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New Features in the Next Release of 5G New Radio

Hua Zhou

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Introduction

3GPP approved the first package of Release 17 working items (WIs) and study items (SIs) at radio access network (RAN) plenary #86 meeting held in December 2019. The approved WIs and SIs cover the work in RAN1 (physical layer enhancements), RAN2 (radio protocol enhancements), and RAN3 (radio architecture enhancements). Due to the global outbreak of COVID-19, the Release 17 specification time plan has been adjusted based on agreements in RAN plenary #87 meeting, as shown in FIG. 1. In this paper, we review some 3GPP Release 17 SIs/WIs mainly focusing on enhancing efficiency and performance of 5G NR Release 15/16, addressing the needs of vertical industries and support of satellites and High-Altitude Platforms (HAPs).

1. Multiple Antennas and Higher Frequencies in Rel-17

Multiple antennas, generally referred to as multiple-input and multiple-output (MIMO), and higher frequencies are areas particularly suitable for improving spectral efficiency and performance of 5G systems. Currently, operations in two frequency ranges (FRs), FR1 spanning from 410 MHz to 7.125 GHz and FR2 spanning from 24.25 GHz to 52.6 GHz, are supported in NR Rel-16. NR Rel-16 enhances Rel-15 by introducing enhanced codebooks, support for multiple Transmission Reception Point (TRP) transmissions, enhanced multi-beam operation, beam management, and low Peak to Average Power Ratio (PAPR) reference signals.

Rel-17 MIMO WI includes more efficient downlink (DL)/uplink (UL) beam management for high-speed vehicular scenarios and a larger number of Transmission Configuration Indicator (TCI) states at FR2, and panel-specific beam management for increasing UL coverage. Rel-17 MIMO WI also addresses UL dense deployment within macro-cell and/or heterogeneous-network-type deployment scenarios. In addition, Channel State Information (CSI) for multi-TRPs/panels for noncoherent joint transmission (NC-JT), which is missing from NR Rel-16, will be investigated in NR Rel-17.

In addition to enhancing MIMO operations in FR1 and FR2, frequencies above 52.6 GHz are faced with difficult challenges, such as higher phase noise, larger propagation loss due to high atmospheric absorption, lower power amplifier efficiency, and strong
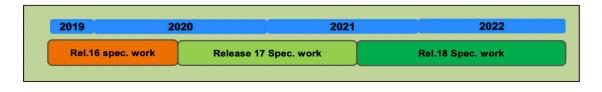

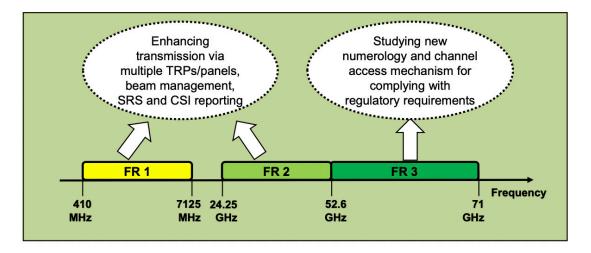FIG. 1 Adjusted timeline of 3GPP Rel-17

FIG. 2 Technology enhancements for different frequency ranges (FRs)

power spectral density regulatory requirements in unlicensed bands. FIG. 2 shows technology enhancements for different FRs. As shown in FIG. 2, NR Rel-17 SI for frequencies between 52.6 GHz and 71 GHz will i) study required changes to NR using existing DL/UL NR waveforms and numerologies, ii) identify potential critical problems to physical signal/channels, and iii) study channel access mechanisms for complying with the regulatory requirements applicable to the unlicensed spectrum.

2. Reduced Capability, Coverage Enhancements, and Power Savings in Rel-17

Connected industries, e.g., industrial wireless sensors, video surveillance, wearables, are important objectives of 5G. The requirements for the devices in these industries are more stringent than LTE-Machine Type Communication (LTE-M)/Narrow Band-Internet of Things (NB-IoT) but less stringent than Ultra-Reliable Low Latency Communication (URLCC) and enhanced Mobile Broadband (eMBB) as shown in FIG. 3. Example requirements of the devices targeting the connected industries are lower device complexity, compact device size, and support for FR1/FR2 bands in frequency division duplex (FDD) and time division duplex (TDD) transmission modes. Power Savings, lower capability, and coverage enhancements are

tightly coupled in terms of improving the spectrum efficiency and performance of the 5G systems.

Rel-17 NR light SI will i) mainly focus on defining a user equipment (UE) feature and parameter list with UE capabilities lower than URLLC, ii) study UE complexity reduction features (antennas, bandwidth, half-Duplex-FDD, processing time/capability, etc.), and iii) study UE power saving and battery lifetime enhancement. Rel-17 NR light SI will also study coverage recovery functionality associated with such complexity reduction. The main topic of Rel-17 NR light SI includes the implementation of features allowing devices with reduced capabilities to be identifiable to networks with restricted access.

Rel-17 NR coverage enhancement SI will evaluate urban (outdoor base station serving indoor UEs) and rural (including extreme long-distance) channel models for FR1, indoor (indoor base station serving indoor UEs) and urban/suburban (including outdoor base station serving outdoor UEs and outdoor base station serving indoor UEs) for channel models FR2. Rel-17 Coverage enhancement SI will focus at least on uplink shared channel and uplink control channel and also time domain/frequency domain/demodulation reference signal enhancement.

Rel-17 NR power-saving WI will address idle/inactive-mode power consumption in NR stand-alone deployments, considering both eMBB UEs and reduced capability NR devices, connected-mode power consumption with FR2 deployments, and optimizing network utilization of Rel-16 UE assistance information.

