Application Development and Generic Interfaces

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5G Test Network Supporting Ecosystems and Co-creation
Ecosystems and co-creation

- Test network itself is already an innovation ecosystem and aims to be part of bigger co-creation environment combining different application domains and their actors.
Basic Concepts (cont.)

- Open & Closed Innovation and application development platforms
  - In practice a server platform providing tools e.g. for application development (APIs), software development kits (SDKs) etc.
  - Platforms and methods can be "open" or "closed"
  - Open Innovation is a paradigm assuming that firms can e.g. crowdsourcing creation and development of ideas by e.g. opening specific system APIs without direct or strict control
  - Closed Innovation is a paradigm assuming the IPR ownership and creation and management of ideas is strictly controlled by company providing the APIs and SDKs
  - The 5G Test Network can host the platform for e.g. some specific SDKs and APIs provided by companies
5G Test Network Enablers for Co-Creation

- Software Defined Networking
- Network Function Virtualisation
- Open Innovation & Service Platforms
5G Test Network Enablers for Co-Creation

Tools to provide flexibility and dynamicity for the platform
Usually hidden from application developer

The way to enable application development
and to build new ecosystems
Examples of different 5G scenarios and challenges tackled in test network

- Enhanced mobile broadband
  - Mobility and high quality of user experience enablers
  - More capacity with licensed shared access
  - Cognitive and autonomic network resource optimisation
  - Dynamic and scalable next-generation CDN solutions
- Massive machine type communications
  - Power efficient wide area connectivity with LTE-M
  - Internet of things gateway solutions with SDN and VNF support
  - Intelligent mesh networking for IoT
- Ultra reliable and low latency communications
  - Real-time handovers
  - Distributed power sources
  - Indoor positioning
  - Remote controlling
Network and Service Infrastructure – more practical view of network setup
- Carrier grade Evolved Packet Core (EPC) connected to 10Gbps Ethernet service core network and running in cloud
- Test network advantages: possibilities to access your own subscriber data/information
- Liquid Applications, Voice over LTE and eMBMS planned for 2016
- Internet connectivity: 10Gbps routed IPv4/IPv6
VMware/Openstack based IaaS platform for applications
- Databases and application servers
- Computing and storage capacity will be increased during 2016 and 2017 based on the requirements, possibilities to use also external cloud service providers
Possibilities to integrate the network with 3rd party cloud systems
- IoT: Microsoft Azure, Thingworx, Amazon web services
- Private clouds

Possibilities to connect also to other external services and networks
- VPN tunneling from remote sites to services
- In future also remote LTE/LTE-M/5G RANs could be connected
Application and Service Interfaces and Tools

- Applications and test scenarios will define what kind of tools are required
- The test network environment provides the generic services
- Support for open source SQL databases such as
  - MySQL, MariaDB and PostgreSQL
- IoT application and transport protocols at the moment, the protocol support is not limited to these
  - CoAP (UDP), MQTT (TCP), Websockets (TCP), REST (HTTP)
- Most of the opensource programming environments and languages are natively supported
  - For example for web development PHP, Perl etc.
- Operating system support mainly for Linux and other open source operating systems
  - Using commercial, licenced operating systems in service core needs to be negotiated if the use is required for application development or services.
Core Network Enablers for Applications

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- Jussi Pajunpää
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BACKUPs: Pushing processing towards the edge of network

- Mobile Edge Computing
- Fog computing
- Cloudlets
Extending cloud infrastructure towards edge of the network

- **The main targets** for distributed cloud solutions are to
  - improve system performance,
  - minimize delays in data processing and service/data access
  - improve energy-efficiency of the systems and
  - enable 3rd party application development for ”in-network” services especially for content distribution, IoT and Tactile Internet applications

- **Virtualisation and software defined networking** are the main enablers also for distributed edge cloud solutions
  - Programmable World (Nokia), Software Networking/Networked Society (Ericsson)
Extending cloud infrastructure towards edge of the network (cont.)

Several almost similar approaches to distribute computing and extend cloud infrastructure in network have been considered

- **Mobile Edge Computing**: ETSI workgroup for standardizing APIs and defining architecture for cloud and virtualization platform especially for mobile networks

- **Fog Computing**: Cisco defined solution for distributed, multi-layer cloud infrastructure

- **Cloudlets**: Extension for OpenStack to support near-realtime/just-in-time application and service provisioning in edge nodes

- **Micro datacentre**: Microsoft proposal for extending hyperscale cloud data centres (Azure) to support low-latency and energy-efficient processing
Extending cloud infrastructure towards edge of the network (cont.)

- Software defined networking solutions for resource management
- Lightweight virtualisation for network function virtualisation
- Distributed processing and edge computing
- Optimising content distribution and IoT services
- Network slicing and security solutions
Examples:
- IoT connectivity and application development
- Dynamic CDN
Scenario

- Connect "things" with the networks such as Internet
- Sensors monitoring the environment
- Gateways providing the connectivity to the servers/cloud
- Data analysis and reasoning also in distributed cloud
- End users get from the cloud
Cloud server for collecting sensor data: websocket, http, coap, mqtt etc. can be supported

Analysing software also in core network IaaS cloud

Analysis and application can be also in external service. In such a case the connectivity needs to arrange through VPN if data is collected through 5GTN network.
5GTN IoT Platforms

- Application creation at the edge of network
  - IoT data localization, caching and reasoning
  - Multimedia/Video streaming caching
  - Virtualized content distribution network
- API interfaces for Liquid Application during 2016
- API for IoT connectivity available e.g. through VTT’s existing IoT gateway solutions or other gateways and sensor networks

Distributed processing (mobile edge computing with IoT gateways and Liquid Applications APIs)
IoT connectivity software for Gateways

- Interfaces supporting different protocols and for south- and northbound
- Core functionality is not hardware dependent
- Interfaces will be implemented/modified based on the hardware requirements
- Prototypes and testing with Raspberry Pi and Intel Galileo board

Possible to use various technologies for the connectivity modules (Ethernet, Wi-Fi, 3G, ZigBee)
Dynamic and scalable next-generation CDN

- Intelligent load-balancing and resource-aware solutions for content delivery networks (CDN)
  - Utilise network virtualization and enhanced CDN management.
  - Allows scaling of CDN architecture and performs dynamic load-balancing based on content requests from the end users
- Scenario
  - Add and/or remove virtualized CDN edge servers and reroute CDN users based on the resource needs (or location) to achieve more balanced traffic load in the CDN
  - Introduce virtual edge server(s) as close as possible to the end-user (e.g. close to the base station – MEC/Fog/Cloudlet technologies)
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