.g. advertisement/notification when close to a shop/mall, according to user preferences

4.1.2 Performance measures

The experiment metrics to collect and monitor in the various scenarios of the PMM will include the following metrics:

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- QoS parameters to measure on media server side:
  - **Average Bit Rate** – i.e. the average bandwidth being consumed by the video stream from origin server to the client viewing the content. This value will be measured at the various caching surrogate functions, and reported into the Cross-Layer Monitoring and Control (CLMC) module for further elaboration, decision for optimization and visualization
  - **Round-Trip Delay** – i.e. the average/min/max propagation time between the media client and the server. This value will be measured between the various caching surrogate functions and reported to CLCM for computation and optimization
  - **Number of active connections** – i.e. the number of active connections on the caching functions, as a measure of the number of streams served by the cache
  - **Cache hit ratio** – i.e. the ratio of cache lookups which have been satisfied by the in-memory cache**.**
- QoE based metrics
  - **Start Time** – i.e. the elapsed time from when "play" is pushed to when video starts on the screen
  - **Re-buffer Rate** – i.e. the number of times a re-buffering event occurs during viewing
  - **Mean Opinion Score** – i.e. users' perceptive evaluation in the range 1 (bad) – 5 (excellent) of the media streaming perceived quality.

4.2 EXPLOITATION OF FLAME METHODOLOGY AND PLATFORM CAPABILITIES

The PMM experiment is realized by using a number of functions split between the core data centre infrastructure and the street cabinets deployed in the City of Barcelona.

The Personalised Media Origin Server, representing the home-based media streaming platform (based on Symphony by Nextworks), will be deployed at the core data centre of the FLAME infrastructure and specifically located at i2CAT's data centre facility in Barcelona. This media element will include functions for configuring and managing user preferences, transcoding of media contents at various quality levels, and provide mechanisms to access the media library (Catalogue Access).

The Origin Streaming server will be connected through the FLAME platform (using the FLIPS routing) to the street cabinet for FLAME edge computing, emulating various NAPs and a local media library with local cache.

End users will connect to the FLAME infrastructure via the Wi-Fi network configured on the lampposts and directed by FLIPS routing to the more convenient local cache in terms of QoS targets.

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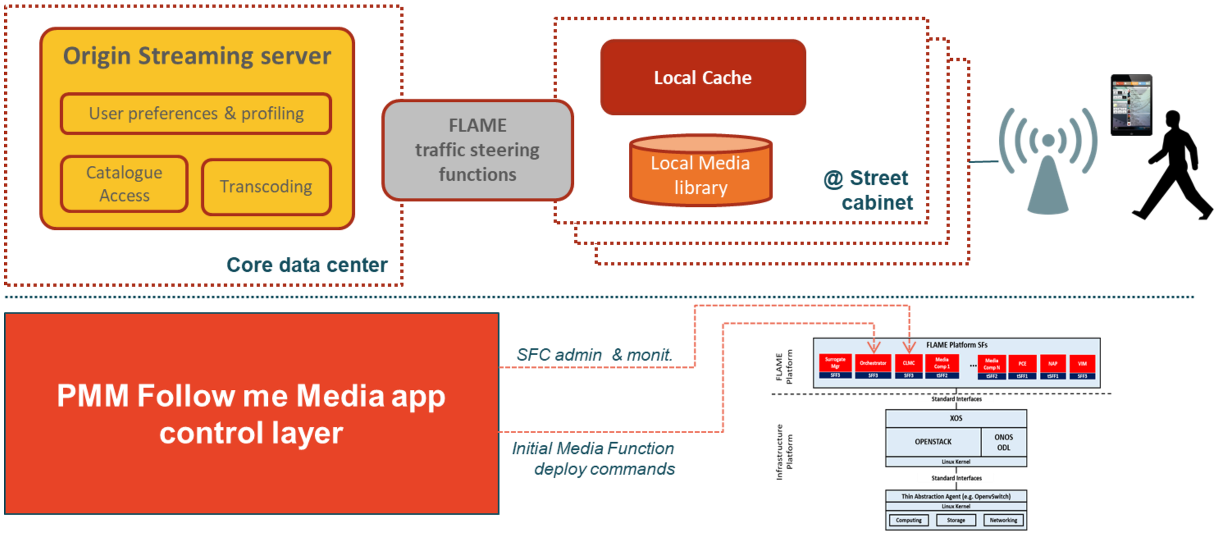

Figure 6: High level architecture of the PMM Experiment

The experiment control will be implemented through a PMM "Follow Me" Media application, which is responsible of interacting with the FLAME platform APIs to instantiate the initial service function chains, activate and retrieve monitoring data on media streaming performances, manage the lifecycle of the media service and eventually terminate it once the experiment is over.

