The Fifth Generation of Mobile Network as the Core for the Industrial Revolution 4.0

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Abstract - This paper provides an overview about the coming 5th generation of mobile technology which integrates all previous computer and mobile technology, and the next phase of industry development called the 4th industrial technology and how it depends on the success of developing 5G, the main aim of this paper is to present cyber-physical system and the big challenges of new infrastructure of Internet service provider based on 5G wireless broadband system, interconnected devices smart and non-smart devices will adapted internet of things and allow big data to evaluate and analysis data more efficiency in cyber-physical space, the paper investigated in literature review and studies previous work of 5G heterogeneous network and internet of things.

Keywords— mobile network heterogeneous, 5G, Broadband, IoT, IR 4.0,

I. INTRODUCTION

The concept of 4th industrial revolution is just a suggestion and still debatable, somehow unlike the 5G which start to be implemented. Even there are lots of peers reviewed papers about 5G as early as 2013 [1], it all was proposals and ideas about the current 4G development.

5G is not just about mobile technology and communication, the idea integrates many concepts of interaction between humans and machines.

Integration of concepts such as augmented and virtual reality, which require large scale of AI software in mobile devices, which means much larger processing capability for mobile CPUs, also much higher bandwidth which mean higher bit per frequency hertz b/Hz, also the usage of light field (hologram) technology for display and the 3d camera. Most of these technologies are still in their infant stages [2].

Introducing 5G technology started by the advancement of communication technology and the unification of networking and mobile services and its protocols[3] [4].

But these 5G technologies which now lead by China[5] [6] has too much political reluctance in the western world [7] [8], and Large companies like SpaceX, Google, Facebook, Microsoft are trying to replace it with rival technology[9].

Components of 5G technology are now in the market, more are coming for sure. But the core idea of the 5th generation which is the unified hierarchy of technology and protocols managed by dynamic AI systems is still to be developed.

Internet of things IoT [10] and 5G with advanced AI and computer practical human interaction [11] all combined are what called the 4th Industrial revolution 4th-IR.

Though it's obvious that 5G and the unification of services and protocols hierarchy are essential in building the rest pillars of 4th-IR.

IoT is developing for sometimes but still need core unification of different services, which supposed to be provided by 5G to achieve full integration between different types of things supposed to be communicated and linked together.

In the next section will provide a brief overview of how the 5th generation should work as the 4th-IR core.

II. PREVIOUS RESEARCH STUDIES

A. 5th Generation

5G wireless networks will support 1,000-fold gains in capacity, connections for at least 100 billion devices and a 10 Gb/s individual user experience capable of extremely low latency and response times. Deployment of these networks will emerge between 2020 and 2030" this was Huawei vision of 5G at 2013 [6].

As per Huawei reference, 5G will utilize the developed version of all the previous (LTE, HSPA, GSM, Wi-Fi, and Wi-Max.) technology into one unified integrated network. Using new Radio access technology RAT to achieve very low latency at super high speed 10 Gbps for the individual.

As early as 2013 Sapakal gave a vision of 5G architecture, their concept it will be flat IP v6, depend on WWWW wireless www and higher speed with dynamic ad-hoc wireless networks, the unified protocols hierarchy and integration of IoT, AI, a virtual reality where less important in their concept [1].

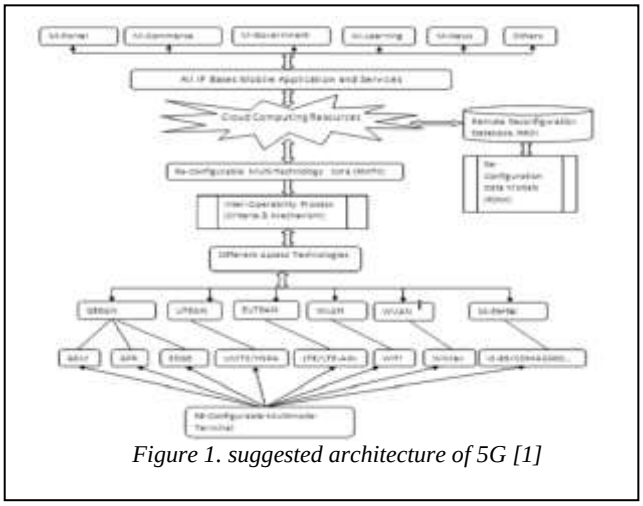

Figure 1. suggested architecture of 5G [1]

WiMax, WWWW, RAT, virtual reality and AI was expected to be the core of 5G according to P. Sharma [12].

