3GPP Rel-19 Toward 6G

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1. Abstract

The 5G system achieves a breakthrough increase in the key performance indicator of communication systems, compared to the previous generation 4G system. In addition, the 5G system introduced new functionalities supporting various emerging application scenarios. Based on the success of the 5G system, the 6G system is likely to emerge around end of 2020s. There are many ongoing activities to define requirements of the 6G system. Recently, 3GPP SA1 started various studies for Rel-19 5G systems. The outcome of the Rel-19 may not only show the additional capability that the 5G system will bring, but also provide a guidance on what future the 6G system needs to be capable of. In this whitepaper, the ongoing areas of the Rel-19 studies are discussed.

2. Introduction

3GPP has established itself as the premier global standard for telecommunication, from GSM (2G), WCDMA (3G), LTE (4G) to recent NR (5G). Essentially, almost all handsets and devices connecting to cellular networks support at least one of these standards. On top of the phenomenal success of the 4G system, which is commonly known as LTE, the 5G system has dramatically increased the capability of cellular communication system. The KPI requirements of the 5G system for various scenario are summarized in [1].

Since the first commercial launch of the 5G system in 2018, 3GPP has continually added new features into subsequent 3GPP releases. As illustrated in Figure 1, Rel-15, Rel-16 and Rel-17 are the first three releases supporting the 5G system and provide basic features that distinguish the 5G system from the 4G system. The upcoming Rel-18, Rel-19 and Rel-20 are expected to add advanced features into the 5G system and are called as 5G-Advanced.

While 3GPP Stage-2 and Stage-3 WGs are developing system architectures and protocols for Rel-18, 3GPP Stage-1 WGs are discussing Rel-19 5G system-level requirements. In the past, studies, works, and features of Rel-13 and Rel-14 4G system became the foundation of Rel-15 5G system. Likewise, activities out of Rel-19 of 5G system may provide a glimpse of what future 6G system look like.

