

# MULTIMEDIA COMMUNICATIONS GROUP

## HEAD OF THE GROUP RESEARCH REPORT

Multimedia Communications Group (COMM) started its activities in 2004, and nowadays is composed of a group of 6 researchers, focusing its research lines on multimedia systems and Quality of Experience (QoE). During the last year 2019/2020 the group has continued with its work lines focused on the distribution of multimedia content using protocols like Dynamic Adaptive Streaming over HTTP (DASH); carrying out more in-depth studies and developments related to the Internet of Things (IoT) trend; analysing and proposing new metrics for estimating the QoE; and developing new functionalities for multimedia systems based on DRM and cross-layer techniques.

These lines of action have been articulated through the execution of different research and development projects, as well as scientific publications. In addition, in order to promote the main activities of the group, we have been continuously updating the webpage and being very active in social networks (Facebook, Twitter, Youtube, LinkedIn and Instagram).

Following, the main results of the group are summarized, which are accessible through the COMM webpage ([www.comm.upv.es](http://www.comm.upv.es)).



*Website and social networks of the COMM*

## 1.- PROJECT ACTIVITIES

The COMM has continued during the last year with its main research and development lines.

Also, new emerging activities have appeared. A short summary of the main advances carried out is presented below:

### Adaptive video through MPEG-DASH

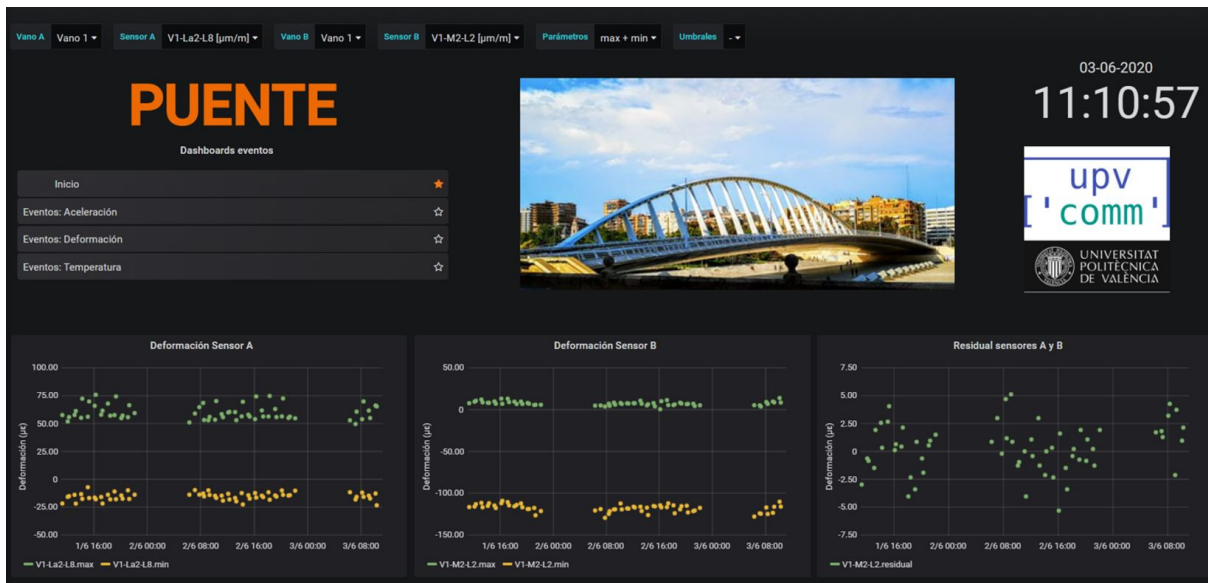
One of the main research lines of this year has been the study and development of DASH-based applications. In this sense, the proposed algorithm Look Ahead takes into account the information of the size of the forthcoming segments. With our proposal, there is no need to encode videos with constant bitrate because clients will have the tools to choose the best quality that fits in its available bandwidth. To test the algorithm, we have implemented Look Ahead for the ExoPlayer library, the video player behind the YouTube app in the Android platform. Also, the proposed algorithm is compared to relevant algorithms existing in the literature, specifically the Müller and Segment Aware Rate Adaptation (SARA) algorithms as well as to the adaptive algorithm integrated into ExoPlayer. The comparison is carried out by using the most relevant parameters that affect the Quality of Experience (QoE) in video playback services, that is, the number and duration of stalls, average quality of the video playback and number of representation switches. Also, during this year we carried out a subjective study with real users in order to prove the validity of the proposed algorithm.

### Measure of the Quality of Experience

In this year we have deepened in the study and analysis of different objective models for estimating the quality perceived by users when consuming video contents. Taking the ITU recommendation P.1203 as a reference, we have proposed different QoE models, based on well-known parameters such as the PSNR (Peak Signal-to-Noise Ratio) and the VMAF (Video Multimethod Assessment Fusion), for the evaluation of the QoE in an objective way. The different evaluations carried out prove that the proposed QoE models are more realistic than other similar models proposed in the literature, including the ITU-T P.1203 recommendation.