The evolving of smart grid network for the next generation of WiMax was the core expectation of A.Usman [13].

N.Bhushan and others expected in 2014 that the densification of wireless will became the core development for networking without care of 5G [14].

More details were introduced by Toshiba Europe research team expecting smaller cells, more dense wireless, more services, protocols integrations such as 3GPP, OneM2M, a device to device D2D communication and heterogeneous networks with the integrated software development to be the main development towards 5G [15].

The need for concurrent multiple network paths and communication and the integration scalability between these networks was expected to be the core development towards 5G by [3].

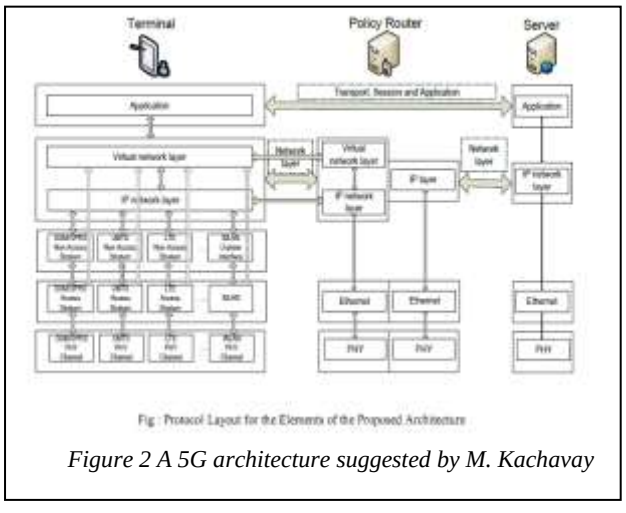

Figure 2 A 5G architecture suggested by M. Kachavay

Moreover, Rost et el researched about RAN as service RANaaS ad multi-layer protocols within a multi-type of communication and the machine to machine M2M, all integrated into larger cloud service to be essential in the 5G network [16].

Intel corporation research team studied the 5G enabled device technology and architecture, to be integrated within IoT utilizing heterogeneous networks and advanced technologies such as RAT, multi-input multi output MIMO with all previous suggested technologies and they proposed a device architecture [4].

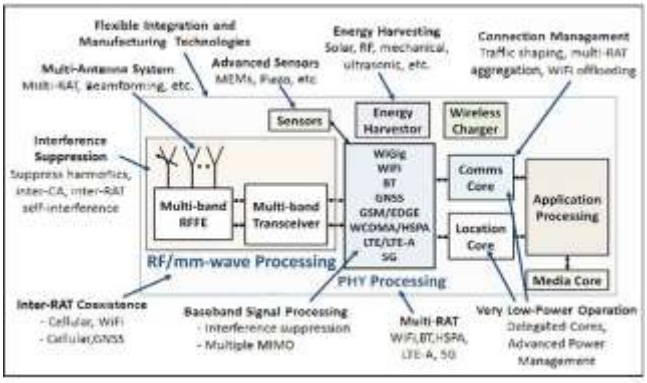

Figure 3: Intel suggested cellular device architecture

Wireless network signals and core devices architecture was studied by the team of researchers, especially high-density MIMO and antennas and cells distribution [5].

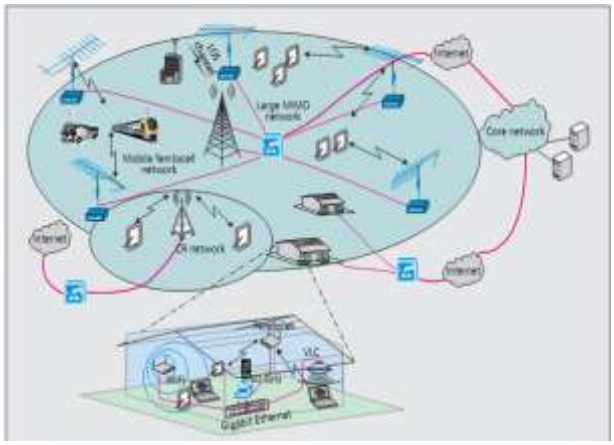

Figure 4: 5G heterogenous wireless cellular architecture

YUAN Yifei and ZHU Longming studied the management strategies for the 5G network and the major application of it [17]. The expected traffic/speed/latency was the major contribution they provided as shown in table figure 5.