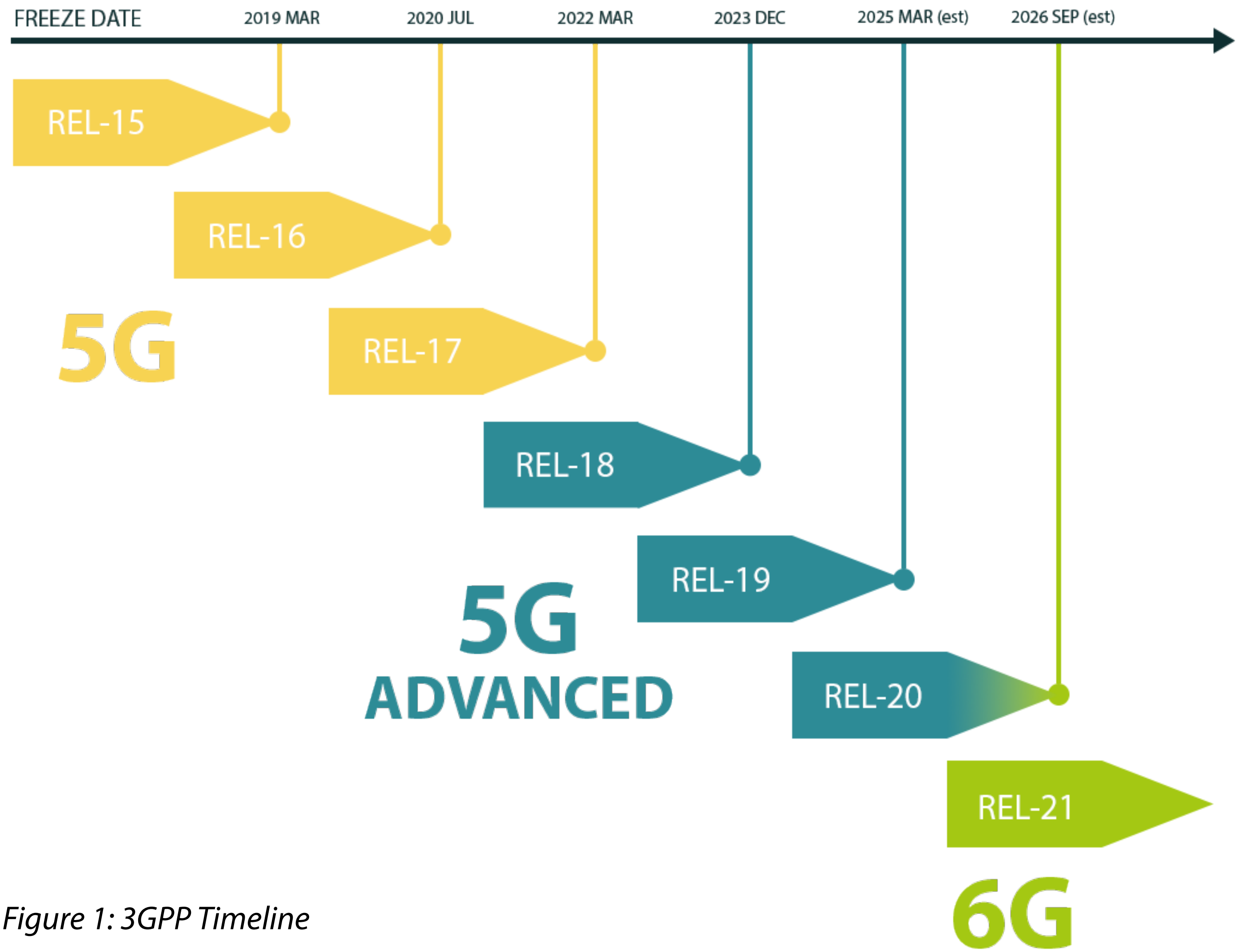


Figure 1: 3GPP Timeline

3. Overall Rel-19 Stage-1 Status

At SA1#97 (Feb, 2022) and SA1#98 (May, 2022) meetings, 3GPP WG SA1 agreed on SIDs (Study Item Description) for Rel-19, as shown in Table 1.

As titles of the studies suggest, 3GPP standards are addressing more specific requirements of industries that are considering use of 3GPP-based communication systems. In the past releases, 3GPP standards added support for various industries. For example, to support machine-to-machine communications, 3GPP introduced features such as support for low energy IoT communications, wide-coverage IoT communication, vehicle-to-vehicle communication, and so on. However, the support in the previous releases is not enough for some other industries, and new studies are trying to address the needs of the other industries. For example, the study on metaverse services (FS_Metaverse) will address requirements arising when 3GPP-based systems carry traffic for the application implementing metaverse scenario. On the other hand, as new scenarios emerge when industries adopt to use 3GPP-based communication technologies, additional studies will be required in 3GPP. For example, studies on satellite access (FS_5GSAT_ph3) are trying to address additional requirements from the satellite industries, on top of previous works on this area.

Table 1: Rel-19 SAI Agreed SIDs

SID Acronym	Reference Tdoc	Title
FS_Sensing	SP-220084	Study on Integrated Sensing and Communication
FS_AmbientIoT	SP-220085	Study on Ambient power-enabled Internet of Things
FS_Metaverse	SP-220353	Study on Localized Mobile Metaverse Services
FS_NetShare	SP-220087	Study on Network Sharing Aspects
FS_AIML_Ph2	SP-220083	Study on AI/ML Model Transfer_Phase2
FS_RAILSS	SP-190838	Study on Supporting of Railway Smart Station Services
FS_5GSAT_Ph3	SP-220443	Study on satellite access - Phase 3
FS_UAV_Ph3	SP-220444	Study on UAV - Phase 3
FS_RVAS	SP-220442	Study on roaming value added services
FS_DualSteer	SP-220445	Study on Upper layer traffic steering, switching and split over dual 3GPP access
FS_EnergyServ	SP-220446	Study on Energy Efficiency as service criteria
FS_SOBOT	SP-220447	Study on Network of Service Robots with Ambient Intelligence

3.1. Integrated Sensing and Communication

Integrated Sensing and Communication studies scenarios where sensing functionalities are provided by 3GPP communication system. Basically, for the wireless communication between a transmitter and a receiver, a lot of information of radio environment is exchanged for the fine-tuning operation parameter of the communication. In this process, the transmitter and the receiver may acquire a lot of information of radio environment, and this information may help applications adapt its behaviour. In fact, a lot of devices/applications use sensors for the perception of environments and for determination of action. If the functions that the sensors provide can be cost-effectively provided by the communication system, more compact and power-efficient operation of devices are possible. Example scenarios are [2][3]:

