Deliverable 1.1

Set of Use Cases supported by the Holistic 5G Converged Network Architecture

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Abstract

This document presents use cases and derived functional and performance requirements that are used as a basis for future work on a holistic 5G converged network architecture. The presentation of use cases is largely uniform and based on a common template.

[End of abstract]

Disclaimer

Impressum

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Executive summary

This document elaborates at an abstract level on the most relevant use cases for the 5G system concept defined by the CONFIG project and that reflects the business interests of the consortium members. It defines functional and performance requirements for the 5G system concept, based on selected use-cases.

Special focus was given to define scenarios for the emerging trend towards network cloudification with network virtualization technologies such as NFV, SDN and context awareness. These scenarios cover selected use cases from areas such as M2M and V2V communications, context awareness, content delivery services, real time media and business applications. These use cases take into account the high capacity, low latency and guaranteed QoS requirements specific to 5G.

Attention is given to scenarios that benefit by the use of edge computing where the network hosts functions running services that are distributed and located in datacentres in the local edge. This induces new requirements on the protocols in the networks and datacentres. Furthermore, use cases take into account the fixed-mobile-wireless-broadcast convergence provided by the network architecture in CONFIG.

The use cases act as the basis to derive and define the system requirements for the 5G system concept, also including functional and high level performance requirements as input to the functional architecture and deployment architectures. These requirements cover capacity and latency for wanted QoE and new service delivery time in various scenario settings. The requirements defined in the EU FP7 project METIS[1] and the visionary challenges defined for the 5G-PPP[2] such as “saving up to 90% of energy per service provided”, “creating a secure, reliable and dependable Internet with a zero perceived downtime for services provision” and “enabling advanced user controlled privacy” were also important input when defining the requirements.

This work took as input information from various scientific publications, dissemination of previous research projects (e.g. METIS), and other fora, such as the NGMN.

The output of this work is intended for use by other project tasks and work packages covering, a set of selected use cases, as well as system functional and performance requirements that drive architecture and modelling work for a Holistic Converged Network Architecture.

[1] METIS Deliverable D1.1 ”Scenarios, requirements and KPIs for 5G mobile and wireless system”, ICT-317669-METIS/D1.1, March 2013

[2] https://5g-ppp.eu

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Abbreviations

Abbreviation	Definition
(x)DSL	Digital Subscriber Line
AMR	Adaptive Multi-Rate
CAPEX	Capital Expenditure
C-ITS	Cooperative Intelligent Traffic Systems
CPE	Customer Premises Equipment
EC	European Commission
eNB	eNodeB (LTE femtocell or small cell)
EPC	Evolved Packet Core
GSM	Global System for Mobile Communications
HSPA	High Speed Packet Access
HSS	Home Subscriber Server
IEEE	Institute of Electrical and Electronics Engineers
ITS	Intelligent Transport System
LTE	Long Term Evolution
M2M	Machine to Machine
MNO	Mobile Network Operator
MTC	Machine Type Communication
OPEX	Operational Expenditure
OTT	Over The Top
QoE	Quality of Experience
QoS	Quality of Service
SDN	Software Defined Network
SME	Small Medium Enterprise
UMTS	Universal Mobile Telecommunications System

V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
V2X	Vehicle to Anything
VM	Virtual Machine
VMNO	Virtual MNO
VNF	Virtual Network Function
VoLTE	Voice over LTE
WAMCS	Wide Area Monitoring and Control Systems
XaaS	Anything as a Service

1 Introduction

This document provides detailed descriptions of the most relevant use cases for the 5G system concept. The documentation of the use cases has followed a common template which is provided in section 1.2 below.

The identified use cases have been categorised in:

- "Improved performance" use cases
- "Convergent core" use cases

1.1 Objective of this document

This document proposes a first set of use cases for a 5G System concept, and identifies the requirements on the 5G converged control plane.

1.2 Template for use case description

This template should be used for the description of use cases in order to capture a significant part of them in a uniform manner. Not all items are mandatory. Optional items are preceded by “O” .

