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Overview of Architecture and Softwarization in 5G Technology

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ABSTRACT

5G is the fifth-generation wireless broadband technology based on the IEEE802.11ac standard. An important goal of 5G is to erase the differences between wireline and wireless networking to accommodate the growing mobility of network users.A 5G network will be able to handle 10,000 times more call and data traffic than the current 3G or 4G network. The signal technology of 5G has also been improved for greater coverage as well as spectral and signaling efficiency. These improvements stand to further enable changes like pervasive computing and the Internet of Things (IoT).

Keywords: 5G aggregator, 5G nanocore, network softwarization

I. INTRODUCTION

5G continues to generate buzz and grab the efforts and the attention of many of us in the Communications Technology Industry. Huawei, a major player in the Chinese mobile market, believes 5G will provide speeds 100x faster than 4G LTE offers. 5G also increases network expandability up to hundreds of thousands of connections. Low-band 5G" uses frequencies from 600 MHz.[1] [2] Millimeter wave 5G offers higher capacity than 4G and lower latency.[3] As of 2017, development of 5G is being led by several companies, including Samsung, Intel,Qualcomm, Nokia, Huawei, Ericsson, ZTE and others.[4]

5G TECHNOLOGY CHALLENGES

"Cellular standards are enormously complex. It takes a huge amount of time to work," said Sundeep Rangan, associate professor at NYU Wireless, an academic researchcenter at New York University's Polytechnic School of Engineering in Brooklyn.

Rangan has been researching 5G technology and prototypes at NYU Wireless with industry partners including National Instruments, Samsung and Intel.

"Right now, most of the focus has been on technology, moving cellular standard design to high-frequency bands," Rangan said.

High-frequency bands have shorter wavelengths and are not typically considered viable for cellular networks. But Rangan said low-band spectrum is constrained and becoming expensive. Research and testing has focused on deploying 5G on spectrum above 30 Ghz, known as millimeter wave.

The lack of a business case to drive innovation is another issue facing 5G. When 4G was under development, was a driver for faster standardization of 4G, Rangan said. But 5G does not have a competing standard under development to drive further innovation.

"Not all technology we think will be part of 5G are ready," he said. Technology like network functions virtualization can support 5G, but other technology like millimeter wave requires more research.The first step will be determining the Third GenerationPartnership Project (3GPP) requirements for a new generation of wireless

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technology and then consolidate the requirements, Viswanathan said. Once requirements are determined, the standardization process can begin.

When will 5G hit the market?

5G is expected to make its debut in 2020. The time frame is realistic when compared to the development of similar technology, like LTE, Rangan said, but the question is whether mobile operators will find a business case to start putting out large deployments. Events like the 2018 Olympic Games in South Korea and the 2020 Olympic Games in Japan are coming up in the 5G time frame, he added. Operators may have limited deployments of 5G technology as a showcase, but Viswanathan does not expect widescale deployments at that time.

COMPARISON OF 5G WITH OTHER

1G - Introduction of cellular networks and bringing voice (analogue) to mobile devices

2G - Moving to digital voice and basic digital communication

3G - Introducing internet access to mobile networks

4G - Enabling mobile internet access being competitive to fixed wireless

5G - Higher speeds, more use cases, etc. But the most important aspect of 5G for me is it's flexibility to capture different applications' requirements and softwarization of the network.

TECHNOLOGY	1G	2G	3G	4G	5G
Start/ Deployment	1970/1984	1980/1999	1990/2002	2000/2010	2014/2020
Data Bandwidth	2Kbps	14-64Kbps	2Mbps	200Mbps	1Gbps and higher
Technology	Analog cellular	Digital cellular	Broadbandwidth/ CDMA/ IP technology	Unified IP & seamless combo of LAN/WAN/WLAN/ PAN	4G+WWWW
Multiplexing	FDMA	TDMA/CDMA	CDMA	CDMA	CDMA
Core network	PSTN	PSTN	Packet network	Internet	Internet
Service	Mobile telephony	Digital voice, short messaging	Integrated high quality audio, video & data	Dynamic information access, variable devices	Dynamic information access, variable devices with AI capabilities

Fig 1 - Comparison of 5G with Other

II .5G NETWORK ARCHITECTURE AND **5G PROTOCOL STACK**

The 5G network architecture consists of all RANs, aggregator, IP network,nanocore etc. The 5G protocol stack consists of Open Wireless Architecture, lower and upper network layer, open transport protocol and application layer. These have been explained below with the figures[5]. Figure-2 depicts 5G network architecture. As shown 5G network uses flat IP concept so that different RANs (Radio AccessNetworks) can use the same single Nanocore for communication.

