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5G: A REVOLUTION IN MOBILE NETWORKS

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Abstract— **The telecommunication field had been witnessed as one of the most dynamic and fast growing segment in the market. With the introduction of wireless communication, revolutionary technologies have been introduced in the recent years. The latest technology brought into use in this field is 4G that is 4th generation Mobile Network .4G is also called as LTE (Long Term Evolution) With its speed and efficiency it has raised the comfort level for consumers worldwide. However, researches aim to introduce an upgraded version of 4G that is 5G (5th Generation Mobile Network) to answer the challenges of 4G with it's amazing data speed in gigabytes and low latency period. The 5G architecture is called as the 5G Nanocore which consists of Nanotechnology, Flat IP Network and Cloud Computing. 5G was aimed to be introduced in the year 2020 ,however recent reports contradict the fact as various techniques are under research to achieve the goal data transfer in gigabytes using proper frequency spectrum. 5G also introduces the concept of WWWW(World Wide Wireless Web).**

In this paper, we would elaborate the research work going on regarding 5G and some alternative solutions under research to face challenges of 5G.

Index terms- **LTE, 5G, 4G, WWWW, All IP Network,Cloud Computing, 5G Nanocore Architecture,Project Skybender,Artemis Networks Pcell.**

I. INTRODUCTION

Every year drastic changes take place in Telecommunication field. Means of communication has changed from wired modes of transport to wireless media. With the 5G technology devices will be enabled to get connectivity with the network anytime, anywhere and therefore could connect different devices without human interaction and could be base for IOT (Internet Of Things).Further 5G can be used in building Anti-Collision System for vehicles and help in Highway Surveillance.Vehicles can connect and communicate with each other to provide traffic related information.Other example for using 5G in IOT is using wireless charger that can There are various technologies which the 5G technology integrates in order to optimize the communication. It includes the integration of technologies like WI-FI, Bluetooth, WCDMA, LTE to provide a efficient communication solution. WI-GIG is the new IEEE standard for WI-FI and it uses the 60HZ frequency band. The spectrum to support the 5G technology is to be decided in the World Radio Conference(WRC) in 2019.5G will aim at providing Data rates at the range of 1-10Gbps/100s of mbps and Energy consumption will be 10% of today's energy consumption. Security problems with the technology arise because of the All-IP-Network. Also because of the heterogeneous network architecture due to the use of WI-FI,LTE etc,security issues related to the accessing of different technologies have arised.The possible solutions for this could be as follows:

1. Secure Infrastructure
2. Isolated virtual network slices
3. Hybrid Authentication Management

A. Evolution Of Mobile Generations

1st Generation(1G):This technology was introduced in the Early 1980's and used FDMA(frequency division multiple access) modulation techniques with a channel bandwidth of 30kHz.This channel used the frequency band 824-894MHz.The data rate was 9.6-14.4 Kbps.The drawbacks were poor battery life, voice quality, large phone size and lack of security

2nd Generation(2G):This technology was introduced in the year 1991's and used TDMA(time division multiple access) modulation techniques with a channel bandwidth of 200kHz.The data rate was 22.8 Kbps.The drawbacks it required strong digital signals

3rd Generation(3G):This technology was introduced in the year 2000's and used CDMA(codedivision multiple access) modulation techniques with a channel bandwidth of 5-20MHz.This channel used the frequency band 1.6-2.5GHz.The data rate was 3.1Mbps.The drawbacks were high bandwidth requirement,expensive handsets,and complex infrastructure

4th Generation(4G):This technology was introduced in the late 2000's and used CDMA(code division multiple access) modulation techniques with a channel bandwidth of 100MHz.This channel used the frequency band

2-8GHz.The data rate was 1Gbps.The drawbacks were more battery usage,difficult to implement complicated hardware.

5th Generation(5G):This technology might be introduced in the Early 2020's and used CDMA(code division multiple access) modulation techniques with a channel bandwidth of 160MHz.This channel used the frequency band 15GHz.The data rate was 1-10Gbps.The drawbacks will be handset compatibility, security issues, high cost affair.

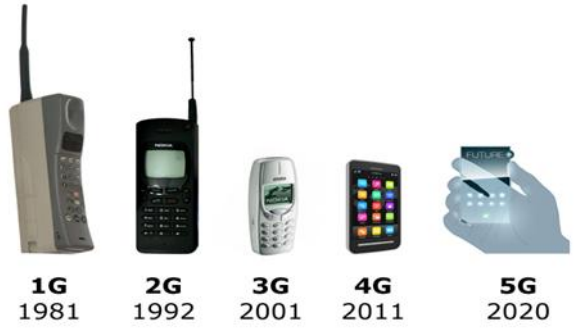

Fig.1 Evolution in Mobile Communications

II. KEY CONCEPTS IN 5G

Key difference between 4G and 5G will be **System Spectral Efficiency.** It is the measure of number of user devices connected simultaneously in a limited Radio Frequency Bandwidth within a geographic area.5G will have significantly higher System Spectral Efficiency compared to the 4G LTE. Other Concepts Are

MIMO (multiple input multiple output): MIMO is used to increase the capacity of the channel transmission by increasing the number of antennas at the transmitting as well as the receiving end. If millimetre waves for data transmission are used, MIMO will play important role as the wavelength for millimetre waves is short-distanced.