M-1. Name/identifier

M-2. Description of use case

-- Context, scenario

-- Goal to be achieved

-- Source for requirements

M-3. Functional requirements

M-4. Non-functional requirements – performance

O-5. Actors involved / stakeholders

O-6. General assumptions

O-7. Systems involved

-- Platforms

-- Edge devices

-- Tools

O-8. Steps / Sequence of interaction

O-9. Expected impact on the domain problem

O-10. Validation methodology

2 Improved performance

2.1 Mobile and Wireless Networks Connectivity Dynamic Management and Optimization

2.1.1 Description of use case

Originator: IT-Aveiro

Mobility management and connectivity optimization mechanisms shall be made available by the networking procedures that will compose the base operations of the upcoming 5G architecture. This can be achieved by exploiting the flexibility of SDN procedures in partaking of wireless aspects, going beyond backstage core control of network end-nodes, and actually reach into the wireless entities. Moreover, such procedures can be realized in a dynamic way considering current conditions of the network (i.e., capacity, load), the connectivity experienced by the mobile terminal (i.e., signal strength) and the requirements of the current flow session (i.e., more bandwidth, less latency).

2.1.2 Functional requirements

The SDN control path shall be extended down to the wireless network end-nodes, allowing them to be controlled for the realization of mobility management and connectivity optimization procedures

The SDN control path shall be extended down to the mobile terminal, allowing it to be controlled by the network for mobility and connectivity procedures, as well as to report back on connectivity conditions, and even on application traffic flow requirements.

The SDN control entity will be able to interface with other network entities who are in charge of networking procedures (e.g., QoS, Security, Virtualization) that can be impacted by mobility, allowing for a harmonious operation.

2.1.3 Non-functional requirements – performance

The connectivity and mobility procedures must be realized in a way that considers the type of mobility subscribed (i.e., seamless vs. non-seamless) and without impacting the service subscribed by the user (i.e., low latency).

The capability of the control entities involved in the mobility and connectivity procedures must be able to deal with large amounts of users without suffering any performance impairment, or scalability issues. Moreover, it must be able to support a dynamic assessment of the current conditions. Concretely, this scenario aims for the consideration of new “profile” aspects in 5G, namely the capacity of having the latency (and other parameters) more dynamic. For example, the user starts to use an app that has no latency requirements. This would dynamically update the latency profile of the user for that specific data flow, and would allow the network orchestration mechanisms to re-allocate (virtualised) resources from that user to others with higher requirements. Conversely, the opposite action is also supported, in the sense that more resources can be requested as data flows with more stringent requirements can be requested by the user, triggering the networking procedures to obtain more capacity/resources for their forwarding.

2.2 Ultra high availability and reliability provisioning in mobile networks

2.2.1 Description of use case

Originator: Huawei

As mentioned in the NGMN white paper, the potential 5G services in many scenarios requiring very different reliability and availability requirements. For instance, scenarios like eHealth for extreme life critical type of services cannot tolerate unavailable or unreliable system. However, not all the potential services require the same level availability and reliability as such. For instance, certain MTC service may tolerate 8.76 hours system down time per year (which implies 3-9 availability), upon which, the packet loss ratio should not be higher than 0.1% for 99% of contract time, Another example is, if an end user cannot browse a web, he/she may simply try later, meaning, reliability and availability is less an issue for this case. Therefore, the reliability and availability requirements are very diverse between services, which need to be supported by the 5G system. For instance, the eHealth service provider X provides remote health monitoring service, and correspondingly provider X also develops three different business models which target different user groups:

- Elderly Group (Group A): Provider X cooperates with hospital Y to provide health monitoring and emergency rescue services. Meanwhile, provider X may also provide medical instruction reminder services, e.g. take tablet at 17:00, or drink 0.5 l water every two hours, etc. Their targeted user group is elderly people (living in elderly care homes or residential area). If an elderly person has a heart attack (e.g. his/her heat beat increases dramatically in a short time period), such signal should be identified and corresponding information should be transmitted back (together with geographical location) to the hospital and trigger emergence service immediately. This user group is considered as a high risk group, which require ultra-high reliability and availability.
- Youngster Group (Group B): Provider X provides the body condition monitoring, statistic collection, and/or training assistance services to the end users for sports and exercise purposes. This targeted user group is normally youngster people. For such type of services, service may be tolerant to temporary unavailable system, for instance, the measured data could be stored in the mobile device. Once the system is available, high reliability is required, meaning, the collected data should not be lost during the transmission, e.g. the probability of packet loss rate lower than 0.01% should be 5-9.
- Special Event (Group C): Provider X provides short-term health monitoring and information pushing services for temporary events, for instance city marathon. Such event may easily have more than 10000 participants. This user group is also a high risk group, because not all the participants are professional or well-trained athletes, and they are challenging their physical body limitation. Services provided for this type of events are used temporally (e.g. several hours) and may require ultra-high availability and reliability and may also require high throughput due to the high density of targeted users.

