Building 5G through FLAME

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Urban Hacking in 5G
Welcome to FLAME – Urban Hacking in 5G
Bringing researchers and early adopters together
We’ll cover a lot of ground

• **Convergence** across devices, clouds, networks and services and emerging **user experiences**

• Approaches to interactive media **innovation** by bring together users, technology and live events in a series of experiments conducted in real world settings

• **Analysis of** Quality of Service (QoS) to enhance Quality of Experience (QoE)
Introduction to FLAME
The FLAME Programme (Jan 2017 - Jun 2020)

• A 3.5 year, EUR 7M H2020 project to advance the adoption of 5G for media
  • develop a **software based 5G platform** that sits on top of programmable infrastructures tight integration of media systems with networks
  • adopt **advanced 5G infrastructures** encompassing compute, storage and software-enabled communication infrastructure
  • establish an **Future Media Internet (FMI) ecosystem** bringing together three distinct sets of stakeholders (5G, Media and Experimentation)
  • support **experimentation and trials of novel FMI services** delivering outcomes to creative industries, media service providers, infrastructure providers, and beyond
FLAME Facts

- EU H2020 R&I grant
- 4 replicators
- 12 partners
- ...more to come

The Consortium

**Platform Providers**
- InterDigital Europe Ltd. (United Kingdom)
- Atos España (Spain)

**Content providers**
- VRT.be (Belgium)
- The Walt Disney Company GMBH (Switzerland)

**SMEs**
- Martel Innovate (Switzerland)
- Nextworks Srl (Italy)

**Municipalities**
- L’Institut Municipal d’Informàtica de Barcelona (Spain)
- Bristol is Open (United Kingdom)

**Academia & Research Institutes**
- University Southampton (United Kingdom)
- i2CAT Foundation (Spain)
- University of Bristol (United Kingdom)
- ETH Zürich (Switzerland)

- 3.5 years
  - Jan-17 to Jun-20
- 11 Partners
- 438 PMS
- EUR 6.9M Budget
- EUR 2.2M 3rd party project investment
Create the FLAME capabilities to bootstrap the ecosystem

Start validation experiment, kick off open calls for 3rd party experimentation and replication projects.

Transition towards sustainability, through engagement and unfunded experiments, next stage investment and standards
Future Media Internet

- Convergence of technologies for distributed multi-stakeholder systems
  - changes the way multimedia systems need to produce, deliver and consume content
- Systems must create value by linking people to each other and to locations (both real and virtual)
  - capture the popular imagination
  - address desires of consumers to share their experiences
Users at the Heart of the System

- User centricity is a critical for design and development of multimedia systems
- Two main principles in our user centric design processes:
  - users are the primary beneficiaries, and other benefits to providers of services and technology will follow from user benefits
  - users who participate in observations are also those same users that realise the primary benefits
- Principles reflect the shift towards the democratisation of Internet services
  - users play a greater role in generating information
  - need to recognise explicitly the cost and benefit of participation

IoT = Wearables
Future Media Internet - Experiences

• Enhanced personalisation
• Non-linear story-telling
• Interactive immersive experiences
• Social communities which allow people to use 3D environments to communicate and interact with each other
• Capture and reproduction of the real world in 3D
• Creation of perceptual congruity between real and virtual worlds
Media Scenarios

- Personalisation
- Interactivity
- AR/VR
- Localisation
- IoT
- Video/Audio
- 360
- Interactivity
- Mobility

Human-Centric Interaction

IoT

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source: www.5g-ppp.eu
Real-Life Media Scenarios
The Invisible Infrastructure?

Over-the-top content (OTT) refers to delivery of audio, video, and other media over the Internet without the involvement of a network operator in the control or distribution of the content.

Current Online Media Services

Future Online Media Services

source: ottsource.com/ott-blog
Future Media Internet - Infrastructures

• Applications place significant demands on network and content management infrastructures
  • delivery of Quality of Service and enhanced Quality of Experience
  • communities that dynamically organise themselves around socially distributed, fixed and mobile content
• Software defined compute, storage and communications infrastructure
  • increasingly distributed including the mobile edge
Future Media Internet: Tighter integration of media services and distributed infrastructures.
Approach

FLAME is developing a **software based 5G platform** that sits on top of programmable infrastructures, improving media delivery to end users.

The platform allows for flexibly controlling the provisioning of content and services with the ultimate vision of the service ‘just being one hop away’

**For citizens** this means:

- **Better performance and lower costs** through efficient network mechanisms
- Access to **new services offerings** that exploit personalisation, interactivity, mobility and localisation
- **Easier collaboration** with other people on the network
- Enjoy the Internet through simply installing an **application** on their phone
We say....

It’s important to investigate what 5G will be used for

.....not just how it will be operated
What kind of user experience?
Schladming Ski Resort, Austria
Super G World Cup Night Race
World’s 1st Mixed Reality Ski Race

2-3 Feb 2015
Let’s see the action - BBC Click
Outside gear

Smart Data Goggles

Inputs
- Real GPS Location
- Biomechanics
- Environment conditions
- Game control
- Voice and Background Sound

Outputs
- Player voices and Game Sounds
- Augmented slope scenes
- Virtual player location
- Online competitor locations
- Online player’s movements

Headphones

© University of Southampton IT Innovation Centre 2015 and other members of the 3D LIVE project consortium
Inside gear

Ski Simulator or Wii Fit

Oculus Rift, CAVE

Inputs
• RT 3D reconstruction of players
• Activity recognition
• Voice

Outputs
• Player voices, Game Sounds, Real Sound
• Immersive 3D environment
• Virtual player location
• Real and Online competitor locations
• Reconstructed 3D online players

1 to 4 Kinect Sensors

Laptop

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## Worlds 1st Mixed Reality Ski Competition 2-3 Feb 2015

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**Final Result**
3D Live Challenges

• Research challenges
  • Rendering and visualisation
  • Activity recognition
  • 3D reconstruction in real-time
  • Data compression and transmission
EXPERIMEDIA – Media Cloud Platform

*Cloud services that combine social networking with media production and delivery technologies for trials that explore new forms of social interaction and experience between online and real-world communities*

https://eprints.soton.ac.uk/374078/1/374078.pdf
Venues

Sports Training and Science @
CAR High Performance
Training Centre

Cultural Learning @
The Foundation of
the Hellenic World

Outdoors And Leisure @
Schladming Ski
Resort

Anywhere!