### Adaptive streaming for 2D and 3D video

During this year we have continued working on the development and improvement of a framework for the automatic assessment of the Quality of Experience in adaptive video streaming systems. The proposed framework, which can be used for both 2D and 3D video streaming services, allows the automated execution of different DASH players such as Bitmovin and Shaka Player and automatically emulates any bandwidth variation scenario by using Google Puppeteer.



*Dashboard for sensors monitoring in real-time*

The system outputs provide all the information required for the reconstruction of the played video. Reconstructed video is evaluated using objective metrics (PSNR, SSIM or VMAF) and in 2D video scenarios, automated QoE subjective assessment is carried out using ITU-T P.1203 recommendation. Currently, we are focus on how to predict the quality of stereoscopic 3D videos from objective and automatic subjective assessment of 2D single-view videos.

### Optimization of the multimedia content transmission with cross-layer

We have continued our work on cross-layer mechanisms in order to improve the performance of video streaming in crowded scenarios where many people are streaming content at the same time. To improve the experience of users we have developed a cooperation service that uses the data reported by the players (measured bandwidth, buffer level and displayed quality among others) to create recommendations that players take into account for the common good. All communications are carried out using websockets to keep the same level of compatibility as MPEG-DASH. To that extent, the cross-layer server is based on MPEG SAND (Server and Network Assisted DASH). This technology offers standardization messages and protocols in order to improve the user experience in the streaming service and to better use the bandwidth.

### Internet of Things and Smart Cities

Smart cities entail a combination of people, technology and strategies that makes the city more sustainable regarding strategic pillars, such as mobility, health or energy. For this to be feasible, the application of Internet of Things (IoT) is a key

factor to improve the life of citizens. IoT technologies comprise sensors to acquire data but are not limited to that. For a full comprehension of IoT applied to Smart Cities, a wider vision is needed, including data storage, analysis and presentation. Data can be collected with sensors, but this data must be processed and analysed in order to be transformed into information. Afterwards, citizens and city managers need an assortment of tools to manage this information to take advantage and transform it into knowledge. It is only with this full path when data can be transformed into knowledge and be fully profitable, and this should be the focus of a modern Smart City.

Following this approach, during this year, the group has been collaborating with Valencia City Council on tasks related to Valencia Urban Platform (VLCi). Within the context of MAtchUP project, we aim at improving the performance of the city, decision making or citizen participation, among others, guaranteeing interaction between the city of Valencia and its citizens, designing new data models, datasets and APIs for the new services and devices integrated into the urban platform.

### Monitorization of information in real-time

Following the previous research line about IoT, this year we have delved into applications for monitoring information in real-time. The objective is to develop solutions that, apart from collecting and processing data in real-time, display information neatly in order to allow users to consult this data in a clear and simple way. Among the developments carried out, we highlight a dashboard for monitoring bridges or a mobile app for monitoring shots on a paddle racket.



App for monitoring shots on a paddle racket

## Synchronization of audio and video devices

Following one of the main lines of the group, this year we have carried out tasks referred to media synchronization. Specifically, we have developed an application that allows to carry out an automatic realization of a recording in real-time. To that extent, the application detects the active microphones in each instant of time and, considering certain parameters as the number of cameras or the refreshing time, decides which camera should be on air.

### 1.1.- ONGOING PROJECTS

**Name of the project:** MAtchUP: MAtximizing the UPscaling and replication potential of high level urban transformation strategies (774477, Call H2020-SCC-2017)

**Webpage of the project:** <http://www.matchup-project.eu>

**Funding entity and duration:** European Union's Horizon 2020 Research and Innovation Programme. 2017-2022.

**Summary of the project:** The project aims at strengthening the planning processes for urban transformation, consolidating the benefits of deploying large scale demonstration projects of innovative technologies in the energy, mobility and ICT sectors, by means of substantially improved models for replication and upscaling, based on impacts evaluation, and ensuring the bankability of the solutions by means of innovative business models, which lead to achieve real deployment further than the pilots carried out in the lighthouse cities. With this, it is sought a high penetration of the validated technologies in those cities less prepared to adopt very innovative solutions and formalize it in a standard commitment, accompanied by capacity building strategies, to guarantee at least medium term implementation. The project started in October 2017, with an expected duration of five years. COMM focuses on actions related to ICT. As the project progresses and KPIs are going to be calculated for the interventions, new data models have been defined for these KPIs based on FIWARE data models. Regarding open APIs, the environment to develop and deploy new APIs has been defined and the first usable API have been developed, which enables the possibility of request predictions about sustainable mobility and bicycle availability, complementing current urban platform services. Moreover, the needed building blocks to analyse Big Data is ready for processing data collected from electric and hybrid buses when they are available. From this data measured on the vehicles, the platform can distinguish whether the driving pattern is eco-friendly and show an alert in real-time in case it is not.

**Name of the project:** Sistema de grabación y realización automatizada

**Webpage of the project:** <https://digiacta.com/>

**Funding entity and duration:** ESVEU Media Systems. 2019-2020.

**Summary of the project:** The main objective of the project is the design and development of a new automatic and unattended audiovisual recording and production multimedia system.



