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A Study of 6G Architectural Framework

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ABSTRACT

In recent years wireless technology makes tremendous growth increasing from 1G, 2G, 3G, 4G to 5G in a few decades. The extract of modern culture is the digital economy, which is also the base for a wireless system of connections. From the last few decades the request for wireless connectivity has developed exponentially. Fourth generation communication are far with elements of fifth generation and it will be deployed soon in world wide. Between 2027 and 2030a new paradigm of wireless communication system with the uphold of artificial intelligence, is expected to be implemented with name Sixth-generation (6G). The researchers and engineers are working on the architecture and development advancing of 6G architecture and the future of Wireless Cellular Networks will bring change, enhancement, and transformation in networks. In this paper the study contributes architectural frame work of 6G.

Keywords: Communication, Cellular generations, Mobile technologies, Networks

I. INTRODUCTION

2030 and beyond will have a unique set of challenges and opportunities of global significance and scale. We should have an ambitious 6G vision for the communications that simultaneously allows growth, sustainability and full digital inclusion. Going beyond the digital revolution of the 2020s, in future we may predict human possibilities and capabilities are considerably increased and augmented by 6G technologies [1]. Emerging new devices with more intuitive interfaces, new sensing technologies, and the availability of ubiquitous distributed computing, human experience will shift from multi-media to the creation and consumption of new immersive, digital worlds. 6G networks have novel radio and access architecture for both communications and sensing purposes, AI optimized wide area network and data center co-design, as well as dynamic orchestration of personalized services to revolutionize the long tail of niche consumer interests. The important requirements for 6G architecture are network programmability, deployment flexibility, simplicity and efficiency, security, robustness and reliability and automation.

The Exploration of 6G architectural innovations, is convenient to decompose the architecture into four building blocks 1.Platform 2.Functional, 3.Specialization 4.Orchestration. In two recent articles [2], [3] on 6G architecture, the authors propose new ways for supporting better QoS and use of artificial intelligence and machine learning for network optimization. In [4], new security architecture for mobile services with

implications on billing is presented. This paper is focused on the basic network architecture and does not consider new security architecture aspects.

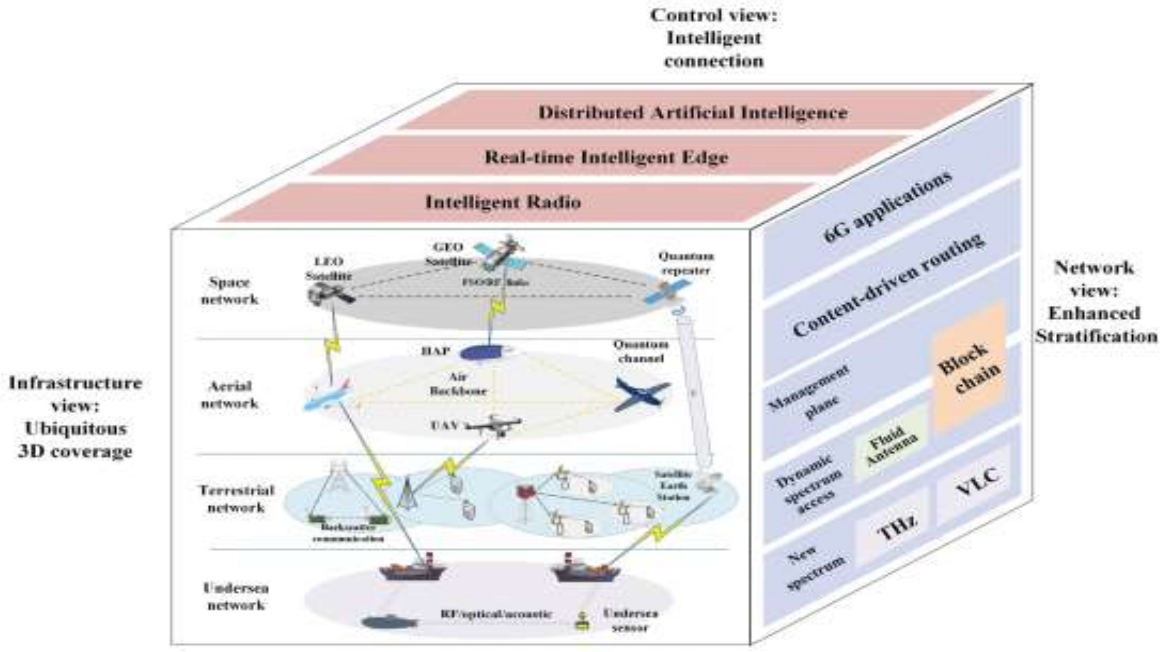

Fig 1: **Different dimensions of the architecture of 6G**

II. 6G ARCHITECTURAL FRAMEWORK

The building blocks of 6G architecture encompasses across key architectural domains of a communication network, from the physical layer to the service layer in combination with a secure and automated orchestration architecture. 6G architectural building blocks, are illustrated in Figure 2.