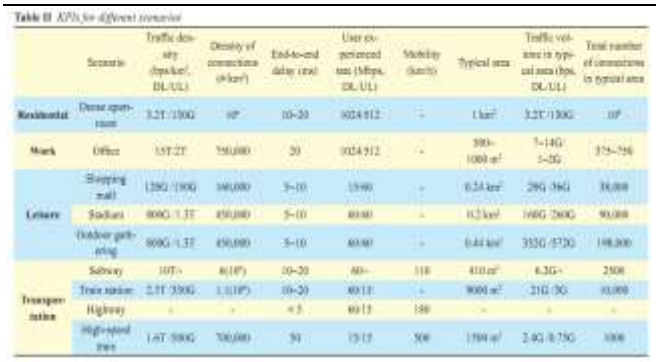

Figure 4 Table Show Management Parameter For Scenarios.

E.Hossain and M.Hasan also studied the management faced by 5G network and distribution architecture of different technology [4].

LTE advance integration with 3GPP and the development of v13 then v14 which later became integrated with WiMax v2 was studied by Samsung corporation team [18].

III. 4TH-INDUSTRIAL REVOLUTION

Head of Mobility Industries at World Economic Forum introduced a full study of the 4th-IR aspects and it's a major component as it depends mainly on cyber-physical production, and its effect of the most aspect of the world economy and development method[10].

Cyber-physical system in production and manufacturing was studied in extensive technical research from all points. Its architecture [19] design problem [20] communication [21] management [22] and integration in the production process [23], [24].

4th-IR aspects and characteristics especially human resources impact, employee and the skills enhancement requirement opposed via the 4th-IR studied by Uwe Dombrowski, Tobias Wagner [11].

B. 5G and the 4th-IR dependency

As 4th-Ir studies illustrated, the integration of all communication technologies, with the development in speed, latency and most importantly the density and multi-path availability, all are very essential for success development of the 4th-IR as an integration between machine, data, communication and AI as interface between human and machine or between machines and management of their diversity[25].

However for such integration and development of diverse technology to succeed the unification of protocols and services hierarchy and interchangeability is very important, which is the core concept of 5G beside the speed and integrity advancement of each communication technology.

Such integration could not be done without the agility and dynamic ability of artificial intelligence AI, which serve as a management layer on top of all services, and an interface layer between each different services or protocols[26].

C. 5G current challenges

The foremost challenge for 5G to be developed is the political hassle about its technology between China which took the lead in development and the western world concern about the security of the china produced technology serve as infrastructure for 5G.

Secondly, many problems still exist at developing the high-speed signals technology, which utilizes high frequency with very little solid material penetration[27].

The penetration problem solved partly at WiMax v2.1 by the concept of the in-door modular out-door receiver [28].

The high-frequency issue was tested successfully in a controlled environment but still, need test in the high density super high-speed load.

Vertical Handover Decision (VHD) algorithms are indispensable components of Forthcoming 4G heterogeneous wireless networks architecture. [29][30]

Integration and unification of a different variety of protocols and services are still a major technical issue, which required a highly agile AI solution to link and manage all these technologies. Take note that AI technology still in infant stage compared to most other IT technologies.

In addition, high speed bandwidth of 5G wireless network is support Integration system application such as E-learning system [31], E-shopping and biometric integration devices in smart campus, in data transmission is important to use method of compression with high compression ratio to reduce time of data transmission via internet [32, 33] simulations based powerline channel [34, 35] has presented and investigated in adaptive shuffled frog leaping for optimal power rate allocation in high speed network data systems [36, 37].

IV. CONCLUSION

The Idea of 5th generation 5G is promising most challenges seems to be solvable, but the time needed to solve each challenge is unpredictable, but we can say it will be solved eventually.

As for evolving to the 4th-IR which require many other components we still don't have enough detailed concept about them. Such development is debatable in the foreseen time.

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