RANs supported by 5G architecture are GSM, GPRS/EDGE, UMTS, LTE, LTE-advanced, WiMAX, WiFi, CDMA2000, EV-DO, CDMA One, IS-95 etc. Flat IP architecture identify devices using symbolic names unlike

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hierarchical architecture where in normal IP addresses are used. This architecture reduces number of network elements in data path and hence reduces cost to greater extent. It also minimizes latency.

5G aggregator aggregates all the RAN traffics and route it to gateway. 5G aggregator is located at BSC/RNC place. 5G mobile terminal houses different radio interfaces for each RAT in order to provide support for all the spectrum access and wireless technologies.

Another component in the 5G network architecture is 5G nanocore. It consists of nanotechnology, cloud computing and all IP architecture.

Cloud computing utilizes internet as well as central remote servers to maintain data and applications of the users. It allows consumers to use applications without any installation and access their files from any computer across the globe with the use of internet. It is used to route data from source IP device to the destination IP device/system. It is divided into lower and upper network layers.

It marks the data as per proper format required. It also does encryption and decryption of the data. It selects the best wireless connection for given service. Events like the 2018 Olympic Games in South Korea and the 2020 OlympicGames in Japan are coming up in the 5G time frame, he added.

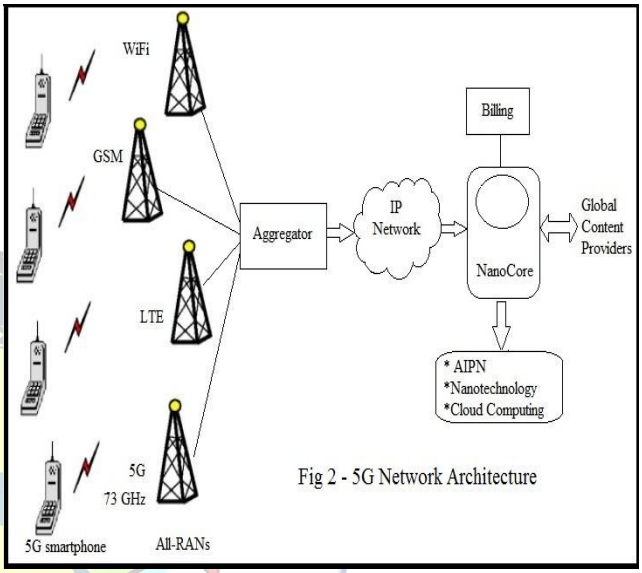

Fig 2 - 5G Network Architecture

5GPROTOCOL STACK

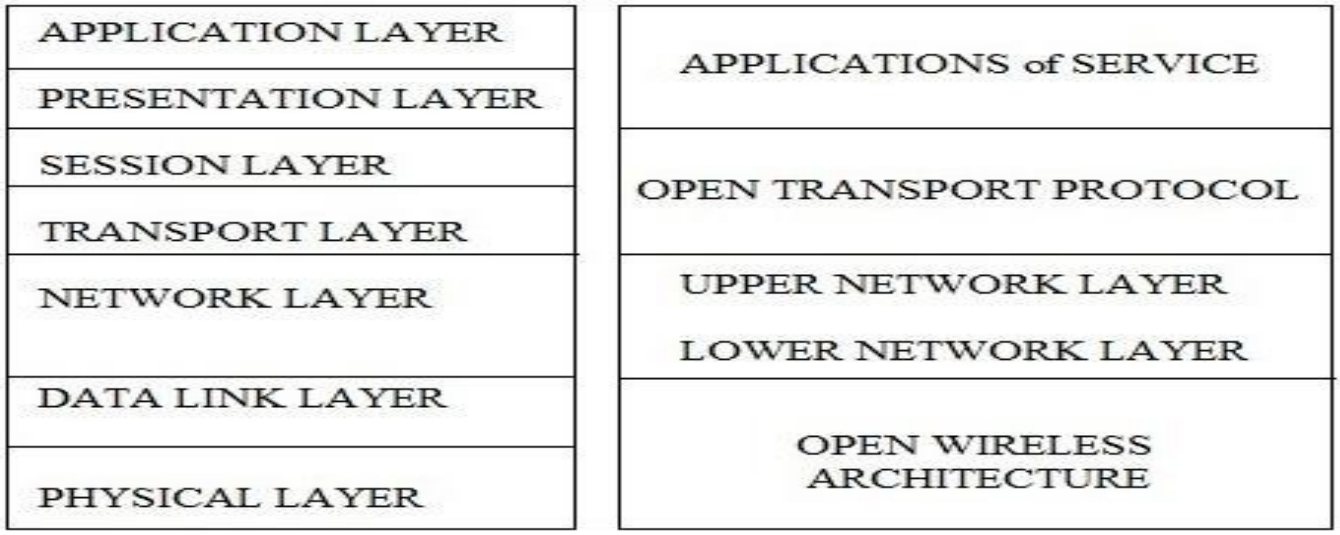

Fig 3 - OSI stack 5G network stack

The figure-3 below depicts 5G protocol stack mentioning 5G protocol layers mapped with OSI stack. As whown 5G protocol stack consists of OWA layer, network layer, Open transport layer and application layer.

OWA Layer: OWA layer is the short form of Open Wireless Architecture layer. It functions as physical layer and data link layer of

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OSI stack.

Network Layer: It is used to route data from source IP device to the destination IP device/system. It is divided into lower and upper network layers

Open Transport Layer: It combines functionality of both transport layer and session layer.