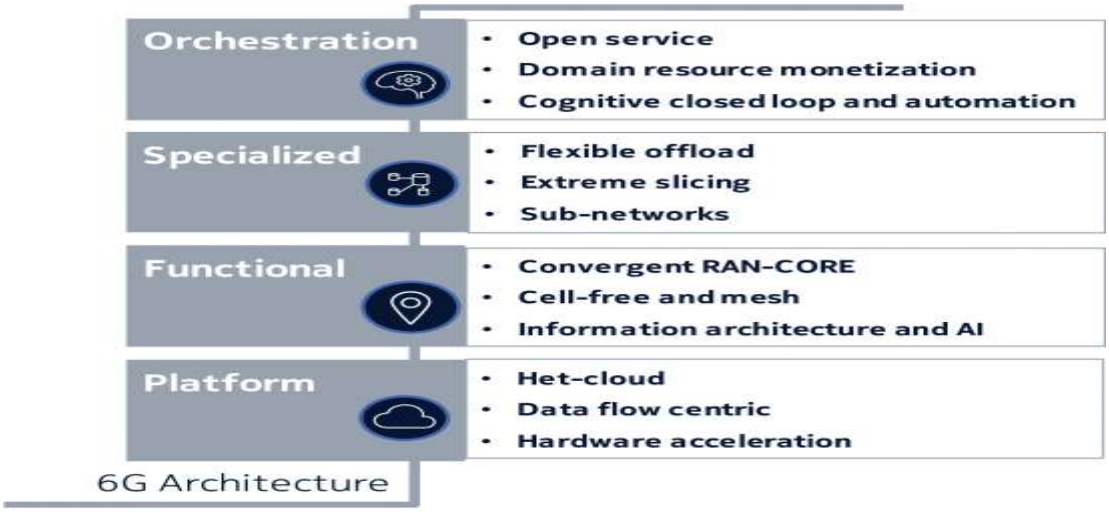

Fig 2:6G architectural framework: building blocks.

The decomposition of 6G into building blocks is made by Nokia Bell Labs with four major components of interworking, which gives an open and distributed reference framework. 6G architectural cloud transformation is broadly associated with the "het-cloud" component which has open, scalable and agnostic run-time

environment. "Data flow centricity" and hardware acceleration, and essentially constitutes the infrastructure platform for the architecture. The "functions" component involves the functional architecture and includes the themes of RAN-CORE convergence, cell free and mesh connectivity as well as information architecture and AI. A big transformational theme of the 6G era is the emergence of specialized networks and associated performance attributes. Architectural enablers of flexible off-load, extreme slicing and sub-networks are shown as part of the "specialized" building block. Of key business impact relevance is the "orchestration" component of 6G architectural change which will assure open service enabling and ecosystem play, domain resource monetization as well as cognitive closed loop and automation.

2.1 Het-cloud

The het-cloud environment is a heterogeneous cloud environment with many stakeholders that run applications at different sites as on-prem, far edge, edge and core with a variety of different hardware and software stacks. The benefits of the het-cloud approach are the ease with creating, placing, subsequently scaling and moving new services between the clouds and the efficiency with the execution and the next is the knowledge of the cloud capabilities to optimize service performance. A het-cloud approach is foundationally flexible and simple and well in line with 6G architectural expectations. Also, this concept will allow highest level of trustworthiness by implementing trusted execution environments (TEE) [5]. The het-cloud will encompass cloud software platform for serverless functions in the 'FaaS' or Functions-as-a-Service layer that sits on top of the Backend-as-a-Service (BaaS). The BaaS has data collection and analysis, logging and monitoring and distributed data storage in network.

The cloud capability should include exposure of available hardware accelerators like GPUs and trusted computing platform modules of TEE with remote attestation support and APIs that are integrated into the cloud platform. Other examples of such capabilities include supported computing types (such as IaaS, bare metal, PaaS, SaaS, FaaS), high availability characteristics, processing capacity, latency and type of cloud platform. We thus envision a cloud capability discovery and function placement service as an integral part of the future het-cloud as shown in Figure 3.