4.3 DEPLOYMENT AT FLAME INFRASTRUCTURE

The deployment of the PMM experiment in the Barcelona FLAME infrastructure is planned to use some key media functions to be delivered for integration as per following summary:

- **Origin Streaming Server** (based on Symphony media server by Nextworks)
  - Virtual machine characteristics:
    - Processors: 4vCPU Intel type, 2.4 GHz or better
    - Memory: minimum 8GB RAM
    - Storage: minimum 200 GB for central media library
    - OS: at least Ubuntu 16.04 LTS
    - Networks: 1 interface gigabit network equivalent for streaming + 1 interface for server control
  - Number of instances: 1
- **Local Cache** (based on Apache Traffic Server)
  - Virtual machine characteristics:
    - Processors: 2vCPU Intel type, 2.4 GHz or better
    - Memory: minimum 2GB RAM
    - Storage: minimum 100 GB for local media library
    - OS: at least Ubuntu 16.04 LTS
    - Networks: 1 or 2 interfaces gigabit network equivalent for streaming + 1 interface for server control
  - Number of instances: 3
- **Transcoding, transrating for MPEG-DASH** (based on ffmpeg)
  - Virtual machine characteristics:
    - Processors: 2vCPU Intel type, 2.4 GHz or better
    - Memory: minimum 2GB RAM

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        - Storage: minimum 30 GB for local media library
        - OS: at least Ubuntu 16.04 LTS
        - Networks: 1 interfaces gigabit network equivalent for streaming + 1 interface for server control
    - Number of instances: 3
- **Client media app**
    - Media application for Android/IOS connect to the cached media server
    - Number of instances: as many as end-users

The planning of the experiment at the time of writing this deliverable is based on the deployment of local caches in VMs to be hosted in the four NAPs instantiated virtually in the server in the FLAME street cabinet in Calle Pere IV; origin media server and transcoding/transrating hosted in VMs deployed in the main DC in Omega Building. For scenario 2 and 3 discussions are ongoing to identify a local business in the Calle Pere IV where to host a fixed instance of the NAP to run the scenario in aggregation areas.

Use of foundation media functions from FLAME WP4 is also under evaluation to complement and/or preliminarily test media distribution functionalities in FLAME platform with FLIPS.

4.4 EXPECTED OUTCOMES

The experiment is designed to primarily provide results on technical and business feasibility of the PMM scenarios based on the "Follow-Me media". Two viewpoints are to be considered:

- The Media/VoD service provider perspective, e.g. the role and benefits of a broadcaster using the FLAME infrastructure to serve their Smart City customers
- The Media/VoD technology provider, e.g. a solution provider like Nextworks who intends to validate a media product offering in an experimental facility like the one built through FLAME.

The expected outcomes from the experiment in the City of Barcelona can be grouped in two major categories:

- Technical outcomes, to achieve
    - A better understanding of the mechanisms to optimize bandwidth and resources among the core and edge parts of the city infrastructure
    - The assessment of the feasibility of personalised media streaming services in the software defined infrastructures
    - An evaluation of the benefits of the FLAME benefit through FLIPS routing among surrogate functions with respect to traditional Content Distribution networks
- Business feasibility outcomes, to evaluate
    - The user acceptance and interest in such PMM service, through the trial phases in public areas.
    - The applicability of a PMM service model to Smart Cities, e.g. to stimulate new offers for value-added touristic services by the municipalities or for enhanced user information streamed via various devices and access points (e.g. digital signage totems)

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Further analyses of the collected results will be elaborated in D4.4 “Insights from Broadcast, Gaming and Transmedia Experiments”.