- Real-time monitoring of environment: Wireless signals can be used to detect changes and conditions of environments may enable environment related applications to use that. For example, as the wireless signal passes through different environment, it may experience different changes. The quality of the received wireless signal displays different attenuation characteristics with changes in air humidity, air particulate matter (PM) concentration, carrier frequency, etc. This can be used for weather or air quality detection.

- Autonomous navigation of vehicles/UAV: For the autonomous driving of vehicles, it is essential for the vehicles to identify humans and objects around. By using the wireless signal generated from the smartphones of human users, the vehicles can determine the existence of human users and potential locations of the human users. Based on that, the vehicles can perform driving manoeuvre to safely navigate around humans and objects.

3.2. Ambient Power-Enabled IoT

Internet-of-Things (IoT) is a concept that has been in the use for many years. It is about billions of sensors or devices connected to internet, to support various use cases, e.g., gathering sensor information remotely, controlling remotely actuators, etc. Motivations of dedicated works for IoT devices in previous releases were that IoT devices were limited in processing power, communication capabilities, batteries. Especially, in 3GPP's point of view, the major focus is to reduce power consumption for communications, because a majority of IoT devices are cell-battery operated. For example, optimizing message exchanges between a device and a network or reducing the time when a device transmits/receives data may help the device to reduce battery consumption. However, this optimization may still be used under the assumption that the total usable amount of battery of the device is still limited.

The Rel-19 study takes a different approach. In Rel-19 study, 3GPP are discussing whether the so-called 'energy-harvesting' can help communication, whether the energy-harvesting and communication can be designed together, or how the characteristic of the energy-harvest-based IoT device can be used for optimizing communication system. [4]

Example scenerio:

- 3GPP-based TAG: At a warehouse, a tag (e.g., information of goods, logistics, tracking) is attached to each good. This tag is discovered, scanned and tracked by 3GPP based networks, while the tag moves. Because this tag is 3GPP standards compliant, it may be a cost-effective way to track goods in wide area (e.g., outside of warehouse, outside of factory, or on the road) without using battery.

3.3. Localized Mobile Metaverse Services

Use of the Metaverse tools in diverse sectors evokes several new experiences, products and services, based on Augmented Reality (AR) and Virtual Reality (VR) frameworks. As services based on Metaverse concepts received a lot of attention, 3GPP SA1 decided to perform a study on this topic to derive requirements of 3GPP system. From 3GPP's point of view, the Metaverse refers to a persistent, shared, perceived set of interactive perceived space, both locally and remotely. [5][6]

The SA1 study investigates specific use cases associated with a user presenting himself or herself remotely by means of a representation: an avatar. These use cases provide users with immersive and interactive media representing the remote location in which the avatar is present. The focus of 3GPP is on the local representation of a remote user, and interaction with him or her. Though there were previous works on Extended Reality (XR) media in 3GPP and support for enhanced Mobile Broadband services, more improvement is required. For example, for shared interactive services in an environment in which activity is rapid, it may be challenging to provide timely, synchronized and highly available delivery of low latency media to enable interaction which in the area of games perform comparable to existing sports in terms of responsiveness.

The following are study areas:

- Performance (KPI) aspects; e.g. latency, throughput, connection density.
- Efficiency and scalability aspects, for large numbers of users in a single location.
- Identification of users and other digital representations of entities interacting within the metaverse service.
- Acquisition, use and exposure of local (physical and digital) information to enable metaverse services- Acquiring local spatial/environmental information and user/UE(s) information.
- Exposing local acquired spatial, environmental and user/UE information to 3rd parties to enable metaverse services.

3.4. AI/ML Model Transfer

In Rel-18, 3GPP already did some initial study on AI/ML, developing use cases where AI/ML applications can utilize information of 3GPP system to optimize its operation. For example, in Rel-18, use cases where a number of UEs are involved in Federated Learning are discussed and information exposure from 5G system to third parties are discussed.