2.2.2 Functional requirements

Availability and reliability should be configurable and provided to the end users as a service, because not all the devices requires five-nine or higher availability and reliability requirements, for instance, delay and fault tolerant sensor type devices.

Availability and reliability could be provided on-demand (e.g. for special event).

For certain group of devices (e.g. machine type devices), they may use the same availability and reliability requirement. For certain group of devices (e.g. smart phones, tablets, etc.), a single device may use services that enforce one or multiple availability and reliability levels.

Availability and reliability provisioning mechanism should be functional for the device with or without mobility.

The system should have the self-healing capability (especially for software type failure), e.g. system component failure detection, VM rebook and service reload, VM migration from failed site to another site, etc.

2.2.3 Non-functional requirements – performance

Provision system availability at level of five-nines or better, e.g. "Five-nines" means unscheduled downtime less than 5.26 minutes per year and "Four-nines" means unscheduled downtime of less than 52.56 minutes per year.

System ultra-high availability provisioning design should not cause dramatic CAPEX or OPEX, or at least such feature investment in the 5G system should be comparable or lower than the service revenue.

Taking the three user groups defined in the use case section as the example, the service requirements can be specified as the following table.

Table 1 Service requirement examples for different user groups

Group	Availability*[3] [4]	Reliability**	Capacity	User density	Mobility	Duration
A	H	H	Low	Low	Low	Long term
B	L	H	Low	Low	Mid-Hi	Long term
C	H	H	Mid-Hi	High	Mid-Hi	Short term
Note: (*): Availability Class can be low (L: no requirement), Default (D: 3-9/4-9) or High (H: e.g. 5-9 or higher). Note: (**): Reliability Class can be low (L: no requirement), Default (D: 3-9/4-9) or High (H: e.g. 5-9 or higher)).						

[3] "Five-nines" means unscheduled downtime of less than 5.26 minutes per year

[4] "Four-nines" means unscheduled downtime of less than 52.56 minutes per year

2.3 WAMCS (Wide Area Monitoring and Control Systems)

2.3.1 Description of use case

Originator: Huawei

A wide area measurement and control system (WAMCS) consists of advanced measurement technology, information tools, and operational infrastructure that facilitate the understanding and management of the complex behaviour of large service infrastructures, e.g. smart grids of power systems. 5G System shall support wide area measurement control systems involving end to end transmission of small amount of data with low latency, flexibly exploiting the heterogeneous available access technologies.

Typical WAMCS components are substations (measurement units and actuators), data concentrators, data buffers and application software such as energy management system.

2.3.2 Functional requirements

Due to their geographical distribution, the connectivity to the substations may require the core network to enforce low latency requirements across heterogeneous wireless (UMTS, LTE, 5G, WiFi, mm-wave), wired (xDSL) and satellite access networks. This use case involves the realization of a convergent core network, capable of enforcing low latency requirements for devices connected through heterogeneous (fixed and wireless) access technologies.

Since low latency requirements apply only to specific devices and applications (e.g. connectivity between substations and data concentrators, data buffers and application software of wide area monitoring and control systems), the 5G infrastructure may support configurable control plane procedures (such as attachment, service request and paging in wireless networks) in order to provide the performance intended for reliable low latency communication only to those devices and applications. For instance, substation could be always-on or always-attached.

Performance requirements are derived from EC FP7 project METIS Deliverable D.1.1:

- Throughput: from 200 to 1521 bytes reliably delivered in 8 ms, corresponding to a range between 150 kbps and 1.5 Mbps.
- End-to-end communication latency between substations and application software: 8ms.
- Device density: dense urban, hundreds per square km; urban: around 15 substations per square km; populated rural: up to around 1 substation per squared km.