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5 COLLABORATIVE INTERACTIVE TRANSMEDIA NARRATIVES

The validation experiments of DRZ, also called "City-wide Storytelling", utilises the FLAME platform to explore interactive media services for storytelling within urban environments. Imaginative story content is embedded in real-world locations in close proximity to FLAME infrastructure. Location-based media services make it possible to efficiently deliver multimedia assets to the consumer. The story is experienced through a mobile device, which augments physical locations with story content (e.g. images, videos and 3D renderings). The user experiences a branching, interactive narrative within a branching city environment. The user is able to influence the narrative progression and a record of the personalized narrative experience is saved.

5.1 EXPERIMENT DESIGN

The goal is to explore how to leverage FLAME media services to enable a user to experience a branching, interactive narrative within a branching city environment as depicted in Figure 7. This section describes several of the system capabilities influencing the design of the validation experiment.

Figure 7: Experience a branching, interactive narrative within a branching city environment.

5.1.1 City-wide storytelling requirements

The city-wide storytelling scenario includes the following components that rely on FLAME:

- **Story Computations** – A story engine is required for users to experience an interactive narrative. DRZ had previously developed a system for computer-assisted narrative animation synthesis, called "CANVAS: Computer-Assisted Narrative Animation Synthesis" [3]. The system uses a formal representation of a story world to enable computer assisted generation of 3D animated stories. In the context of FLAME, DRZ has been developing an interactive

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version of the system, called "iCANVAS", which enables the computer-assisted telling of interactive stories. With iCANVAS, the user may be represented as a character in the story, has agency to interact with the story world and influence narrative progression. Interactive stories are pre-authored and then consumed based on user participation. Virtual characters may guide the user to experience an author intended narrative.

In the context of city-wide storytelling, elements of the story (e.g. characters, props and places) are associated with physical locations of a city, which are in proximity to FLAME-enabled infrastructure.

- **Authenticated Mobile Application** – A user experiences the personalized interactive narrative through a mobile application, which makes it possible to experience the narrative while moving through the city. The user is authenticated via the application in order to have a personalized narrative experience. The mobile application augments the visualization of physical locations with virtual, animated characters and props as depicted in Figure 8. The characters and props are primarily pre-authored based on the possible narratives. Narrative progression is then influenced by the physical locations that the user chooses to visit and also on virtual character interactions.

  The mobile application provides the AR visualization to augment physical locations with virtual narrative content (e.g. video, audio, and 3D rendered content).

- **Delivery of Media Services** – The citywide storytelling application presents multi-media content as part of the storytelling process. Some of the content is video, audio or text, while other story content is based on virtual 3D renderings of animated characters and props. A primary design concept is to not require the mobile application to have all content to be preloaded. Such a requirement would require significant preloading of assets and would not be flexible to dynamic changes in narrative content. The aim is to utilize an efficient mechanism for loading of multimedia content according to the personalized narrative experience.

  In the context of city-wide storytelling, the scenario requires that a geo-distribution of multimedia content is used to augment physical location.

- **Content storage and retrieval** – One of the aims is to record the unique, personalized experience of the user. If previous objectives are reached, a stretch requirement is to record and store a user's actual AR experience of the virtual content imposed on physical locations. This content could be stored on the server and used to generate a summary of the city-wide storytelling experience.