Application Layer: It marks the data as per proper format required. It also does encryption and decryption of the data. It selects the best wireless connection for given service.

III. SOFTWARIZATION IN 5G

Softwarization of networks includes the implementation of network functions in software, the virtualization of these functions, and the programmability by establishing the appropriate interfaces. This softwarization requirement is also identified by ITU-T Study Group13 network.

Network softwarization is an approach to use software programming to design, implement, deploy, manage and maintain network equipment/components/services. It takes advantage of programmability, flexibility and re- usability of software for rapid re-design of network and service architectures. The goal of network softwarization is to optimize processes in networks, reduce their costs, and bring added value to network infrastructures.

Leveraging virtualization technologies, softwarization is one of the key enablers for unifying the 5G end-to-end service platform, and for realizing network slicing as a service. Softwarization evolves networks into the management and orchestration of complex software systems, encompassing and harmonizing what hitherto was thought of as inseparable domains: network and resource-oriented functions and application-oriented functions. This joint expressive power will be one of the main drivers of innovations enabled by 5G.

While softwarization plays this key role for 5G network management and service provisioning, it is important to note the variety of needs for softwarization in different segments of 5G networks. 5G network segments include radio access networks, core networks, transport networks, network clouds, mobile edge networks and Internet. Certainly, each segment has its own technical characteristics, and thus different requirements of softwarization. The software network technologies applied in 5G network segments are illustrated in Figure 4.

In the following subsections, the views of 5G on softwarization in radio access networks, mobile edge networks, core networks and transport networks are examined.

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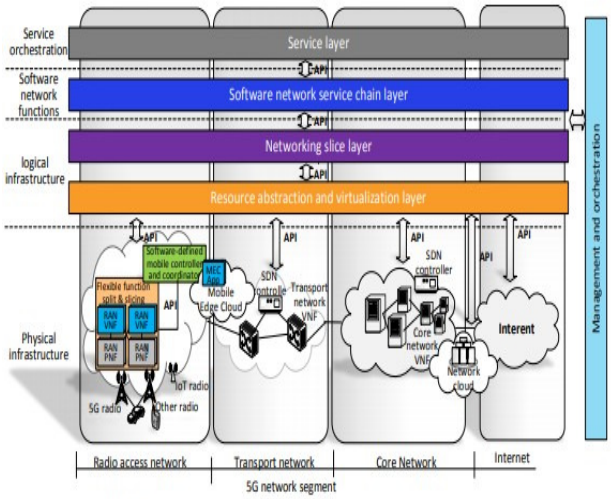

Fig 4 - Software network technologies in 5G overall architecture.