In Rel-19, for better support of AI/ML applications, new use cases will be studied. For example, for fast adaptation and for distributed learning application, data and models for AI/ML may be shared directly between devices, without traversing 5G networks. This may entail further study on the privacy protection, energy savings, etc. Also, in case of distributed learning, 5G systems need to efficiently handle scenarios such as device's movement into and out of coverage area, limited power, offloading computation between devices, trade-off among AI/ML model accuracy, model generation latency, power constraint, computing capabilities, etc.[7]

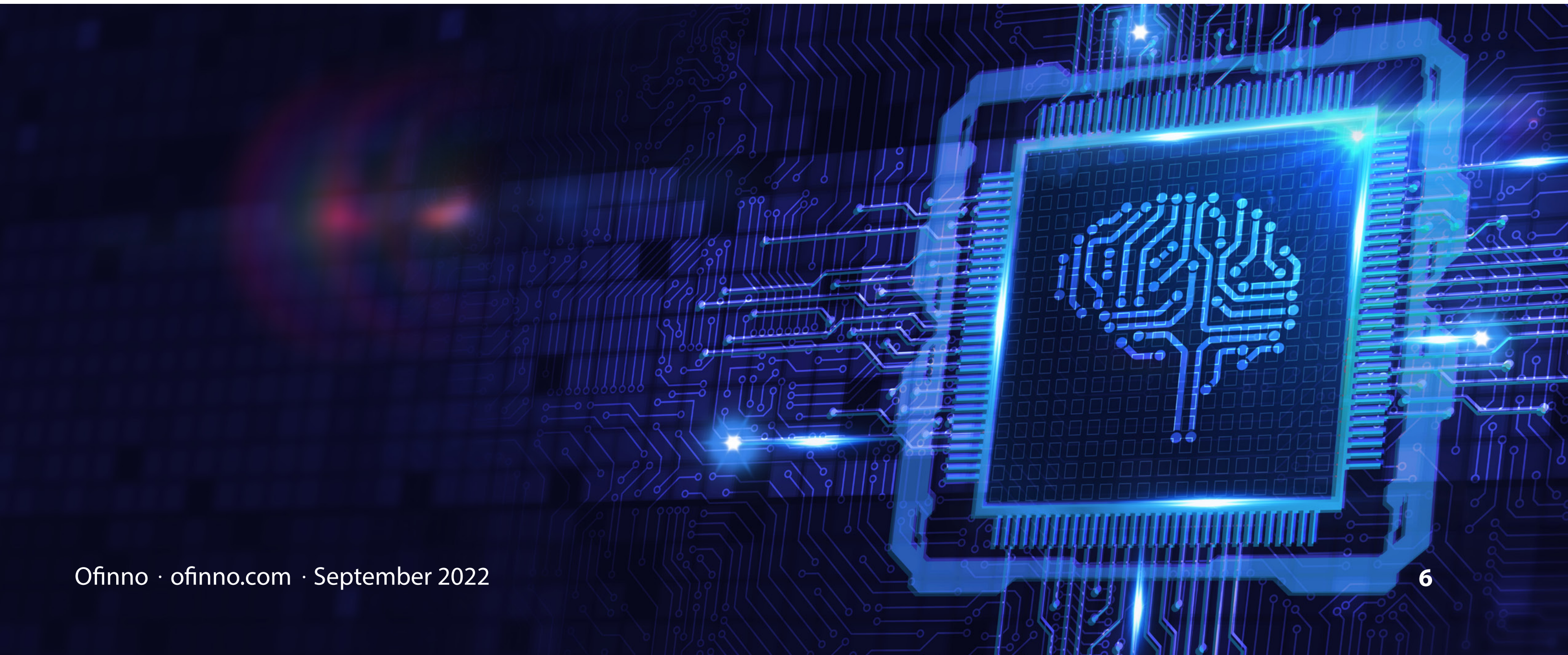
As such, the objective states studies on potential service and performance requirements to support efficient AI/ML operations using direct device connection.