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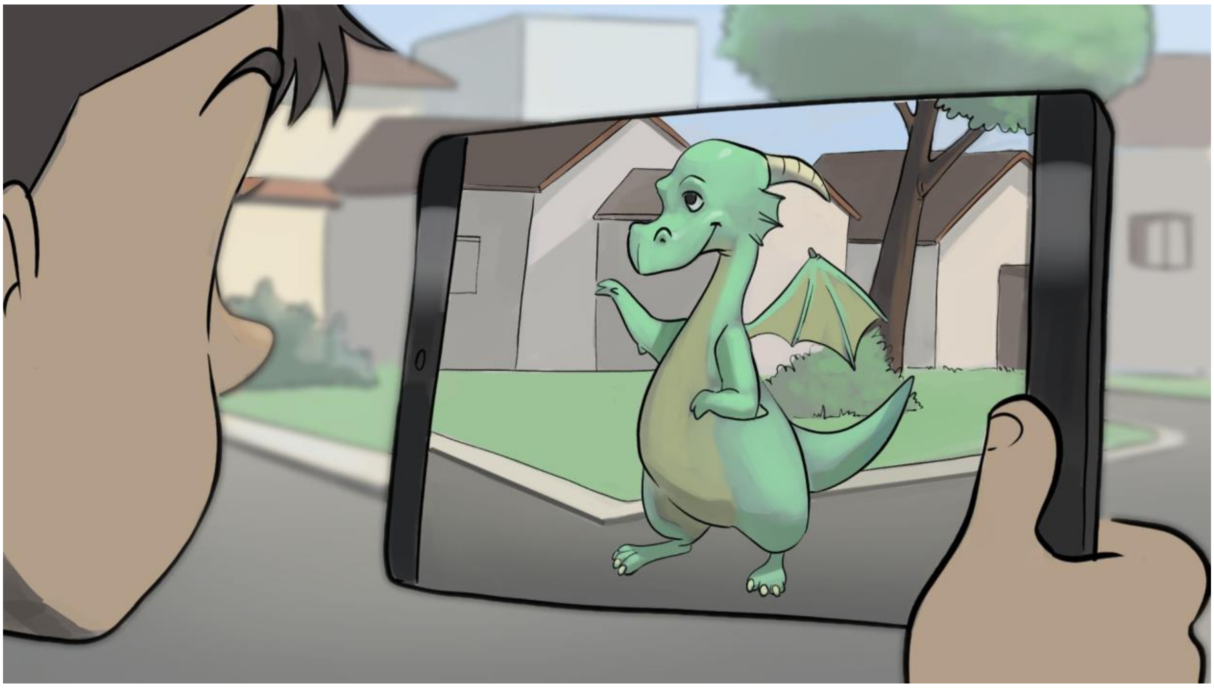

Figure 8: A mobile application provides the interface to experience the story. Virtual characters enact the narrative and guide the user to participate.

5.1.2 Definition of KPIs

Requirements of the City-wide Storytelling scenario introduce the following KPIs for the FLAME platform:

- **Authentication** – A user should be registered within the system in order for the story computations to generate a personalized narrative.
    - A user authenticates via the FLAME-enabled storytelling application.
- **Storage** – The interactive narrative exists within a story world, which is composed of multimedia assets related to the narrative. These assets will be stored in the platform. Storage requirements vary according to the media type (e.g. video, images, text, 3D models, 3D animations).
    - The platform should provide 1 – 5 GB of storage capacity to account for the storage of 3D models, animations, and video content.
- **Availability** – The narrative progression will be influenced by the user going to physical locations. The multimedia assets associated with the narrative of a particular location will be available for download at that location.
    - Approximately 10 – 500 MB of multimedia assets may be downloaded at a particular location in the city. This multimedia content should be available for fastest possible download to the mobile device. The duration will be measured from the client device.
- **Processing** – Story computations determine the narrative progression and which assets are required at a particular location.
    - Story computations will determine the process of front-loading multimedia content at particular locations within the FLAME infrastructure.

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- **Storage of user generated content** – The users experience will be recorded. The minimum requirement is to record the locations visited and narrative experienced. A stretch goal includes a video recording of the user's actual AR experience as visualized through the user's mobile device. This would include the virtual content superimposed on the captured visualization of the physical environment.
    - The user's physical locations visited and narrative experience is recorded. Storage requirements will be minimal as this will be stored as a story graph containing metadata and not the actual assets.
    - The stretch goal of recording the user's AR experience would require enough storage to record the audio and visual experience of the user.

5.1.3 Experiments and measurement of KPIs

A minimal set of experiments are summarized in Table 3. These experiments are intended to test the core functionalities of the city-wide storytelling experience. Experiment scenario #1 will explore the story computations and frontloading of assets on a small scale. The experiment will occupy a small area and persist for a number of days in order to test system capabilities. Experiment scenario #2 will explore a larger narrative that occupies more area of the urban environment. This area is determined by constraints imposed by the FLAME enabled environment described in Section 5.3. The experiment duration will persist over weeks to collect data from users. Experiment scenarios #1 and #2 will measure the previously described KPIs associated with authentication, storage, availability and processing.

Experiment scenario #3 explores the storage and retrieval of the user's personalized experience. At a minimum, this will explore the construction of a story graph associated with the user's personalized experience. This story graph will be used in a post process to create a video summary that depicts the locations visited and visualizes the virtual narrative presented to the user. A stretch goal is to explore the storage and retrieval of the AR visualizations of the user. This will represent the user's actual experience with the narrative. As a post process, the user generated content will be mixed with the pre-existing narrative.