Softwarization in radio access networks

The fundamental system requirement for 5G RAN is unprecedented agility in spatial, temporal and frequency dimensions. The four design aspects for 5G RAN that will greatly benefit from the introduction of software network technologies, namely i) flexibility in spectrum management; ii) fine-grained network programmability; iii) dynamic provisioning of network slices; and iv) heterogeneous and dense deployments.

5G RAN should support a wide range of physical deployments, and be able to maximally leverage centralization, while also supporting distributed base stations and being able to operate over non-ideal backhauls. A key enabler for this is the implementation of some radio functions as VNFs, allowing these to be flexibly shifted toward or away from the radio edge, depending on the physical architecture and specific application requirements.

The following considerations are important regarding the softwarization of radio network functions. Preliminary analyses in concluded that functions that are asynchronous to the radio interface – in LTE these are packet data convergence protocol (PDCP) and radio resource control (RRC) functions related to measurement control and reporting, handover preparation and execution, dual connectivity, random access, RRC state transition etc. – are most suitable to be implemented as VNFs and possibly centralized, as they typically require low data rates on their interfaces, and scale with the number of users and not the overall traffic. Further, these functions can typically cope with relatively larger latency (e.g. tens of milliseconds in LTE).

Softwarization in mobile edge networks

In line with the vision of the Mobile Edge Computing (MEC) paradigm, e.g., from ETSI MEC Industry Specification Group (ISG), it is widely recognized that mobile edge networks will extend softwarization from the conventional data center to the edge of 5G networks. It will also enable services to be deployed on demand to the most effective locations within the access network according to the requirements of applications e.g., in terms of real-time service delivery for fast and efficient deployment/re-deployment of mobile edge networking and computing, it is essential to develop automatic softwarization mechanisms to establish the required services from scratch (even bare metal) in a timely fashion.

Softwarization in core networks

The majority of the CN and service plane functions are expected to be deployed as VNFs in the 5G timeframe, thus running in virtual machines over standard servers, potentially on cloud computing infrastructures (i.e. data centers). These VNFs can be flexibly deployed in different sites in the operator's network, depending on the requirements with regards to latency, available transport, processing and storage capacity, etc. Different services or network slices can utilize different CN and service plane VNFs, which can be deployed at different network sites.

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Softwarization in transport networks

The softwarized, programmable transport networks can act as a platform for applications, user services and network services, to adapt the operation of the transport network to the needs of the RAN.. In addition, a softwarized transport network will allow for tightly coupled interactions with the RAN, whereby transport and RAN could jointly coordinate aspects such as mobility and load balancing, or manage sleep periods of RAN and transport equipment.

IV 5GTECHNOLOGYFEATURES

As 5G is a user centric approach, so to satisfy and facilitate the consumer the key features of 5G are discussed below [7]:

- 5G wireless network is a real wireless world with no limitations [8].
- HD TV is a most fascinating feature of 5G as it provides multimedia features [8].
- Increased data rates as compared to previous generations.
- A 5G technology is a way that provide artificial intelligence capabilities to users.
- Smart radio technology to share unused range/bandwidth is a part of 5G networks
- High resolution applications and large bandwidth can be possible in coming network technology.
- Large transmission range by introducing 5G networks [10].
- Worldwide roaming is easily possible in coming technology.
- There are smaller number of antennas used in 5G to employ single-user that is fit for current standard of cellular communication.

DISADVANTAGES

- Since 5G services are likely to run on ultra-high spectrum bands, which travel shorter distances compared with lower bands, they may be more suited to enhanced indoor coverage.
- Higher frequencies could be blocked by buildings and they lose intensity over longer distances. That means, offering wider coverage would be a challenge.

APPLICATIONS

5G is a promising Generation of wireless communication that will .Some of the applications of 5G technology

- Wireable devices with AI(Artificial Intelligence)capabilities.
- 5G iPhones.
- With 6th Sense technology.
- Global Networks.
- VoIP(Voice Over IP) enabled devices.
- Radio resource management.
- Media independent handover.

V. CONCLUSION

5G technology is going to be a new revolution in wireless systems market. It is expected that the implementation of 5G Wireless Technology would take four more years from now to make it usable for the people. We need more time to develop its functionality. 5G will be user centric and in totally it is safety and secure for public.

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