Meeting of the MAtchUP project in Skopje (North Macedonia)

The new solution is aimed at environments with several participants, such as the municipal plenary session of a city council, a conference or a meeting of a company's management board. Specifically, the objective is to develop a new application that manages, on the one hand, the communication with the microphone system, and on the other, the realization software in charge of managing the video cameras and the recording process. Thus, once the video cameras and the microphone system have been configured, the developed solution is in charge of carrying out the entire process of recording and audiovisual realization of a session as if it were an autopilot, without the need for human intervention.

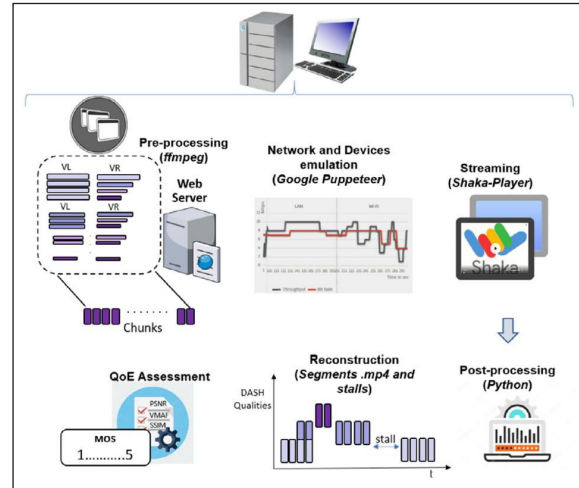
## 2.- RESEARCH RESULTS

### 2.1.- FEATURED PUBLICATIONS

**New objective QoE models for evaluating ABR algorithms in DASH.** I. de Fez, R. Belda, and J. C. Guerri, *Computer Communications*, vol. 158, pp. 126-140, doi: <https://doi.org/10.1016/j.comcom.2020.05.011>, 2020. This paper proposes three new models to measure the QoE analytically in DASH (Dynamic Adaptive Streaming over HTTP) video services. The first is based on the bitrate of the displayed video segments, whereas the second and the third are based on the PSNR and VMAF of each video segment, respectively. The proposed models are compared to the ITU-T standard P.1203 as well as the bitrate-based QoE model proposed by Yin et al.

**Automatic QoE evaluation for asymmetric encoding of 3D videos for DASH streaming service.** P. Guzmán, P. Arce, and J. C. Guerri, *Ad Hoc Networks*, vol. 106, article 102184, doi: <https://doi.org/10.1016/j.adhoc.2020.102184>, 2020. The paper is based on the study of the performance of a Dynamic Adaptive Streaming over HTTP (DASH) system for 3D video streaming. The proposed framework allows performance measurements to be carried out in an automated and systematic way. We have used Puppeteer, to automate actions such as starting playback, causing bandwidth changes and saving the network statistics. From this data the video played is reconstructed, quality metrics are extracted and users' QoE assessment are carried out.

**Interoperability network for traffic forecast and full electric vehicles power supply management within the smart city.** V. Fernández, J. C. Guerri, and A. Roca, *Ad Hoc Networks*, vol. 93, article 101929, doi: <https://doi.org/10.1016/j.adhoc.2019.101929>, 2019. It is relevant for the mobility in our future cities to integrate the Full Electric Vehicle (FEV) in an interoperability network. The target is to optimize energy consumption and to improve the mobility in the city. This paper proposes an infrastructure to



Proposed framework architecture of paper "Automatic QoE evaluation for asymmetric encoding of 3D videos for DASH streaming service"

efficiently manage the power supply availability in the network of charge stations in the city and an adaptive model to predict the traffic based on historic data and on time series obtained mathematically.

**Automatic QoE Evaluation of DASH Streaming using ITU-T Standard P.1203 and Google Puppeteer.** P. Guzmán, P. Arce, and J. C. Guerri, in *Proc. of Int. Symposium on Performance Evaluation of Wireless Ad Hoc, Sensor, & Ubiquitous Networks (PE-WASUN)*, pp. 79-86, Miami Beach, FL (USA), Nov. 2019. This document presents a framework for the automatic evaluation of DASH (Dynamic Adaptive Streaming over HTTP) system. We have used Google Puppeteer, the Node.js library developed by Google, which allows us to automate actions on Chrome Devtools Protocol. From this data, the reconstruction of the visualized video, as well as the extraction of objective quality metrics and the automated evaluation of the QoE (Quality of Experience) using the ITU-T P.1203 standard are carried out.

**Evaluación automática de la QoE del streaming DASH utilizando el estándar ITU-T P.1203 y Google Puppeteer.** P. Guzmán, P. Arce, and J. C. Guerri, in *Proc. of Jornadas de Ingeniería Telemática (JITEL)*, Zaragoza (Spain), Oct. 2019. This document presents a framework for the evaluation of DASH systems that allows performance measurements in an automated and systematic way. By using the high-level API provided by Google Puppeteer, that allows to automate actions on Chrome Devtools Protocol, such starting playback, making bandwidth changes and saving the results from the streaming processes. By processing this data, the reconstruction of the video is carried out and the subjective evaluation using the ITU-T P.1203 takes place.