3.5. Upper Layer Traffic Steering, Switching & Split Over Dual 3GPP Access

In 5G systems, core networks are designed to support not only 3GPP-based access technologies (E-UTRA, NR), but also non-3GPP-based access technologies such as Wi-Fi and Fixed Broadband. By designing core network access technology agnostic, 5G systems support integration with or migration from other access technologies.

The use of non-3GPP based access technologies can be used to provide additional coverage for a wireless device. For example, when users move from outdoors into indoors where 3GPP radio signal cannot penetrate, the use of Wi-Fi to access 5G core networks allows the users to enjoy a continuous use of 3GPP system, without experiencing interruption to the communication service.

The non-3GPP-based access technology can also provide additional capacity to the device. For example, when the devices are in area where both non-3GPP based access technology and 3GPP based access technology are available, the simultaneous use of both access technologies provides the devices increased data



rates, additional reduction of packet delivery error. By flexible adjustment and configuration, 3GPP system can steer some specific traffic to use one of the available access technologies, can switch the specific traffic from one access technology to other access technology, and split some portion of the traffic over one access and remaining portion of the traffic over other access.

In Rel-19, the functionality of traffic steering, switching and split is expected to expand. From Rel-16, 3GPP incorporated support for NTN (non-terrestrial network) and support for NPN (non-public network). Both NTN and NPN are based on 3GPP access technologies, provides additional opportunities for connectivity. Accordingly, the ground for simultaneous use of multiple 3GPP based access technologies are ripe. (Fig. 2)

In this study, following combination are pursued:[8]

- Single PLMN, PLMN plus (standalone) NPN, two PLMNs
- Same or different 3GPP RATs (NR or NTN, plus one of NR, NTN or LTE)

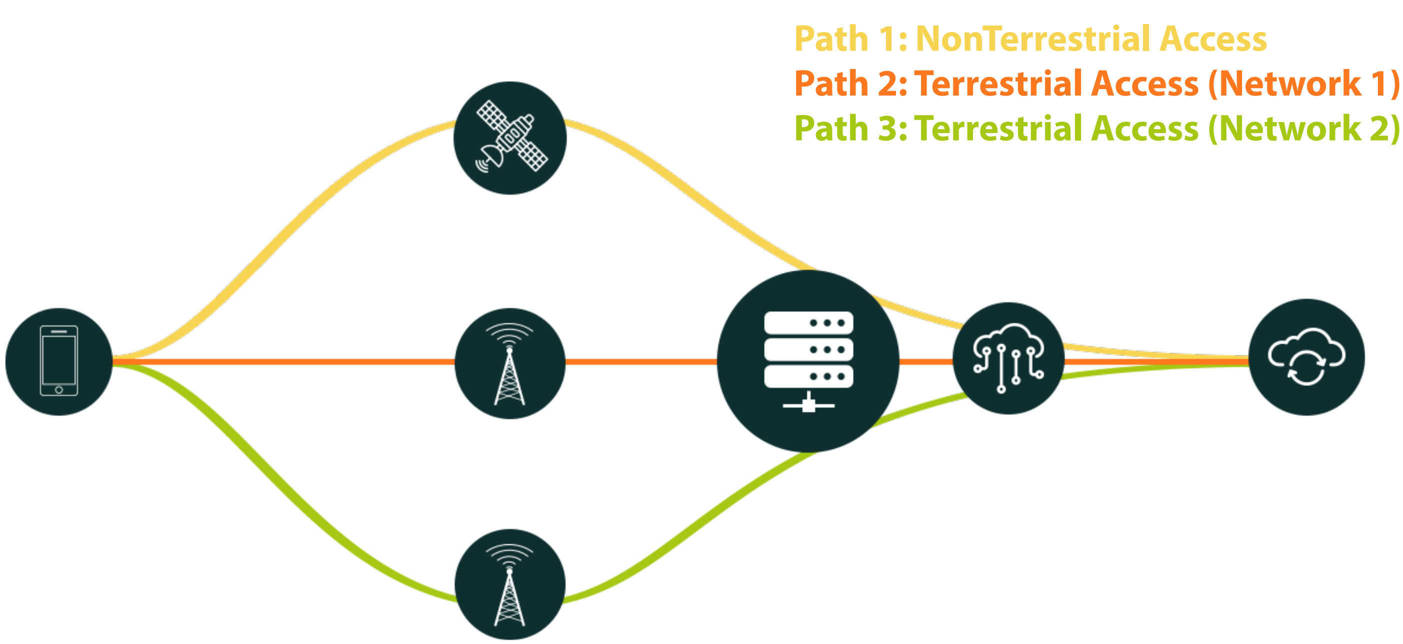
3.6. Study on Energy Efficiency as Service Criteria