.3. Support for Vertical Industries in Rel-17

Sidelink communications have been specified in Rel-16 as a tool for UE-to-UE direct communications, which are required in various vertical industry use cases. Sidelink communications provide solutions for vehicle-to-everything (V2X). The service requirements and operational scenarios are not fully supported in Rel-16 due to time limitations for completing Rel-16 specifications. NR Rel-17 sidelink WI provides a wider coverage of NR sidelink for newly identified use cases and introduces power saving techniques, enhanced reliability, and reduced latency. In addition, Rel-17 sidelink WI includes resource allocation enhancements and sidelink Discontinuous Reception (DRX) procedures.

As an important enabler for vertical industry applications in 5G, location technologies have been specified in 3GPP Rel-16 to support regulatory and commercial use cases. However, the target positioning requirements achieved by Rel-16 does not satisfy high accuracy positioning requirements, which are characterized by ambitious system requirements for positioning accuracy in many verticals. NR positioning in Rel-17 will evaluate and specify enhancements of Rel-16 positioning technologies to meet high accuracy positioning requirements. For example, Rel-17 includes enhancements and solutions necessary to support the high accuracy, low latency, network efficiency, and device efficiency requirements for commercial uses cases, and solutions necessary to support the integrity and reliability of assistance data and positioning information.

4. Non-Terrestrial Network (NTN)

Non-terrestrial networks refer to networks using an airborne or spaceborne vehicle for signal transmissions. 3GPP approved use cases for 5G satellite integration and identified corresponding service requirements. FIG. 4 shows an example of communications via a HAP based system. NR Rel-17 NTN WI will develop specifications to support transparent payload-based Low Earth Orbit (LEO), Geosynchronous Orbit (GEO), and HAP scenario. For LEO and GEO scenarios, circular orbit at an altitude greater than or equal to 600 km will be considered. The technical area comprises timing, synchronization, Hybrid Automatic Repeat Request (HARQ), random access, DRX, scheduling request (SR), feeder link management, beam management, and bandwidth part operation.
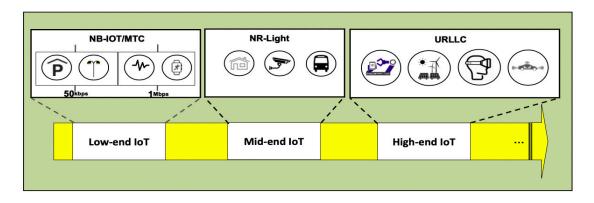

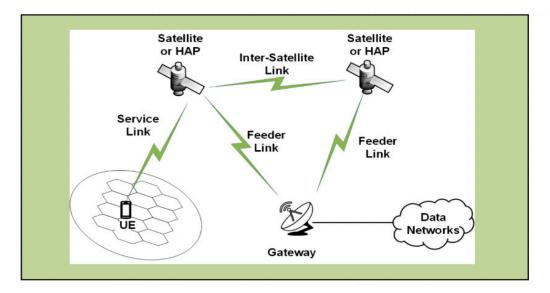FIG. 3 Technologies targeting different IoT scenarios

FIG. 4 An example of non-terrestrial network

5. Summary

This paper presents an overview of some 3GPP Rel-17 features enhancing efficiency and performance of 5G NR Rel-15/16, addressing the needs of vertical industries and supporting satellites and HAPs. There are many other features targeting different performance metrics (such as latency reduction and quality of experience (QoE) improvement) and targeting new services/applications (such as multiple cast and broadcast, multi-SiM, and eXtended Reality (XR) applications). As RAN Chairman, Mr. Balazs Bertenyi indicated, 3GPP Rel-17 is perhaps the most versatile release in 3GPP history in terms of contents.

List of Acronyms in alphabetic order

CSI	Channel State Information
DL	Downlink
DRX	Discontinuous Reception
eMBB	enhanced Mobile Broadband
FDD	Frequency Division Duplex
FR	Frequency Range
GEO	Geosynchronous Orbit

HAP	High-Altitude Platform
HARQ	Hybrid Automatic Repeat Request
LEO	Low Earth Orbit
LTE-M	Long Term Evolution – Machine Type Communication
MIMO	Multiple-Input and Multiple-Output
NB-IoT	Narrow Band-Internet of Things
NC-JT	Noncoherent Joint Transmission
NTN	Non-Terrestrial Network
PAPR	Peak to Average Power Ratio
QoE	Quality of Experience
RAN	Radio Access Network
SI	Study Item
SR	Scheduling Request
TCI	Transmission Configuration Indicator
TDD	Time Division Duplex
TRP	Transmission Reception Point
UE	User Equipment
UL	Uplink
URLCC	Ultra-Reliable Low-Latency Communication
V2X	Vehicle-to-Everything
WI	Work Item
XR	eXtended Reality
3GPP	3rd generation partnership project

About the Author:

Hua's research areas cover radio access network technologies/procedures for IEEE 802.16, LTE Advanced, LTE Advanced Pro, and New Radio for 5G. Prior to working for Ofinno, he held a research expert position at Fujitsu and participated in IEEE and 3GPP standardization activities. He is an inventor of more than 300 US patents on wireless communications. He received his Ph.D. in communication and information systems from Beijing University of Posts and Telecommunications.

About Ofinno:

Ofinno, LLC, is a research and development lab based in Northern Virginia, that specializes in inventing and patenting future technologies. Ofinno's researchers create technologies that address some of the most important issues faced by wireless device users and the carriers that serve them. Ofinno's inventions have an impressive utilization rate. Ofinno's research involves technologies such as 5G Radio and Core networks, IoT, V2X, and ultra-reliable low latency communications. Our innovators not only create the technologies, they oversee the entire process from the design to the time the technology is sold. For more information about Ofinno, please visit www.ofinno.com.