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FLAME infrastructure in Barcelona

DESCRIPTION OF FLAME INFRASTRUCTURE IN BARCELONA

The Barcelona infrastructure offers a real deployment of a wireless access and backhaul scenario. The implementation of the FLAME architecture consists of (1) the on-street deployment that provides Radio Access Network (RAN) capabilities and a dedicated wireless backhaul, (2) the Multi-Access Edge Computing (MEC) installations to provide light added value services close to the edge, and (3) the main DC deployment in i2CAT facilities. Main DC IT resources are used to provide heavy computational / storage services, e.g. high definition video content, video transcoding, quality of service and consumption analytics, as well as resource orchestration and management logic, e.g. OpenStack, ODL, DHCP servers, etc.

The on-street deployment consists of the wireless nodes mounted on lampposts that provide connectivity for user equipment over Wi-Fi. The lampposts are each connected via optical fibre with the FLAME edge infrastructure and are connected from one lamppost to another via wireless backhaul links. In Barcelona, the edge infrastructure is deployed within a street cabinet, consisting of an edge server to enable ICN routing and providing VNF capabilities, as well as networking devices that aggregate traffic coming from the lampposts and also provide connectivity towards the main DC. The fibre connection between the edge cabinet and the main DC has an intermediate hop in the IMI facilities at Glòries area, Barcelona. Figure 1 shows the city of Barcelona, highlighting the location of the i2CAT and IMI premises, as well as the street Pere IV, where the on-street infrastructure (Wi-Fi and edge cabinet) are deployed. In the following, each of the deployments (on-street, edge, and main DC) are explained in detail.

Figure 1: Barcelona city overview with the locations of i2CAT, IMI and the on-street deployment (Pere IV)

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On-street deployment: wireless nodes on lampposts

Within the Pere IV street, a segment of around 400m hosts the deployment of the four wireless nodes that provide RAN capabilities. Figure 4 shows an isometric view of the Pere IV with the FLAME street segment and the wireless nodes.

Figure 4: Barcelona FLAME on street deployment at Pere IV street

The wireless nodes are equipped with either 2 or 3 wireless network interfaces implementing IEEE 802.11ac standard with backwards compatibility for the IEEE 802.11 a/g/n standards. One of these interfaces is always used for the RAN, i.e. it is used to instantiate wireless Access Points (APs), whereas the remaining 1 or 2 interfaces are used to provide wireless backhaul connectivity from each lamppost to its neighbours. Figure 2 shows the data rates achieved over the wireless backhaul between each of the lamp posts. The numbering follows the order of the street (from left to right, as show in **Error! Reference source not found.**). The RAN performance depends on where the clients are located and how the APs are configured. For single STA connections we observe throughput of up to 200-250 Mbit/s.

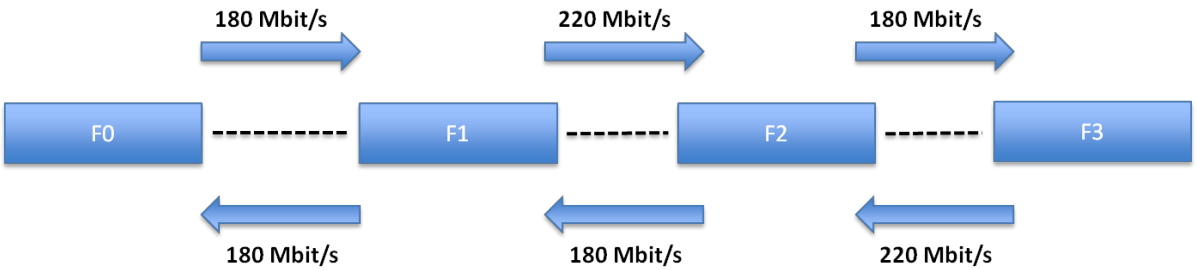

Figure 2: Barcelona Wi-Fi backhaul data rates achieved from each lamp post F0-F4 to its neighbouring lamp post(s)

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The lamppost equipment also has two Ethernet ports that are both connected to the fibre media converter which enables a wired connection over fibre to the edge cabinet. This wired connection is planned mainly for control and management purposes. Data in the 3rd party projects will be transferred through the wireless backhaul network to forward it to other lamp posts or to send it to the edge cabinet, where it can be forwarded to the main DC or the Internet. The wireless nodes will not store data or provide computing capabilities for experimenters; computing will be performed in the cabinet server and in the main DC.

Edge deployment: cabinet server and networking devices

Barcelona infrastructure includes an edge computing server and a switch, both placed in the cabinet at Pere IV street. The edge server offers application developers and content providers to 3rd party project with cloud-computing capabilities close to the end users. In principle, having services closer to the end user will improve the user experience. Just as an example, resources on the edge computing server might be used for supporting the following: video analytic applications, location services, IoT, augmented reality applications, optimized local content distribution and data caching. In the context of FLAME, a portion of the edge server resources should be allocated for the instantiation of FLAME platform inherent services (e.g. Network Attachment Points (NAPs)). The remaining resources, not used by the FLAME platform, in the cabinet server will be available for the experimenters. In Barcelona deployment, the edge cabinet server is a 12 core CPU mini-tower server with 128 GB RAM and around 2 TB of storage capacity. This machine has been registered as a compute node into the OpenStack controller hosted in the main DC. The Barcelona infrastructure setup represents a cost-effective infrastructure installation where a single cabinet server is assigned per several lampposts.