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2.3.3 Non-functional requirements – performance

The criticality of the application determines tight security requirements. Substations, data concentrators, data buffers and specific application software must authenticate each other when exchanging data and commands. Authentication supported by the 5G infrastructure or delegated to the WAMCS components. For instance, as low latency in the control plane procedures is required, authentication could be skipped for always-attached substations, delegating it to a service-specific certification hierarchy implemented by the WAMCS components (data concentrators, data buffers, application software); this solution results in an “augmented” data plane, capable of taking in charge some control plane functions (such as authentication in this case) for some applications and devices.

2.4 Dense urban information society

2.4.1 Description of use case

Originator: Deutsche Telekom, Ericsson

Connectivity is to be ubiquitously (time and space) provided in dense environments, enabling human to human and human to cloud communications, as well as direct communication of humans with their environment (e.g., sensors). Communication types vary between conversational audio/video, instant and e-mail messaging, web browsing, video audio streaming etc. For these communications the same quality of experience should be perceived regardless of whether the user is at the workplace, enjoying leisure activities, is walking or driving. Furthermore, users tend to move in “dynamic crowds”, for example people who are waiting at a traffic light, people traveling by public transportation. This leads to sudden peaks of local mobile broadband demand. The usage is corresponding to METIS scenario “Great service in a crowd” focussing on providing mobile broadband experience even where very high user densities require extreme area capacity (i.e. about 1000 times the data volume, 10-100 times the data-rate and 10-100 times the number of devices as compared with today)[5].

2.4.2 Functional requirements

Connectivity shall support traffic patterns deriving from "dynamic crowds", i.e. mobility and session connectivity management supporting pedestrian and vehicular mobility up to 50 km/h, as well as grant of acceptable latency and security/privacy as today which however should be available especially in case of peak data volume, data rate, and device density.

2.4.3 Non-functional requirements – performance

QoE shall be provided with continuity in the environment where communication service is deployed.

Efficient delivery of data packets (e.g., sending the video stream once and not multiple times for multiple users).

High Availability and high Reliability (95%) in time and space.

Energy efficiency in terms of device battery drainage and energy consumption of infrastructure should be reduced reasonably by 50-70%.

Latency requirement:

- 0.5 [s] for web traffic
- Less than 0.5 [s] until video starts

User mobility:

- Most users: up to 3 [km/h]
- In some cases up to [50 km/h]

Throughput:

- Downlink: 300 [Mbps]
- Uplink: 60 [Mbps]

[5] METIS Deliverable D1.1 ”Scenarios, requirements and KPIs for 5G mobile and wireless system”, ICT-317669-METIS/D1.1, March 2013

2.5 *Real-time remote computing for mobile terminals*

2.5.1 Description of use case

Originator: Deutsche Telekom, Ericsson

The system enables remote execution of applications on behalf of the mobile terminals. Certain complex processing tasks (e.g. augmented reality services such as real-time text translation abroad for tourists or problem solution support for industrial technical maintenance applications) are shifted to a remote server, whereas the terminal itself only serves as a user interface and therefore can relieve its own local processor units.

These remote services should not only be available in stationary and slow-mobility scenarios (e.g. in the office) but also on-the-go at higher speeds, e.g. on their way to the work either while using public transportation or while driving their cars.

The automotive and transportation industry will rely on remote processing to ease vehicle maintenance and to offer novel services to customers with very short time-to-market. This requires robust communication links with very low latencies together with an availability that is close to 100%, while moving at velocities up to 350 [km/h].

2.5.2 Functional requirements

Remote applications/services shall be centrally maintained and updated without user interaction.

Data and applications – such as augmented reality – shall be accessible to all users regardless of the terminal processing capabilities.

Real time remote computing shall be supported for high speed devices.

Service deployment shall be simplified to achieve a short time to market.

To uphold service level during user movement change of data centre for remote computing should be supported.

Service should also be deployable in different (visited) operator networks (Roaming).

To optimize service performance the service should be following the users.

