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5G New Radio Network Planning

Whitepaper

February 2019

Abstract- In this whitepaper, firstly, we give a brief overview of the key enabling technologies for 5G New Radio (NR). Secondly, we analyse 5G NR network planning requirements. Finally, we use Ranplan Professional to study three 5G NR deployment scenarios - fixed wireless access (FWA), outdoor urban dense small cell/HetNet deployment and stadium.

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1. Introduction

The fifth generation (5G) mobile network promises to create a platform and an eco-system to provide ubiquitous access to a wide range of applications and services. It will support both the mobile industry and verticals such as automotive, industry automation and public safety. It is foreseen that 5G will co-exist with other radio access technologies (RATs) such as LTE-A/Pro, NB-IoT, and WiFi for a considerable amount of time.

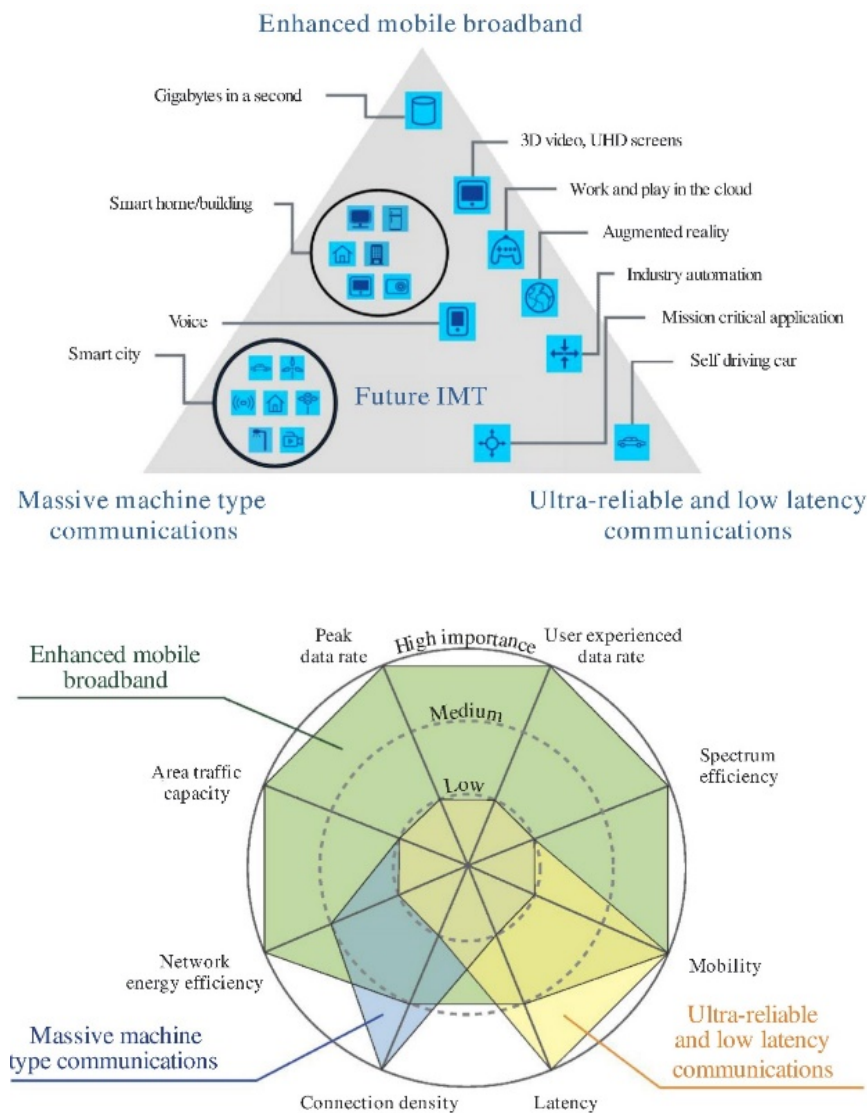


Figure 1-1. New categories in 5G [1]

In addition to supporting traditional services provided by the existing mobile networks, three new service categories are envisioned for 5G – enhanced mobile broadband (eMBB), ultra-reliable and low latency communications (URLLC) and massive machine type communications (mMTC). The eMBB category includes services such as HD video, virtual/augmented reality; the URLLC category includes services such as vehicular communication and industry automation; and the mMTC category includes services such as IoTs for smart city.

These three new categories of services have diverse requirements in terms of bandwidth, latency, mobility, connection density, and data rates, as illustrated in Figure 1-1. For example, eMBB services

place high requirements on spectrum efficiency, user experienced data rate, peak data rate, area traffic capacity and network energy efficiency. Detailed requirements of eMBB, URLLC and mMTC services can be found in the following table:

Table 1-1. 3GPP NR requirements

Use Cases	Key Performance Indicator	Specification
Enhanced Mobile Broadband (eMBB)	Data Rate	10-20Gbps peak
		100 Mbps whenever needed
		10000x more traffic
	Mobility Speed	500km/h
	Use Scenario	Macro and small cells
	Network Energy efficiency	Network energy saving by 100 x
Massive Machine Type Communications (mMTC)	Connection Density	$2 \times 10^5 - 10^6 / km^2$
	Coverage	Long Range
	Data rate	1-100 kbps
	Battery Life	10 years
	Cost	M2M ultra low cost
	Access method	Asynchronous access
Ultra-Reliability and Low Latency Communications (URLLC)	Latency	<1ms air interface latency
		5 ms E2E latency
	Reliable and Available	99.9999%
	Data Rate	50 kbps – 10 Mbps
	Mobility	High speed mobility

In order to account for a greater diversity of services that will be supported by 5G, and to be spectrum and energy efficient, 5G New Radio (NR) needs to have a much higher degree of flexibility and scalability unseen in the previous generations of mobile networks. This results in a much more complicated radio system.

To fulfil what 5G promises, 5G NR, which sits at heart of the 5G network, needs to be empowered by the following key enabling technologies:

- **Millimetre wave (mmWave) communications;**
- **Massive MIMO and 3D beamforming;**
- **Ultra-dense small cell and heterogeneous network (HetNet) deployments;**
- **Scalable OFDM numerologies: 2^N sub-carrier spacing, scalable CP, TTI, etc.**

Aiming at enabling a first phase of 5G NR deployments in 2020, a set of initial 5G NR features have been defined in 3GPP Release 15 (aka phase 1), with a frozen date at the end of June 2018. The complexity of 5G NR, the need of cost-effective deployment and the inter-working with existing networks based on multi-RATs will bring the complexity of 5G NR network planning to an unprecedented level unseen in previous generations of mobile networks.

In this whitepaper, we aim to analyse 5G NR network planning requirements and demonstrate how 5G NR networks can be planned in typical eMBB scenarios and evaluate their expected performance in terms of a set of defined key performance indicators (KPIs).

The rest of the whitepaper is organised in the following manner: In Section 2, we give a brief introduction to 5G NR specified in 3GPP Release 15, followed by the requirement analysis of 5G NR access network planning in Section 3. We will present three case studies for typical 5G NR deployment scenarios in Section 4 and draw some conclusions in Section 5.

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