The FLAME cabinet is connected to the main DC via a private network owned / operated by IMI. This network consists of two segments: 1- Optical network which connects Glòries node to the FLAME set up in the Pere IV street and 2- an optical network with maximum capacity of 8 lambdas (each supporting 10 Gbps) between the Glòries node and the main DC. The initial capacity considered on the optical segment is 20 Gbps but depending on the FLAME needs an adequate bandwidth will be allocated for the experimentations.

Main Data Centre

The FLAME street deployment in Barcelona is connected to a Data Centre managed by i2CAT where resources for FLAME are provided in a non-exclusive manner. It consists of computing devices, hosting a production-level virtualisation environment and the necessary networking devices that interconnect with the edge deployment.

Specifically, the virtualisation environment consists of three servers running OpenStack Ocata, ranging from 32 GB to 96 GB RAM, from 4 to 6 cores and ~2 TB of storage capacity. The nodes exert the actions of controlling, computing and storing. The production-ready environment is defined following some of the best practices, such as high availability and redundant storage. To meet the former, the aforementioned servers provide different and/or replicated functionality. The control plane of such cluster for virtualisation is architected in a way that punctual and/or localised faults can be overcome.

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Overall, the DC resources are utilized to instantiate and host functionality such as the control plane management for the wireless nodes (ODL), required storage capacity for media server content or other experimenter needs and the required FLAME platform services.

The following image depicts the architecture of the Barcelona infrastructure for FLAME.

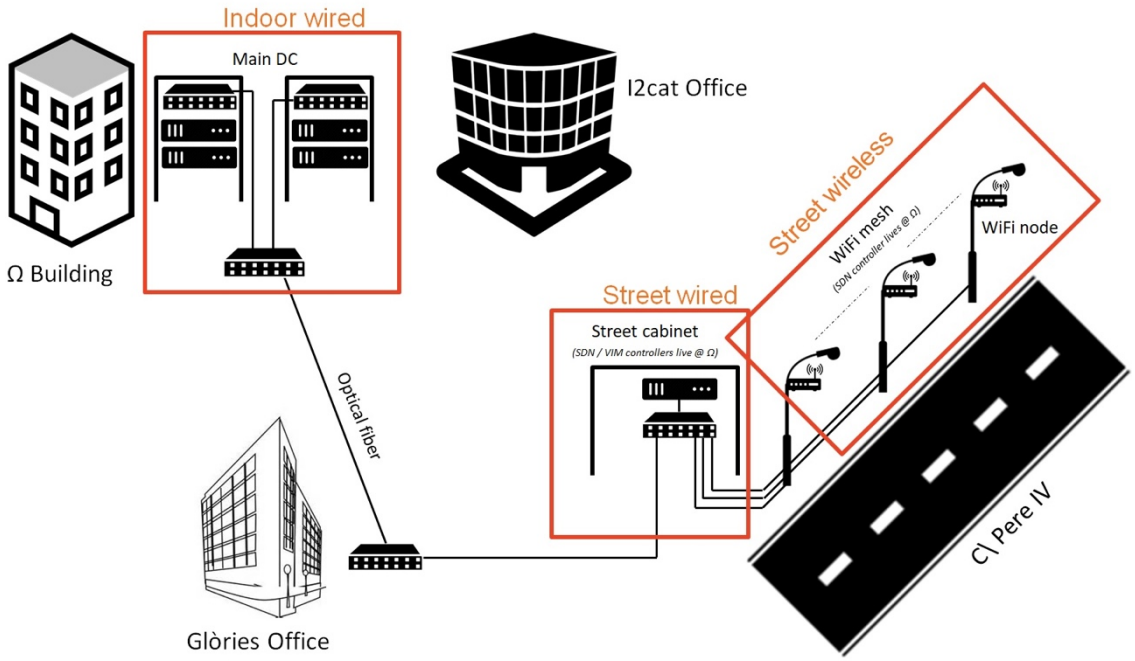

Figure 5: High-level view of the FLAME infrastructure in Barcelona

For the 3rd party projects, the overall amount of vCPUs, RAM and Storage available for their experiments is given in Table 1. These resources can be used to instantiate their own VMs and media services provided by FLAME.

Table 1: Compute resources available for 3rd party projects at the main DC and edge

	vCPUs	RAM	Storage
Main DC	10	32	200 GB
MEC	14	32	200 GB

Barcelona deployment represents a cost-effective city installation where the FLAME solution could provide the significant leap forward for media delivery supporting personalized, interactive, mobile and localized (PIML) workflows. Leveraging on 5G-enabled programmable infrastructure, FLAME advantages, such as faster access to media and services, lower latency and higher personalization of the experience through closer media processing, will be offered through virtualized resources at the main and edge DC. This creates room for a significant reduction in the overall costs while ensuring fast availability of services towards end users. In particular, unlike the Bristol deployment where the hardware installation per lamppost is required to enable FLAME offerings (without providing any extra

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computing capacities for other added value service like content caching), resources on the general-purpose server mounted on the cabinet in Barcelona create a virtualized environment where NAPs as well as other added value services can be instantiated on demand. This will significantly reduce the installation cost (CAPEX) as well as maintenance and operational costs (OPEX).

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