Table 3: Minimal experimental trials of the City-wide Storytelling scenario.

Experiment scenario #	Scale	Key demonstration points
1	**Small**	Technical validation of story computations and asset frontloading
2	**Urban**	User validation in a real environment with focus on user experience (story computations and asset frontloading)
3	**Urban**	User validation in a real environment with storage and retrieval of user's personalized experience

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5.2 EXPLOITATION OF FLAME METHODOLOGY AND PLATFORM CAPABILITIES

One of the primary aims of the City-wide Storytelling scenario is to exploit the ability to utilize **low latency content services** offered by the FLAME platform. This is achieved by the **front-loading of multimedia assets** to FLAME Network Access Points. Multimedia content can then be made available for retrieval within the physical location where it will be consumed. For the City-wide Storytelling scenario, the determination of where content will be physically consumed is based on the pre-defined interactive narrative as well as the interaction patterns of the user.

5.3 DEPLOYMENT AT FLAME INFRASTRUCTURE

The City-wide Storytelling experiments aim to create a branching, interactive narrative within a branching city environment. The FLAME infrastructure in Bristol offers a branching topology of coverage in the city centre. BRISTOLOPEN is supporting scenario development by providing details about physical infrastructure utilized by FLAME as well as surrounding physical city infrastructure that may be integrated within the creative concept of the interactive narrative.

FLAME infrastructure in Bristol offers both Wi-Fi and LTE-based coverage over several high-traffic pedestrian areas within the city centre. The City-wide Storytelling experiments will steer users to locations in close proximity to these coverage zones in order to utilize maximal bandwidth and low latency access to multimedia assets stored in the FLAME NAPs.

The Bristol City Council provides a web application (http://maps.bristol.gov.uk/pinpoint/) that offers a map-based interface to historical information about Bristol. Images and text are integrated to describe the historical significance of physical locations and entities within Bristol. BRISTOLOPEN is supporting the identification of physical entities, including buildings and objects (e.g. statues and signs), that are located in proximity to FLAME infrastructure NAPs. Some of the physical entities are being integrated into the narrative as part of the creative concept while others are being utilized to provide visual cues supporting AR visualizations.

5.4 EXPECTED OUTCOMES

The City-wide Storytelling scenario aims to demonstrate how the FLAME platform offers unique capabilities for intelligently and efficiently delivering multimedia assets within an urban environment. The scenario offers the ability to directly explore FLAME capabilities to, for example, provide asset frontloading. The scenario also offers opportunities to indirectly explore the design of urban scale interactive narratives and observe how users can be guided to have an interactive experience that incorporates physical locations.

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6 AUGMENTED REALITY LOCATION-BASED GAMING

The Game Technology Center of ETH Zurich implements “Gnome Trader”, a city-wide location-based video game with strong augmented reality components. In this game, journal boxes located all over the city are augmented to become trading locations where the players can exchange seeds with gnomes. The players can then use the seeds to plant trees and create gardens anywhere in the city. Later on, the players can come back to these gardens to collect rewards.

This section presents the requirements of this game, in particular in the context of FLAME; and the different experiments that will be conducted to evaluate the performances of the platform in different gaming conditions.

6.1 EXPERIMENT DESIGN

Gnome Trader involves several novel game mechanics which can benefit from a high performance underlying network. Played by users during their daily commutes, Gnome Trader requires the network to adapt to the variations of positions and densities of players. Moreover, these moving players request access to large data such as 3D models and expect to experience an uninterrupted gameplay. As a consequence, the requested content should be available close to the players’ locations, and, in some cases, even follow the players as they move in the city.

Overall, there are many ways in which the Gnome Trader game mechanics depend on the performance of the network. The experiments presented in this section have a dual goal of assessing the performance of the FLAME platform, and ensuring the game requirements are met to provide the best player experience.