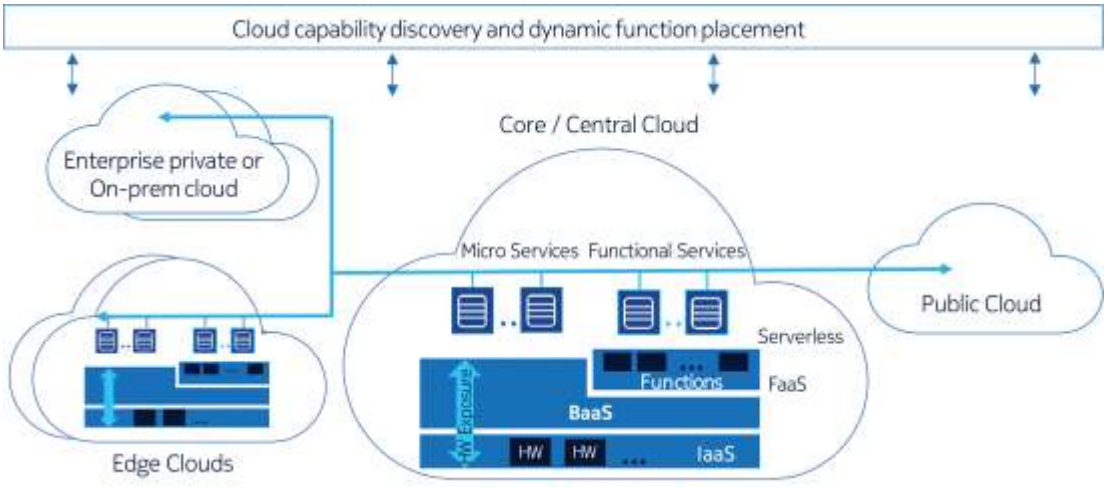

Fig 3: Het cloud conceptual view

The important feature of het-cloud is the inter-cloud service bus that connects the service components across the het-cloud the concept of SBA and SBI of 5G must be refined to create a flexible, on-demand inter-cloud service bus. While strict real-time control services are likely to be implemented using traditional micro-services with pre-provisioned compute resource, latency tolerant control and management applications are expected to be implemented through the server less approach to take advantage of their programming simplicity and automatic scaling capabilities.

The nature of the inter-cloud service bus varies based on the transaction types between the service and their components, e.g., stream data collection vs. real time control plane transaction and, based on their respective need for specific HW resources.

2.2 Data flow centric networks: ultra fast discovery and flow based architecture

With an anticipated disaggregation of devices and millions of 6G sub-networks, on premise and edge resources will be highly specialized using dedicated accelerators and access mechanisms with limited scalability implying stronger reliance on the off-loading of traffic. The traffic routing between service endpoints needs to be based on data flow characteristics that will disassociate transactions and sessions from application context (use case, location, application), used device, used network functions, storage and transport, enabling in-network caching and replication. We expect the network to become "cognitive" with extensive use of AI/ML based optimization for the aforementioned traffic routing as well as for optimal placement of network and service functions. Service discovery i.e., applications, micro-services and functional services locating each other on a network, must operate at the transaction time level to match the changing context and resource allocation situation across the het-cloud. Such approach may lead to introduction of refactoring [6] and distribution of mobile network functions as described.

2.3. Hardware Acceleration

The need for enhanced security paradigm and reduced energy consumption may lead to greatly increased compute complexity, and as a result the definition and leverage of a new computational architecture will be needed. As a first evolutionary step, greatly increased degree of flexibility can be expected from an omnipresent and smart fabric of HW accelerators such as FPGA, GPU, TPU, analog computing chips, and SoCs. The use of AI/ML based receiver processing will require hardware acceleration suited for deep learning models. Computing and networking resources must interact seamlessly to ensure availability of the right computational capabilities just in-time. Accelerator enabled future cloud architecture will be a pre-requisite for 6G experience and performance attributes, enabling new services as well as device and sub-network offloading.

7G Network

7G mobile network is like the 6G in the concept of global coverage. It will be the most advance generation in mobile communication but there will be some researches on demanding issues like the use of mobile phone during moving condition from one country to another country, because satellite is also moving in constant speed and in specific orbit, the standards and protocols for cellular to satellite system and for satellite to satellite communication system. The dream of 7G can only be true when all standards and protocols are defined. May be this is possible in next generation after 7G and can be named as 7.5G or 8G.