2.5.3 Non-functional requirements – performance

Latency: less than 10 [ms]

Reliability: 95%

Availability: 99%

Data rates: 100 [Mbps] DL and 20 [Mbps] UL

Mobility: up to 350 [km/h] for trains (lots of users in one train(up to 300)), up to 250 [km/h] for cars (small amount of users in one car (up to 5))

2.6 Massive deployment of sensors and actuators – MERGED WITH 3.7 (M2M)

2.7 *Traffic efficiency and safety*

2.7.1 Description of use case

Originator: Deutsche Telekom, Ericsson

Cooperative Intelligent Traffic Systems (C-ITS) will be integrated into 5G to make more efficient use of road infrastructure and to reduce risk for traffic incidents. C-ITS includes cooperative active safety (e.g. the system can warn drivers of dangerous situations and intervene through automatic breaking and steering if the driver is unable to avoid an accident) as well as cooperative driving applications such as highly automated driving in platooning (road-trains) to reduce travel time, fuel consumption and increase road safety and traffic efficiency.

In addition to V2V and V2I cooperation, also the cooperation between vehicles and vulnerable road users, e.g., road workers, pedestrians and cyclists, through their mobile devices will be an important key element to improve traffic safety.

C-ITS systems rely on timely and reliable exchange of information. Common to most applications are real-time requirements, and strict requirements on reliability and availability, especially when considering high mobility and large message sizes. End-to-end latency requirements need to be guaranteed for all V2X transmissions. Data is sent either event-driven or periodically.

Different air interfaces are used for autarkic communication between participants. Furthermore, an interaction between those autonomous systems and the mobile infrastructure is required to achieve the high security, latency, and velocity demands.

2.7.2 Functional requirements

Support of radio technologies for high (V2I) and low (V2V) relative velocity and variable detection range (e.g. up to 120m on highways)

Uni-, multicast, and broadcast communication.

Relay function and storage possibility in case of base station absence.

Data is sent either event-driven or periodically with a rate of about 5 - 10 [Hz]; works in parallel.

Secure communication with secure protocol (e.g. to protect messages for alteration) and authentication and authorization entity in the network to make sure that only “certified” devices are participating.

2.7.3 Non-functional requirements – performance

Latency, end-to-end (including detection delay) for receivers within the target range

Real-time requirements

Strict requirements on reliability (99.999%) and availability (100%) to be able to rely on the system.

End-to-end latency: less than 5 ms for message sizes of about 500 - 1600 bytes

Relative speeds of up to 500 km/h are possible on high-speed trains

Communication Range: up to 1 [km] (highway), 500 [m] (rural), and 300 [m] (urban)

Data rate: ~ 100 [kbps]

Relative speed of vehicles (0 – 250 [kmh])

2.8 Service flow based frequency band selection

2.8.1 Description of use case

Originator: NEC

In order to meet expectations on ultra-high speed packet access in 5G, frequency bands above 6GHz may be assigned to build a suitable radio network. Such mmWave band implies radio propagation characteristics which are different from the frequency bands used for current 3G/4G i.e, 900MHz, 2GHz.

Services like VoLTE are becoming popular and deployed all over the world, but may not suit the 6GHz frequency band due to its radio propagation characteristics, e.g. signal loss. Services like VoLTE do not have large bandwidth requirements, in particular not with efficient coding schemes such as AMR.

Goal to be achieved: Depending on a service, the 5G system is capable to choose the best frequency band to be used to meet the service flow's expectation.

Source for the requirements: Enable real-time communication services, such as IMS, in 5G for moving users.

2.8.2 Functional requirements

Based on the knowledge of a service flow in the core network, the core notifies the base station how the specified service flow is to be treated over the radio, assuming that the base station support multiple frequency bands to terminal.

2.8.3 Non-functional requirements – performance

Best matching performance

3 Convergent core

3.1 Access Agnostic Convergent Core Network

3.1.1 Description of use case

Originator: Huawei

5G System shall feature an access agnostic core autonomously tailoring the connectivity service according to the contract agreement with the user, the device type, the enabled service/application type, User Context information (e.g. location, mobility profile etc.), Network load and Resource availability and related cost.

Motivations

From Cisco 2014 and Ericsson 2015 white papers on traffic and devices trends, the following conclusion can be highlighted:

- new Access technologies are always preferred to carry new devices traffic, but their penetration is always moderate compared to legacy systems;
- offloading to WiFi is an increasing trend for cellular networks, affecting more high performance RAT than legacy ones;
- the device type gives hints on the expected bandwidth greediness of the subscriber;
- by 2020, it is likely to expect a distribution of a heterogeneous set of devices, a significant proportion of which will have multi RAT capabilities;

Considering these trends an forecast, we formulate the *Access Agnostic Convergent Core Network* Use Case as follows.