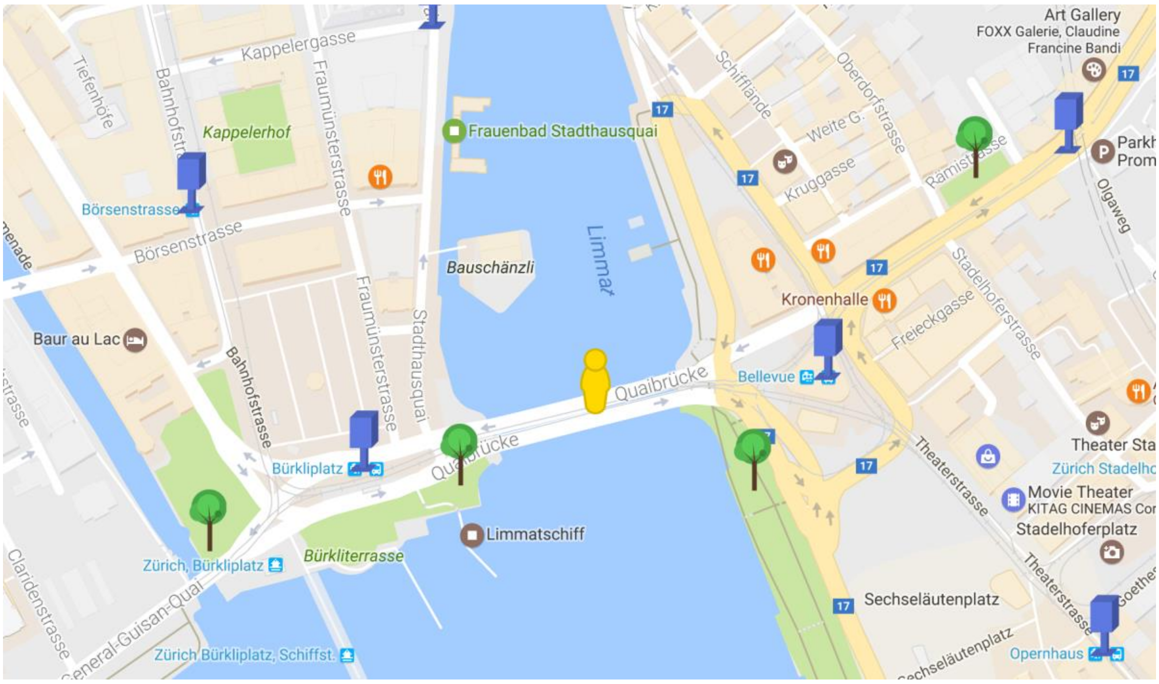

Figure 9: Example of distribution of the trading locations (in blue) and gardening locations (in green) on the map.

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6.1.1 Game requirements

The game presented in this scenario includes three different game mechanics strongly relying on FLAME:

- **Trading** – Players can access "trading locations" positioned at the journal boxes around the city. Here players exchange seeds from their inventories against other seeds from the trading location inventory. For each seed, players can request an overview of the tree the seed ought to become if planted.

  For each trading location, trading requires the trees corresponding to the seeds in the location's inventory to be available to all nearby players.

- **Gardening** – Players can create and explore "gardening locations" positioned anywhere in the city. These locations contain trees planted by the players. Such trees grow, age, and die. In each gardening location, the trees planted at the location are displayed to the players with their correct age. The players can also plant new trees from their inventory and visualize the result.

  For each gardening location owned by a player, gardening requires the trees planted at that location to be available to the player when close by. Moreover, gardening requires a back-end update of all the planted trees to make them age according to predefined rules.

- **Crafting** – At any time, players can go in their inventory and request a preview of the trees corresponding to the seeds they own. Players can also mix seeds together to create new seeds. Once the crafting is over, players can request a preview of the tree corresponding to the crafted seed.

  Crafting requires the trees corresponding to the seeds in the players' inventories to be available at the player's locations at any time. Crafting also requires trees corresponding to the seeds being created to be available at the players' locations as soon as the crafting is over.

6.1.2 Definition of the KPIs

The game requirements can be translated to explicit KPIs for the FLAME platform. These KPIs are separated in different categories:

- **Storage** – The 3D models of the trees involved in the game are stored in the platform. The storage required varies according to the complexity of each tree and the number of trees.
  - For an average of 20MB per tree, this scenario requires a storage capacity over 5GB.
- **Availability** – The different 3D models of the trees need to be available at the trading locations, at the gardening locations, and at the player locations.
  - At a specific trading or gardening location, at least 20 players should be able to retrieve a tree in less than 0.5 second.
  - At a gardening location, at least 20 players should be able to retrieve all the trees in the garden in less than 5 seconds. This can involve preloading of the trees in an area of 5 meters. A garden can contain up to 10 trees.
  - At their location, all players should be able to retrieve a tree from their inventory in less than 0.5 seconds. The delays will be measured from the client device (simulated or physical).

