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Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

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Version x.y.z

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  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

The present document provides a summary of each and every 3GPP Release 15 Feature, and more generally of all Work Items for which a summary has been agreed to be provided.

These summaries are based on the inputs issued by the Work Item Rapporteurs, slightly rewritten by the TR Rapporteur to ensure overall consistency. The original Work Item Rapporteur inputs can be retrieved as temporary document (tdoc), as stated in the first sentence of each clause.

1 Scope

The present document provides a summary of each Release 15 Feature or, whenever needed, of each significant Work Item.

The information provided in the present document is limited to an overview of each Feature, explaining briefly its purpose and the main lines of the system's behaviour to execute the Feature.

More information is available by consulting the 3GPP Ultimate web site, as explained in "Annex C: Process to get further information".

The present document presents the "initial state" of the Features introduced in Release 15, i.e. as they are by the time of publication of the present document. Each Feature is subject to be later modified or enhanced, over several years, by the means of Change Requests (CRs). It is therefore recommended to retrieve all the CRs which relate to the given Feature, as explained in Annex C, to further outline a feature at a given time.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document.*

[1] TR 21.905: "Vocabulary for 3GPP Specifications".

NOTE: Due to the specificity of the present document, consisting in a collection of independent summaries, the references are given at the end of each clause rather than in this clause.

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply.
An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1]. Abbreviations specific to a given clause are provided in the clause they appear.

KPI	Key Performance Indicator
Rel	3GPP Release

4 Rel-15 Executive Summary

3GPP main area of work in Release 15 is the definition of the initial phase of 5G, the Fifth Generation of Mobile Communications, also referred to as "5GS" ("the 5G System").

5G is to be defined in at least 2 phases, the phase 1 being specified in Release 15, as summarised in the present document. Subsequent phase(s) will be specified in future Release(s).

Beside 5G Phase 1, Release 15 also specifies, among other Features: further enhancements on Critical Communications (including Ultra Reliable Low Latency Communication and Highly Reliable Low Latency Communication), Machine-Type of Communications (MTC) and Internet of Things (IoT), Vehicle-related Communications (V2X), Mission Critical (MC), and features related to WLAN and unlicensed spectrum.

The continuation of the present document provides an exhaustive view of all the items specified in Release 15 by 3GPP.

5 The 5G System (5GS) - Phase 1

5.1 Work organisation for 5GS

The 5G System is the main topic of 3GPP Release 15. Release 15 defines the 5G system Phase 1, while the 5G system Phase 2 is to be defined in Release 16.

The specification of Phase 1 has involved all the 3GPP Working Groups and TSG, defining all the (many) necessary aspects.

The table in Annex A provides the overall view of all the 5G-related work items in Rel-15, including their hierarchical structure.

Next clauses provide a summary of 5G System service aspects, its architecture, the protocols, the radio aspects and several specific aspects such as security, charging, etc.

5.2 The 5GS service aspects

Unique_ID	Name	Acronym	WG	WID	WI Rapporteur
720005	**(Stage 1 of 5G) New Services and Markets Technology Enablers**	SMARTER	S1	SP-160364	Vodafone , Li, Alice

Summary based on the input provided by Vodafone in SP-180883.

The 5G requirements have been defined in terms of new services and markets by SA1, under the "SMARTER" work item. These are defined mostly in TS 22.261 [1], which describes different types of requirements for different 5G usage:

- **Enhanced Mobile Broadband (eMBB):** the new requirements -higher than for 4G- are specified for data-rates, traffic/connection density, user mobility, etc. Various deployment and coverage scenarios are considered, addressing different service areas (e.g., indoor/outdoor, urban and rural areas, office and home, local and wide areas connectivity), and special deployments (e.g., massive gatherings, broadcast, residential, and high-speed vehicles). The scenarios and their performance requirements can be found in table 7.1-1 of TS 22.261 [1]. For instance, for the downlink, data rate of up to 50 Mbps are expected when outdoor and 1 Gbps when indoor (5GLAN), and half of these values for the uplink. For services to an airplane, a bitrate of 1,2 Gbps is expected per plane.

- **Critical Communications (CC) and Ultra Reliable and Low Latency Communications (URLLC)**: Several scenarios require the support of very low latency and very high communications service availability. These are driven by the new services such as industrial automation. The overall service latency depends on the delay on the radio interface, transmission within the 5G system, transmission to a server which may be outside the 5G system, and data processing. Some of these factors depend directly on the 5G system itself, whereas for others the impact can be reduced by suitable interconnections between the 5G system and services or servers outside of the 5G system, for example, to allow local hosting of the services. The scenarios and their performance requirements

can be found in table 7.2.2-1 of TS 22.261 [1]. For instance, in the context of remote control for process automation, a reliability of 99,9999% is expected, with a user experienced data rate up to 100 Mbps and an end-to-end latency of 50 ms. This is provided in particular through the Edge Computing capability described below.