Energy cost is taking up a big share of OPEX for a cellular communication system. Operators puts a lot of effort to reduce amount of energy required to run the communication networks. In fact, there has been much effort to reduce battery consumption of wireless devices, because the wireless device is supposed to work on a battery for the most of time, while network devices are plugged into a constant energy source such as power outlet.

To reduce power consumption of network equipment may bring some side-effect. For example, reduced transmit power may resulted in reduced cell coverage, leading to more call drops. Or, switching off some network equipment may result in overload in other network equipment, or impact on quality of service of ongoing users. For example, for the service over URLLC network slice, the degrade in network performance is not something that can be deprioritized for power efficiency.

As such, energy saving for a network can be taken as one dimension while meeting QoS demand can be taken as another dimension. The operation setting for communication service needs to satisfy both user experience and the energy efficiency.

Figure 2: Multiple Paths for Data Communication



In this study[9], the objectives are:

- Define and support energy efficiency criteria as part of communication service to user and application services.
- Support information exposure on systematic energy consumption or level of energy efficiency to vertical customers.

3.7. Study on Satellite Access - Phase 3

In previous releases, 3GPP has put a lot of effort to support 3GPP-based communication via satellite link. Satellite-based communication is an effective tool in providing access to a device in areas where conventional terrestrial based communication cannot reach. The support for satellite-based 3GPP communication assumed that the backhaul network from the radio access node to the core network is available, and that the wireless device is capable of using existing GNSS functionality.

For Rel-19 discussion, 3GPP will investigate scenarios where the backhaul connection is intermittent. For example, a satellite may orbit around the globe regularly, and may receive a data from a location where direct backhaul is not available. In this scenario, the satellite communication is required to provide hold-and-forward capability. In other setting, a device may use 3GPP-based satellite communication architecture, to determine its locations.[10]

4. Conclusions

In this whitepaper, we reviewed the recent 3GPP studies ongoing for Rel-19. The Rel-19 studies is expected to accelerate the integration of various industries with 3GPP technologies, allowing ubiquitous connectivity. This will provide a basic ground for future 6G system will be based on.

5. References

1. 3GPP Technical Specification, TS 22.261, "Service requirements for the 5G system"

2. 3GPP Technical Report, TR 22.837, "Study on Integrated Sensing and Communication"

3. 3GPP Technical document, SP-220084

4. 3GPP Technical document, SP-220085

5. 3GPP Technical Report, TR 22.856, "Study on Localized Mobile Metaverse Services"

6. 3GPP Technical document, SP-220353

7. 3GPP Technical Report, 22.876, "Study on AI/ML Model Transfer Phase2"

8. 3GPP Technical Report, 22.862, "Study on Energy Efficiency as service criteria"

9. 3GPP Technical Report, 22.841, "Study on Upper layer tra_c steering, switching and split over dual 3GPP access"

10. 3GPP Technical Report, TR 22.865, "Study on satellite access - Phase 3"

About the Author

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SungDuck has participated in 3GPP standardization since 2003, for various working groups SA1, RAN2, SA2, SA3. He contributed to radio architecture/protocol design for HSxPA/LTE and system/service requirements definition for 5G. He served as rapporteur for various 3GPP work items, eV2X, MINT, EASNS and V2XIMP. He also participated in standardization for ETSI, 5GAA, and received best contributor award from 5GAA in 2018.

Prior to joining Ofinno, he held a chief research engineer position for standardization, and a manager position for business development at LG Electronics.

He is an inventor in over 750 granted US patents. SungDuck focuses on research of system architecture and communication protocols for 5G and 6G. He received his MBA degree from Sloan school of Massachusetts Institute of Technology, MA, USA. He received his BS degree in Electrical engineering from Seoul National University, Seoul, Korea.