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- **Processing** – All the trees corresponding to gardening locations should be updated according to their age.
  - For the gaming world to be consistent, the update rate should be up to 1000 trees per hour.

6.1.3 Experiments and measurement of the KPIs

As the identified KPIs do not strongly depend on the player's choices, they can be measured without involving real players. Therefore, the experiments will be conducted using a simulation of players' behaviours. This simulation will mimic the movement of the players around the city, from the new players discovering the game and playing during their daily commute, to the invested players exploring the city for the sole purpose of progressing in the game.

First, the simulation will provide a fixed environment that reflects the game design of Gnome Trader. This environment will include fixed trading locations positioned on the experimentation site; predefined locations for the gardening locations mimicking a real gaming scenario; and a fixed maximum number of trees per gardening location.

Second, the simulation will also give access to variable parameters that will be used to evaluate the different KPIs mentioned in the previous section. These parameters include the weight of the 3D models for the trees; the number of trees; the size of the player inventories; as well as the number of players. Varying these parameters will provide insights about the different scenarios in which the KPIs can be achieved.

Table 4: Examples of experiments and trials for the Augmented Reality Location-Based Gaming scenario.

Scenario #	Scale	Key demonstration points
1	**Experiment** *Lab*	**Study on Storage** Studied parameters: Whether the storage capabilities satisfy the different game scenarios (i.e. reach the Availability KPIs). Variables: Simulation of different shop locations, garden locations, and player's behaviour.
2	**Experiment** *Lab*	**Study on Availability** Studied parameters: Retrieval time for the trees at a shop, at a garden, or in a player's inventory. Fixed parameters: Shop locations, garden locations, and player's behaviour. Variables: The number of players at a location (shop and garden), the number of trees in a garden, the number of seed types in a player's inventory.

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3	**Experiment** *Lab*	**Study on Processing** Studied parameters: Processing time to update the price table of each shop, to age the trees in each garden, to compute the rewards of each tree in each garden. Variables: Number of shops, number of seed types in the shops, number of gardens, number of trees per garden.
Optional	**Trial** *Small*	**Study on Trading** Studied parameters: Number of transactions, movement of the seeds on the map, player's satisfaction. Variables: Price differences between different seed types, economic model, shop's inventory size.
Optional	**Trial** *Small*	**Study on Gardening** Studied parameters: Number of gardens created, number of trees planted, locations of the gardens created, player's satisfaction. Variables: Life expectancy of the trees, frequency of rewards for one tree, size of the gardens.
4	**Trial** *Urban*	**Overall study** Studied parameters: When do people play (period, frequency, duration, etc.)? How do people move around the city (for trading, for gardening)? Where do people create gardens?

6.2 EXPLOITATION OF FLAME METHODOLOGY AND PLATFORM CAPABILITIES

While Gnome Trader could technically be implemented with OTT solutions such as Amazon Web Services or Google Firebase, as a mixed-reality experience, which augments real-world locations with virtual content at pre-defined physical locations, the game highly benefits from FLAME's location-based adaptive infrastructure. As opposed to a central, cloud-based location to store and process all virtual game content common in OTT solutions, FLAME allows to replicate and process the data close to the physical location where the data is used. Specifically, players are continuously moving around in the city and large data, for instance, 3D models of trees, are sent to the players dynamically and with low latency. This requires an efficient network infrastructure with a high bandwidth, which FLAME provides.

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6.3 DEPLOYMENT AT FLAME INFRASTRUCTURE

Gnome Trader's virtual game world consists of shops, which allow the players to interact with the gnome characters. The physical real-world location of these shops can be entirely defined by the developers. In FLAME empowered cities such as Bristol and Barcelona these shops should be placed close to access points or computing nodes to enable low-latency, high-bandwidth, and, most importantly, localized access to the game data.

In Barcelona, all FLAME access points are placed along a single street. In the game, a shop would be installed at each access point. While the main trading activities for players are hence confined to this street in Barcelona, players could still create gardens in other areas of the city.