- **Massive Internet of Things (mIoT)**. Several scenarios require the 5G system to support very high traffic densities of devices. The Massive Internet of Things requirements include the operational aspects that apply to the wide range of IoT devices and services anticipated in the 5G timeframe.

- **Flexible network operations**. These are a set of specificities offered by the 5G system, as detailed in the following sections. It covers aspects such as network slicing, network capability exposure, scalability, and diverse mobility, security, efficient content delivery, and migration and interworking.

This diversity of requirements, associated to the different categories of usage described above, enables the use of the 5GS by different sectors of the industry, referred to as "verticals". Some of these verticals are mentioned in the annexes of TS 22.261 [1]:

- Automotive and other transport (trains, maritime communications),
- Transport, logistics, IoT,
- Discrete automation,
- Electricity distribution,
- Public Safety,
- Health and wellness,
- Smart cities,
- Media and entertainment.

Some of these aspects are further described in corresponding clauses of this document: e.g. Railways, eV2X and its associated requirements as defined in TS 22.186 [10], etc.

As for the migration path, the 5G system supports, in addition to the new 5G-specific services, all the former EPS (4G) capabilities that were defined in TS 22.278 [2] and in TSs 22.011 [3], 22.101 [4], 22.185 [5], 22.071 [6], 22.115 [7], 22.153 [8], 22.173 [9]. There are some exceptions, i.e. some 4G services are not supported in 5G: they relate to the interworking with legacy systems, as specified in clause 5.1.2.2 of TS 22.261. Finally, mobility between a 5G core network and an EPC (4G) is supported, with minimum impact to the user experience.

NOTE: In this document, EPS and all the other concepts related to LTE, such as "LTE Advanced Pro", will be referred to as "4G", although this is not an official 3GPP terminology.

References

[1] TS 22.261, "Service requirements for the 5G system".
[2] TS 22.278, "Service requirements for the Evolved Packet System (EPS)".
[3] TS 22.011, "Service accessibility".
[4] TS 22.101, "Service aspects; Service principles".
[5] TS 22.185, "Service requirements for V2X services".
[6] TS 22.071, "Location Services (LCS); Service description".
[7] TS 22.115, "Service aspects; Charging and billing".
[8] TS 22.153, "Multimedia priority service".
[9] TS 22.173, "IP Multimedia Core Network Subsystem (IMS) Multimedia Telephony Service and supplementary services".
[10] TS 22.186, "Service requirements for enhanced V2X scenarios".

5.3 Overview of the 5GS architecture

Unique_ID	Name	Acronym	WG	WID	WI Rapporteur
740061	**Stage 2 of 5G System - Phase 1**	5GS_Ph1	S2	SP-160958	China Mobile, Tao Sun

Summary based on the inputs provided by China Mobile, Nokia, Ericsson, Huawei in SP-180595, by Vodafone in SP-180883 and by NTT DOCOMO, INC. in RP-181724.

5.3.1 Introduction

As seen above, 5G is designed to support diverse services with different data traffic profiles (e.g., high throughput, low latency and massive connections) and models (e.g., IP data traffic, non-IP data traffic, short data bursts and high throughput data transmissions). Various PDU session types are supported including IPv4, IPv6, IPv4v6, Ethernet and Unstructured.

The 5G's main characteristic is the introduction of a new radio interface, the New Radio (NR), which offers the flexibility needed to support these very different types of services.

Another key characteristic of 5G is that the 5G Access Network can connect not only to a new 5G Core Network but also to the 4G (LTE) Core Network. This is known as the NSA architecture, while the 5G AN connected to a 5G CN is called the SA architecture.

On the Core Network side, the 5G System offers also a wide array of new characteristics, such as a deeper use of Network Slicing, Mobile Edge Computing or Network Capability Exposure. All these concepts are presented below.

5.3.2 The NSA versus SA architecture

Two deployment options are defined for 5G:

- the "Non-Stand Alone" (NSA) architecture, where the 5G Radio Access Network (AN) and its New Radio (NR) interface is used in conjunction with the existing LTE and EPC infrastructure Core Network (respectively 4G Radio and 4G Core), thus making the NR technology available without network replacement. In this configuration, only the 4G services are supported, but enjoying the capacities offered by the 5G New Radio (lower latency, etc). The NSA is also known as "E-UTRA-NR Dual Connectivity (EN-DC)" or "Architecture Option 3". See also the clause on EDCE5.

- the "Stand-Alone" (SA) architecture, where the NR is connected to the 5G CN. Only in this configuration, the full set of 5G Phase 1 services are supported.

The NSA architecture is illustrated in the following figure.

