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3rd Open Call FLAME infrastructure in London

EDGE - UCATE 3rd party project (Open Call 2)

DESCRIPTION OF FLAME INFRASTRUCTURE IN LONDON

King's College London (KCL) has developed a state-of-the-art 5G testbed based on OpenStack and SDN-enabled infrastructure. This testbed is interlinked with other universities in the UK, including University of Bristol.

This infrastructure, as well as its interconnection with Bristol, has been tested and validated as part of the first-ever end-to-end demonstration/trial of 5G, funded substantially by the UK's Department of Culture, Media and Sport (DCMS).

The infrastructure comprises of a fully 3GPP-compliant 5G air interface with radios at 3.5GHz powered by Massive MIMO technology and 28GHz powered by millimetre wave specifications. The radios are fronthauled into the baseband unit and then into the virtual radio access network; the resulting data flow is then routed into the virtualized core network. The testbed is completely softwarized, hosting all 5G functionalities as VNFs on commodity hardware. This also allows an interconnection to 3rd party systems, such as the Internet of Things and Autonomous Vehicles. As such, we own the infrastructure, have full access to the facilities on campus, and have the ability (and necessary permissions) to deploy FLAME on top of this infrastructure and demonstrate the replicability of FLAME. Note that the 5G testbed is a TRAC facility within KCL and the access to it by 3rd party projects is costed to ensure its upkeep and maintenance.

5G Infrastructure:

King's College London (KCL) is located in centre of London and has five campuses located in various parts of the city. KCL is the most centrally located of all the London-based universities.

The key infrastructure for replicating FLAME resides in Strand Campus (Figure 1) and the network has a 3-tier design:

- access networks support different technologies, including 4G (through Open Air Interface), Wi-Fi and gigabit Ethernet each one with its own subnet or subnets.
- distribution layer to perform routing functions between different access networks and
- a core layer which aggregates and routes traffic for the VNFs.

The core, distribution and access tiers are interconnected with 40Gbps fibre across all links and the access tier provides 1Gbps and 10Gbps links.

The set-up consists of:

- **Access points.** Located at 10 different places in the strand campus (all of them use WiFi). There is also a cellular set-up in the lab (using open air interface), paving the way to test software-defined radio integrations with FLAME. Programmable SIM cards and multi-vendor end-user devices having AR capabilities are also available to test the services offered.
 - Wi-Fi Cisco AIR-CAP 7021
 - Cellular (SDR, Open Air Interface and virtualized core)
- **5G Lab (Edge).** The first point of contact from the access devices. where 6 compute nodes are located with each node having one of the following specifications:
 - 6 cores, 12 threads with 24GB ram and 512GB SSD and 1 GBPS NIC and a GTX 1080
 - 8 cores, 16 threads, 16GB ram, 756 GB storage (500GB HDD + 256GB SSD), 1GBPS NIC and 2 GTX 1080.

It is planned that two or more of these nodes will be dedicated for FLAME. Depending on resource requirements, up to four other nodes can be available in a dedicated fashion for specific experiments and testing. Since all infrastructure supports virtualization, it will also be able to spin up resources as needed.

- **KCL Datacenter.** This is built upon one controller node (where OpenStack is hosted), seven compute nodes (two with real-time¹ support) with each node having 128GB memory, and two Intel E5-2699A CPUs of 44 cores each (88 virtual processors) clocked at 2.4GHz. The compute node runs the host OS (Ubuntu 16.04) on a RAID1 of SSDs and the VNF instances on a RAID1 of 1TB hard disks. Server hardware is fully redundant as well as the switches and the core network is interconnected with redundant links for bandwidth aggregation and failover. Additional compute nodes and the FLAME controller will be located at the KCL Datacenter which is located in the same campus. The Datacenter is connected to the 5G lab via multi-vendor switches (EdgeCore, CORSA). It is worth noting that we run several subnets with routing between them and the network is not a flat topology but rather a collapsed core topology as found in major operators.
- **5G-EX.** KCL DC connects to 5G-exchange point at Slough runs a fully SDN enabled infrastructure with Corsa switches and connects the KCL testbed to University of Bristol and Surrey testbeds. This will enable potential integration with the FLAME replicator in Bristol.

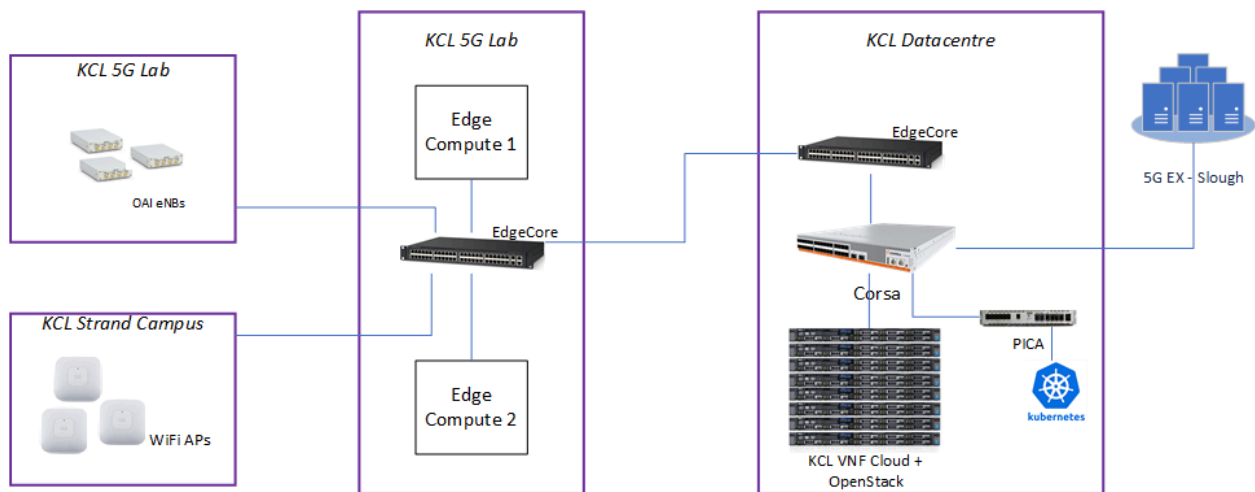


Figure 1: KCL 5G testbed diagram capabilities

¹ The real-time KVM host is configured for SR-IOV and CPU pinning in the BIOS