From trends summarised above, we assume by 2020 a very high penetration of devices requiring **connectivity** will characterise densely populated urban areas. Devices (which will be either static, or nomadic, or mobile) will include laptop PC, tablets, smart phones, wearable devices and household appliances. Such devices will embed multiple access technology chipsets, e.g. legacy HSPA, LTE, IEEE802.16x, IEEE802.11xx, IEEE802.15.4, plus all new forthcoming technologies being developed. Connectivity will be the primary requirement for devices to provide the service(s) they are meant for. Services might be provided either by the same business (possibly virtual) actors providing connectivity, or by OTT entities. Each type of device will support a subset of all possible services, and some services will be supported by multiple types of devices.

By 2020, the deployment of physical access infrastructures, including cellular networks, WiFi hotspots, home xDSL connection, will have created a heterogeneous scenario where a variety of technology shall provide ubiquitous broadband access. Mobile Network Operators (MNOs) or Virtual MNO (VMNOs) will deploy or will lease a mixture of physical access infrastructure to build their network and to serve efficiently their customers. MNOs and VMNOs will provide their customers with contracts guaranteeing mobile broadband connectivity according to devices capabilities and subscriber profile, integrating their physical / virtual access infrastructure

5G system shall enable MNOs and VMNOs to handle efficiently such scenario.

Just ass example, let's narrow down the description considering as device a multi-RAT smart phone (e.g. supporting LTE, HSPA and IEEE802.11x) by which a user can access different services, including instant messaging (e.g. Whatsapp and Messeger Apps) and Video Downstream (e.g. Youtube App). The user can access the services in different situations, e.g. when on his way to work sitting in a bus, or at work sitting at his desk, or in a restaurant while dining out. (***Nowadays, the user himself is***

concerned about convergence, as he switches on/off data card and/or wifi according to his own convenience and context!)

When the user switches on his devices, or when the user starts using one application, the network shall be able to provide the required connectivity exploiting the most convenient available access infrastructure from MNOs/VMNOs perspective, still fulfilling quality requirements as per the contract agreement with the customer. Note that the “required connectivity” will have very different requirements according to user context and application e.g. Downstreaming an HD video from Youtube while riding a bus, vs. texting with Whatapp while sitting at work.

The way MNOs/VMNOs will provide connectivity to the use shall depend on:

- The contract agreement with the user;
- The device type;
- The service/application type;
- User Context information (e.g. location, mobility profile etc);
- MNO/VMNO Network load;
- MNO/VMNO Resource availability and related cost.

To handle this Use Case scenario and enable MNOs/VMNOs to serve their population of customers, an Access Agnostic Converged Control plane shall be the kernel of 5G system.

From MNOs standpoint, the integration of fixed and wireless access infrastructure should:

- Facilitate the provisioning of Mobile Broadband connectivity to wider geographical areas and to a higher percentage of the population/devices.
- Improve the efficiency in the exploitation of physical infrastructure, providing services and allocating networking infrastructure (access, back-hauling, and transport) according to economic criteria.
- Simplify the network operation and management (OPEX reduction).

From a VMNO standpoint, the integration of fixed and wireless access infrastructure should simplify the deployment and operation of virtual network to provide connectivity (CAPEX reduction).

3.1.2 Functional requirements

5G Core Network shall coordinate the transmission of System Info by all access nodes, to enable user devices to scan and detect all connectivity options according to their subscription, access capability and context.

At power on, the device shall select a connectivity technology based on its subscription, access capability and context, and perform a 5G Attach procedure with the 5G Core. The procedure shall include Authentication, Authorisation, Addressing, Security Info exchange.

At the 5G Attach, the 5G Core shall tailor the connectivity service provided to the device according to:

- The contract agreement with the user;
- The device type;
- The enabled service/application type;
- User Context information (e.g. location, mobility profile etc);
- Network load;

- Resource availability and related cost.

At the 5G Service Request (either User/Device originated or User/Device terminated), the 5G Core shall modify the connectivity service provided to the device according to:

- The requested service/application;
- Updated User Context information Update Network load info;
- Update Resource availability and related cost info.

While the device is attached or a service is ongoing, the 5G Core shall allow connectivity or service continuity, whenever a change of access technology may occur, due to:

- Incomplete coverage by a given access technology;
- Load Balancing Offloading;
- Cost driven offloading;
- System Capacity optimisation (Interference management).