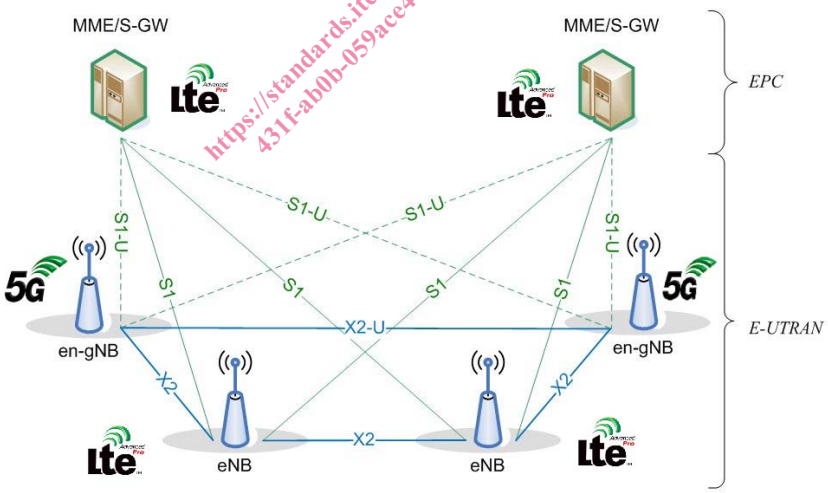

Figure 5.3.2-1: The NSA Architecture

The NSA architecture can be seen as a temporary step towards "full 5G" deployment, where the 5G Access Network is connected to the 4G Core Network. In the NSA architecture, the (5G) NR base station (logical node "en-gNB") connects to the (4G) LTE base station (logical node "eNB") via the X2 interface. The X2 interface was introduced prior to Release 15 to connect two eNBs. In Release 15, it also supports connecting an eNB and en-gNB as to provide NSA.

The NSA offers dual connectivity, via both the 4G AN (E-UTRA) and the 5G AN (NR). It is thus also called "EN-DC", for "E-UTRAN and NR Dual Connectivity".

In EN-DC, the 4G's eNB is the Master Node (MN) while the 5G's en-gNB is the Secondary Node (SN).

This is explained in detail on the dedicated section on NSA of this present document.

The SA architecture is illustrated in the following figure.

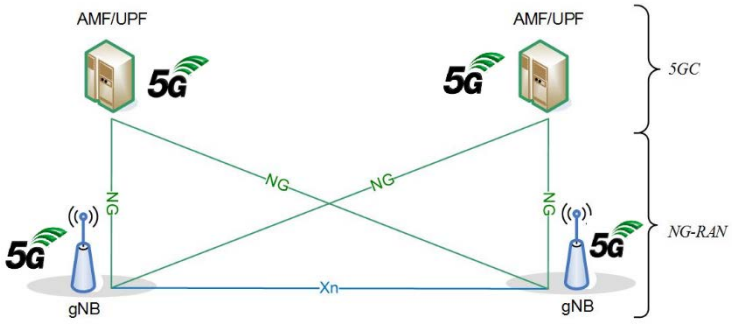

Figure 5.3.3-1: The SA Architecture

The SA architecture can be seen as the "full 5G deployment", not needing any part of a 4G network to operate.

The NR base station (logical node "gNB") connects with each other via the Xn interface, and the Access Network (called the "NG-RAN for SA architecture") connects to the 5GC network using the NG interface.

The continuation of this section refers to the SA architecture, the NSA being addressed in a subsequent, dedicated, section.

5.3.3 Overview of the Core Network

In the SA deployment option, the 5G System (5GS) is composed of the User Equipment, the Access Network (including the "New Radio" or NR) and the Core Network (5GC or 5GCN).

The service requirements, as presented in the previous clause, were used as a basis to define the architecture. The architecture specification (a.k.a. Stage 2) started with a preliminary study in TR 23.799 [4], also called "NextGen TR", before being fully specified in TS 23.501 [1], TS 23.502 [2] and TS 23.503 [3].

The 5GC architecture relies on a so-called "Service-Based Architecture" (SBA) framework, where the architecture elements are defined in terms of "Network Functions" (NFs) rather than by "traditional" Network Entities. Via interfaces of a common framework, any given NF offers its services to all the other authorized NFs and/or to any "consumers" that are permitted to make use of these provided services. Such an SBA approach offers modularity and reusability.

The basic (SA, non-roaming) 5G System architecture is shown below (figure introduced by the editor):

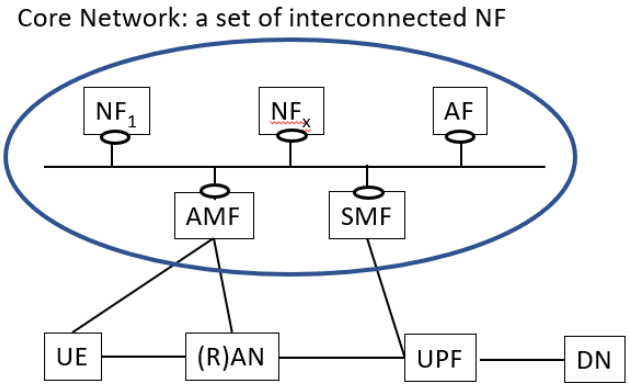

Figure 5.3.3-1: Overview of the 5G System architecture

At this stage, only the following essential Network Functions and elements are highlighted here:

- The User Equipment (UE);
- The (Radio) Access Network [(R)AN];