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III. COMPARISON OF DIFFERENT CELLULAR TECHNOLOGIES

The comparison of different cellular technologies is been illustrated in **Table 1**.

Parameters	Cellular Technologies			
	4G	5G	6G	7G
Frequency	2-8 GHz	4G Frequency	95GHz-3THz	95GHz-3THz
Service	Wi-Fi, VoIP, LTE, WiMAX	WWWW	Secured and global cellular services.	Secured and global cellular services
Multiplexing	OFDMA	All with AI capabilities, MIMO,CDMA	CDMA	CDMA
Switching type	Packet switching	IPv6 but advancements are still to be done	All packet	All packet
Core network	Internet	Internet	Internet	Internet
Data rate	100-300 Mbps	About 100+Mbps	About 11 Gbps	About 11+Gbps
Pros	Speed, high speed hand offs, MIMO tech, global tech	Better coverage area, low battery consumption, availability of multiple data transfer path, energy and spectral efficiency is more and has a high security	Global coverage system	No issue of data capacity coverage and hand off left behind, low cost of call
Cons	Hard to implement, complicated hardware required	It is still under process and research on its viability is going on, it is difficult to achieve because of the incompetent technological support in most parts of the world, developing infrastructure needs high cost, security and privacy issue yet to be solved	Difficulty for space roaming, high cost of mobile call and similar with 5G disadvantages	Similar with 5G and 6G disadvantages
Location of first commercialization	South Korea	Not yet	Not yet	Not yet
Time period	Now	Soon probably 2020	Soon probably 2030	Soon probably 2030
Handoff	Horizontal and vertical	Horizontal and vertical	Horizontal and vertical	Horizontal and vertical

Table 1: Comparison of different cellular technologies.

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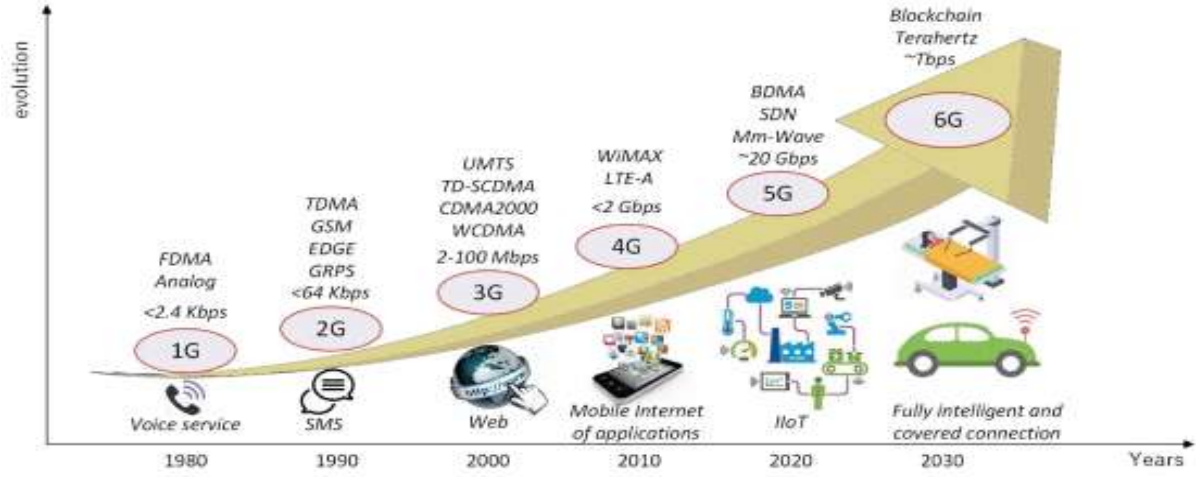

Fig 4: Global mobile data traffic in 2020-2030 forecast by ITU

IV. CONCLUSION

The world started its journey towards 6th Generation, 6G architectural research has been successfully initiated at the same time, commercial and accelerated deployment of 5G is done in most markets of the world soon. The architectural evolution of 5G is far from over as it will likely continue for eight more years or so. The het-cloud platform has new cloud computing capabilities which acts as the foundation for the 6G network. Convergent RAN-CORE is used for simplification and implemented as micro services and simplifies new cell free and mesh architectures. AI/ML optimization will play in the design and operation of the 6G network. The flexibility of 6G architecture will enable the specialization of network for particular purposes like sub-networks and optimized slices. Orchestration architecture and intent based automation and networking will be a key enabler across industries and sectors. Several other aspects such as the security architecture, specific protocol choices, charging and policy control and network exposure were not discussed in this paper.

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