In Bristol, FLAME access points and nodes, and hence the Gnome Trader shops, are placed in a wider circle around the city centre. This forces the players to move around the city to interact with the game, which is intended. This deployment scenario is more interesting for Gnome Trader as presumably a higher dynamic and larger variety can be observed in the game's economy.

6.4 EXPECTED OUTCOMES

Video games, and in particular Gnome Trader, have specific requirements that are not always present in other FLAME use-cases. Therefore, the experiments around "Augmented Reality Location-Based Gaming" are expected to show to which extent FLAME can cover requirements specific to video games, and in particular how FLAME can be an interesting platform for highly mobile video games. Moreover, as described in the previous sections, the design of the experiments enables variation of certain parameters. This will provide some insights about the scope in which the game can be designed without altering the experience of the final user.

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7 IMPACT ON FLAME THIRD-PARTY ECOSYSTEM

The design, implementation and execution of the pioneering FMI experiments (described in sections 3 - 6) will validate the FLAME EaaS proposition. The FMI experiments cover socioeconomically important vertical sectors (Broadcast, Gaming and Transmedia) to ensure the FLAME ecosystem is ready for expansion in 3rd party project open calls.

7.1 THIRD-PARTY ECOSYSTEM, INFRASTRUCTURE REPLICATION AND OPEN CALLS

The validation experiments have a key role in the FLAME strategy to create and grow a vibrant and sustainable 3rd party ecosystem. As described in deliverable "D6.3: FMI Ecosystem Engagement Strategy and Plan" [4], the vertical experiments of FLAME will validate the FLAME's experimentation, platform and infrastructure concept and approaches to demonstrate the value of FLAME methodologies and capabilities. The experiments have been selected to be representative of media services in key vertical application areas (broadcast, gaming, transmedia) and conducted by global leaders in respective sectors like VRT and DRZ to create a trailblazing effect for experimenters following through the open calls. In addition, FLAME includes an experiment from NXW which is an SME to allow validation of engagement models for SMEs, and an experiment by an applied research centre like ETH. The idea is to ensure that FLAME explores the needs of all types of potential 3rd party project stakeholders for the open calls.

Moreover, the FLAME strategy leverages the vertical experiments in its 3rd party experimentation project programme that sees a series of open calls happening throughout the life of the project in order to expand the range of vertical areas to include other parts of the creative industries. Three FLAME replication projects will also be funded during the 2nd Open Call to increase capacity and supply in other European cities.

The validation experiments together with the outcome of the 1st Open Call which has been launched on the 9th of April 2018 will represent success stories for promotion to ensure fast growth in platform users via subsequent Open Calls and unfunded experiments.

7.2 MONITORING, MENTORING AND SUPPORT TO THIRD-PARTY EXPERIMENT PROJECTS

Validation experiments of the FLAME partners provide the hands-on experience regarding infrastructure, platform and application capabilities. The knowledge gained by FLAME partners will be transferred to the 3rd party ecosystem through a mentorship program. This includes the monitoring of KPIs, infrastructure capacity and utilization across experimental infrastructures. These activities will provide additional input to the Experimentation-as-a-Service sustainability/exploitation (WP2) and technology roadmaps (WP3).

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8 CONCLUSION

This document has described recent activities related to WP5: Future Media Internet (FMI) Experimentation and Infrastructure Replication. Specifically, this document outlines the design of validation experiments in order to implement and conduct a series of pioneering FMI experiments in a range of vertical areas of broadcasting, gaming and transmedia. The experiments are designed to use and evaluate FLAME's methodology and platform capabilities through experiments deployed at FLAME infrastructure locations. The process of experimental design specification has been described, and each of the four FLAME validation experiment has been introduced using this common specification. This document has also elaborated on the influence of FMI experiment design on the creation of a 3rd party ecosystem through open calls for additional FMI use cases and infrastructure replication. The experiments described in this deliverable provide the hands-on experience regarding infrastructure, platform and application capabilities. The knowledge gained by FLAME partners will be used to monitor, mentor and support 3rd party experiment projects. The results of experiments described in this document will be reported on month 24 of the project in deliverable "D4.4: Insights from Broadcast, Gaming and Transmedia Experiments".

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