3.1.3 Non-functional requirements – performance

This use case is not about KPIs so no performance statement is given. However what would be necessary is to identify evaluations metrics that allow cost vs. performance comparisons. This is outside the scope of this document.

3.2 *Customer-specific MVNO*

3.2.1 Description of use case

Originator: Orange

In this use case, Operator provides a specific "VNFs catalogue" for Business market, providing capability for a third party to operate itself those chosen VNFs.

Network services proposed could be also linked to the automatic declaration of third party **physical** nodes, through interfaces with an "orchestrator", managing the external nodes integration in the operator network infrastructure.

Parts of the Operator VNF platforms could be rented out to third parties like Business client or MVNOs to enable the provision of services and applications with specific requirements (extremely low latency to end users, …). Besides the XaaS (Everything as a Service) business models that could be facilitated, the flexibility of a cloud, coupled with SDN and NFV technologies, also makes the network easier, faster, and cheaper to deploy and manage.

As an example, the Third party business client has chosen to operate itself functions through virtualization model:

- Identification and Authentication function, meaning that the third party is managing itself the user profiles and services database,
- Service chaining, meaning that the third party is managing itself the network services (for example composed of firewall, optimization, accounting, …)

3.2.2 Functional requirements

- Operator should integrate Third party VNF(c)s inside the 5G system, in a very flexible way, reducing the manual operations to the minimum.
- Operator should integrate external nodes inside the 5G system, in a very flexible way, reducing the manual operations to the minimum.

3.2.3 Non-functional requirements – performance

Set up time for interconnecting third party network around 1 week.

3.3 Interim Network Coverage

3.3.1 Description of use case

Originator: Orange

An operator is specialized in providing connectivity for big events, such us sport, music, and parties. To accomplish this objective, the operator has partnerships with different infrastructure providers, namely Wi-Fi Hotspot providers, other mobile providers etc. In particular, it has a special partnership with a SME that provides nomadic base stations (eNBs) mounted on top of trucks. These temporary network access components can be placed in any location where big events occur, and they can be linked with core network components or with datacentres where virtualized elements (e.g., mobile core elements) are located.

3.3.2 Functional requirements

Capability of integrating access infrastructures

3.3.3 Non-functional requirements – performance

Set up time for integrating temporary access infrastructures around 1/2 days meaning a capability for the Core network in: declaring new access nodes in the IS system for provisioning related to addressing / routing from and towards those Access nodes, and dynamic authenticating of nodes and users.

3.4 (removed)

3.5 (removed)

3.6 *Fixed-Mobile-Convergence use case*

3.6.1 Description of use case

Originator: Deutsche Telekom, Ericsson

On his way home, Bill receives an enriched conversational call (voice and video) to which he replies during driving his car via head-set or car-built-in loudspeaker/microphone (in case of using public transport, e.g. bus, he might receive a video signal on a side-zone of his augmented reality glasses). The call is received via the mobile network of the operator he has a contract with. Alternatively the call might be received via the car/bus communication equipment and relayed via Bluetooth/Wi-Fi towards Bills user equipment (head-set) or mobile terminal (smartphone).

Arriving in front of his home and leaving the car/bus the call is continuing via the mobile user device directly. After entering the house, the communication will be transferred to his wireless local area network. This fixed network connection towards the residential gateway and/or the local (home) area network might be managed by the same operator or by another operator. As soon as available (and depending on e.g. pre-selected policies and current situation, such as presence of other people), the communication session will be seamlessly transferred to a locally installed display (e.g. wall screen, surround audio system) – possibly including a camera for video return channel. The communication may change from pure telephony to a video call. The session transfer will also have a huge impact on the service performance requirements (e.g. higher resolution/quality demanding for more bandwidth).

Note: The application could also comprise joint editing of a document (file sharing) or instead be a live broadcast of a cultural (theatre) or sports event (soccer league game) or participation in interactive gaming with traffic streams of differing symmetry.

3.6.2 Functional requirements

Network controlled mobility and QoS/QoE management across different domains (access technology, network infrastructure, operators) has to be provided seamlessly (without user intervention).

Communication security and privacy across all participating systems (cellular network, fixed network, home network - federation is needed) has to be ensured.