Copyright University of Southampton IT Innovation Centre and other members of the EXPERIMEDIA consortium, 2014
Live Real-World Events

adaptation to environment considering physical, social and ethical constraints

adaptation of content according to individual and/or group preferences

adaptive scaling for large-scale short-lived communities
Live Real-World Events

real-time orchestration allowing for adaptive narratives

adaptation to unreliable sensors and devices for detection and tracking of feature points

adaptation to device capabilities both remote and at a venue

adaptation to cooperative or collaborative frameworks including dealing with selfish or malicious users
What’s happening to the infrastructure?
Infrastructure-as-a-Service
Real Life Infrastructures

Compute resources distributed and integrated with communication infrastructures across real-life infrastructures (edge, metro and core)

FLAME IaaS specification for mobile edge computing and software defined real-life experimental infrastructures

FLAME Trailblazing Infrastructures

3rd Party investment in FLAME Replicator Infrastructure Projects

Experimentation-as-a-Service (EaaS) Sustainability and Governance Models
What’s happening to the analytics?
Experimentation

- We are doing future media internet experiments
- What do you want to know?

If you can’t measure it then you do not know what is going on

- Did people like it? QoE
- If not, why? QoS
- Were there technical problems? QoE
- Did that matter?
Quality of Service

- Commitments from service provider to customers
  - part of Service Level Agreements
  - can be infrastructure, platform or service specific

Temporal and spatial consistency
Quality of Experience

• Complex concept and not easily defined because it is composed of many elements
  • no singular, definitive definition of QoE
  • often viewed as a network of inter-related aspects that connect a person to the world via interactive experiences, highly contextualised

• Measured technical QoE (e.g. quality of content) vs subjective QoE (e.g. satisfaction)
Demand (PIML)-based System Characterisation
Knowledge for Platform Management and Control
Cross Layer Monitoring and Control

User Demand: personalisation, interactivity, mobility, localisation

Cross-layer multi-dimensional data analysis
- time-series data collection and aggregation
- temporal cross-layer graph analysis

Media service template (TOSCA) modelling and evolution

Infra Resource: spatial-temporal allocations, usage, performance
Multi-Stakeholder Trials and Experiments

Working Theory -> Experimentation -> Trial Design

System-Under-Test
- Consumer A
- Consumer B

Knowledge Model
- Quality of Experience and Quality of Service Data
- Resourcing Policies
- Service Level Agreements
- Ecosystem

Applications
- Stakeholder View (Media Service Provider A)
- Data Analysis

Media Services
- Stakeholder View (Media Service Provider A)
- Data Analysis

Platform Services
- Stakeholder View (Media Service Provider A)
- Data Analysis

Infrastructure Services
- Stakeholder View (Media Service Provider A)
- Data Analysis

Monitoring and Control APIs

Business Analysis

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FLAME: Tighter integration of media services and infrastructure
The FLAME Service Delivery Platform

- A new dynamic content production and delivery platform based on 5G network technologies
  - layered modular architecture with cross layer optimisation, analytics and control
  - distributed computing models that combine media cloud with mobile edge
  - NFV-based orchestration with SDN-based network
  - Integrated with multi-RAT environments

- Supporting enhanced Quality of Experience
  - personalised, interactive, mobile and localised media services
Validation through Urban Scale Trials & Experiments

• Validate platform capabilities by trials conducted by ecosystem partners
  • 5 operator infrastructures
  • 25+ customer trials

• New media formats (AR, VR, 360) and distribution channels

• Engagement with media service providers, content providers, infrastructure operators and beyond

• Trials will be conducted in 3 waves from Mar-18 to Jun-20

• Public funding available through H2020 FLAME project
FLAME Overview

Vertical Validation

3rd Party Investment in Large-Scale Experimentation Projects

Service Management API (design specification, runtime control, observation and analytics)

Flexible Service Routing

Surrogate Service Management

Cross Layer Management

Media Services & FMI Instance Templates

FLAME IaaS specification for mobile edge computing and software defined real-life experimental infrastructures

Bristol

Barcelona

European City A

European City B

European City C

FLAME Trailblazing Infrastructures

3rd Party Investment in FLAME Replicator Infrastructure Projects

Experimentation-as-a-Service (EaaS) Sustainability and Governance Models

User Acceptance & Viability of PIML-Oriented Media

FMI Performance Knowledgebase

Infrastructure Utilisation & KPIs

Socio-Economic & Technical Insights
This project received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 731677.

VIRTUAL REALITY

Digital media is everywhere. FLAME is not.
Conclusions

• Interactive media systems will be increasingly transformed by:
  • continuing convergence of infrastructure technologies
  • increasing availability of data from IoT platforms and Big Data

• Benefits must be driven by users at the centre of design processes
  • Creative experience designers have a major role to ensure that the data can be turned into enhanced experiences and sustainable data value chains
  • Developers must be given the tools and APIs to exploit the availability of infrastructures for optimal distribution of socially distributed content

• FLAME brings all of these stakeholders together to explore the acceptance and viability of future media internet systems
  • You will see this week at the hacking event