Context aware content adaptation shall be invoked considering device and network capabilities.

Overall requirements:

- Federation of ID-management systems for consistent secure, private, and reliable session provisioning.
- Effective control and management system for the heterogeneous access technologies (variable mobility, QoS/QoE)
- Context management platform feasible of environment (device, network, location) specific adaptation of service (e.g. resolution) and session parameters (e.g. bandwidth, privacy and security measures as registration and authentication procedures).

3.6.3 Non-functional requirements – performance

For user satisfaction and acceptable (business customer) service quality the performance should at least exhibit following criteria:

- Availability of minimum transmission capacity in urban/suburban, roadside and residential environment (e.g. 364 kbit/s)

- Real-time latency and synchronisation requirements (conversational: less than 100 ms delay) and low-loss session hand-over (imperceptible audio/video degradation e.g. packet loss <10E-03) mechanisms for a consistent QoE between devices, between technologies, especially between different network operator domains.
- Availability of powerful end-devices and CPEs (multiple network interfaces, high quality user interfaces, interaction with context system to provide required information)
- Adaptive/brokered resource provisioning meeting bandwidth and QoS requirements according to service demand and the different technologies' capabilities.

3.7 M2M

3.7.1 Description of use case

Originator: Telenor, Deutsche Telekom, Ericsson

M2M devices such as sensors and actuators mounted to stationary or movable objects enable a wide range of applications connected to monitoring, alerting or actuating. Possible applications are monitoring of environment, materials, structures and critical components, such as buildings, wind mills, high-speed trains and applications connected to agriculture. Furthermore, portable objects may be equipped with tiny tags for the purpose of tracking the location of the objects or monitoring the usage or environment of these objects.

The M2M devices typically need to only transmit data occasionally, e.g. in the order of every minute, hour, week. However in some cases the devices may need to be able to issue an alert too. The devices may further be used to enable remote actuating, e.g. in the context of smart cities to dynamically adapt traffic flows, access or lighting, or in the context of connected buildings to control access, temperature, lighting. So although the traffic volumes are low the challenge with M2M is the massive number which needs to be supported by future cellular networks.

The EPC for 4G was primarily designed for human communication wherein the signalling is dwarfed by the actual payload. However, for most of the M2M, where the number of connections is very high, signalling is of prime concern compared to the very small data volume (e.g., in the order of 20 to 125 [byte] per message). This is where the traditional connection oriented signalling, where in you first establish the connection and then the actual transmission begins, is not optimal for M2M for e.g in terms of scalability, power efficiency and delay (although latency requirements for some applications may be moderate, i.e. in the range of a few seconds). Secondly there are M2M applications such as e-health, traffic safety which require high reliability. Also the mobility requirements are differing between stationary, portable, and high speed moving ones. Furthermore the architecture of the M2M access network will be diverse both in terms of technology and also in the way the devices connect to the base station (Direct or via gateways). This new M2M paradigm calls for network preparedness especially in the mobile core.

3.7.2 Functional requirements

To support massive M2M deployments the 5G core should be

a) light weight in terms of signalling,
b) should have a short connection setup time,
c) shall be highly scalable with respect to amount of managed devices,
d) should meet the reliability demands of mission critical M2M services, and
e) shall be flexible to support M2M with diverse requirements.

To this end an architecture of the mobile core is needed, which

a) enables the control plane to scale independently from the data plane,
b) allows some of the M2M devices to be handled locally in the edge,
c) has M2M specific policies and counters,
d) is able to infer the context of the M2M communication and also get advanced notification of massive signalling built-up,
e) can program the network all the way to M2M devices including the M2M gateways,
f) can provide adaptive Security, ID-Management,
g) is able to differentiate between mobile and non-mobile devices.

3.7.3 Non-functional requirements – performance

- Handle massive M2M devices (~300K/cell)
- Coverage almost everywhere (99.9%)
- Five-nines for mission critical M2M applications.
- Low latency for delay critical M2M applications.
- Small net payload in the order of 20-125 bytes per message with often moderate latency requirements in the range of few seconds.
- Very low energy consumption: about 0.0153 [µJ/bit]
- Very low cost devices (cheaper than GSM) with long battery lifetime (end-device) (more than 10 years)
- Security grade dependent on application