Smart Antenna: Using smart antennas will help in alternating the beam direction to get more directed communication with minimal interference

Pervasive Networks: Using this kind of networking the user can concurrently access several wireless technologies and seamlessly move between them

Cognitive radio technology: If this technology is used then the user handset or device will be enabled to optimize itself to select the optimum radio access network and other parameters to get the best radio connectivity access

Dense Networks: Reducing the size of cells will help in more efficient use of spectrum

World Wide Wireless Web(WWWW):5G aims at creating WWWW i.e. wireless connectivity across the globe. It includes providing Full multimedia capability beyond 4G speeds.

III. 5G ARCHITECTURE

A. CELLULAR ARCHITECTURE:

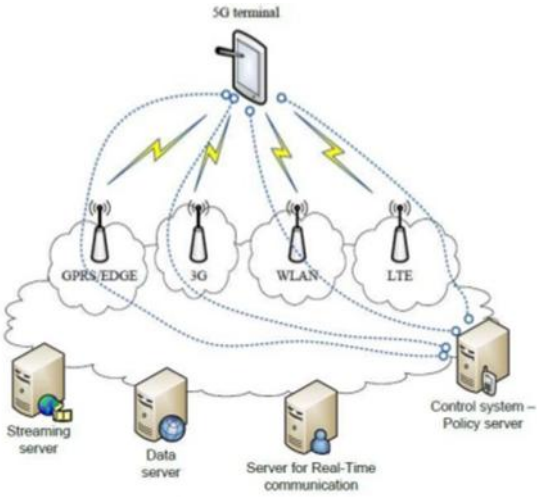

Fig.2 Cellular architecture for 5G

GPRS (General Packet Radio Service): It is very useful in minimizing energy consumption during data transmission using internet. It provides data speed of60kb/sec

EDGE (Exchanged Data Rate): This is the advanced version of GPRS and it provides data speed of 473kb/sec

3G: It provides an efficient way to browse on internet. Also it makes it possible to have video calling on mobile networks

WLAN (Wireless Lan): It provides short range, high-speed wireless data connection between the device and data using radio signal

LTE (Long Term Evolution): This is the standard for mobile communication for high speed data transmission with a speed of about 100mbps

B. NANOCORE ARCHITECTURE:

Flat IP Architecture:

Earlier broadband network connection had very simple architecture where the base station used to link to ASN(Access Service Network) and gateways and from there the IP traffic would directly disappear into the Internet Cloud.This was globally used till few years back.However for supporting the features of next generation mobile devices,the telecommunication industry started using Flat IP concept. In the Flat IP architecture devices are identified using symbolic names.The Flat IP runs entirely via IP and the entire network is reduced into base station with a single core gateway

Here data is not transmitted from multiple layers to the center and then back to multiple layers and finally reach the user end.Instead,the Flat core routers at the transmitting end transmit the data directly to the flat core routers at the receiving end.Direct connections or shortest path routing is required between the transmitting and receiving routers for this architecture.

The All IP Network(AIPN):

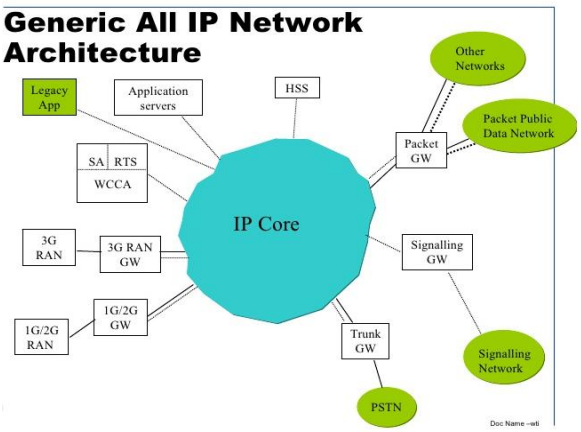

Fig.3 Architecture of the All IP Network

It is the common platform for all radio access technology.

However as the data flows freely and the internet is open to everyone not specifically the developers or authenticated users there are security threats which arise because of the flat IP structure.

All IP Network (AIPN).It is the common platform for all radio access technology.

C. Cloud Computing:

"Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction…" is the definition of cloud computing from the"*The NIST Definition of Cloud Computing"* US National Institute of Standards and Technology Special Publication 800-145, September 2011,by Peter Mell and Timothy Grance.Cloud computing uses central remote server and internet to store and maintain data and its various applications.Using cloud computing users can access their personal files at any computer with internet.In 5G networks the remote server can act as the content provider.This technique will be used in the nanocore architecture where the user can access their personal account with the help of global content provider which uses the method of cloud computing

D. Nanotechnology

Nanotechnology is the atomic level science working on the nanometer scale in the range of 0.1 to 100nm also called as the Molecular Nanotechnology(MNT).Nanotechnology can solve the issues of memory and computing power for offering higher data speeds that would be required for supporting the future generation technology.Using nanotechnology we can create mobile devices as intelligent sensors that can have many application in various industries.Nanotechnoly is helpful in resolving the security isseues of All IP network

Fig.4 5G Nanocore Architecture

IV. GOOGLE'S "PROJECT SKYBENDER"

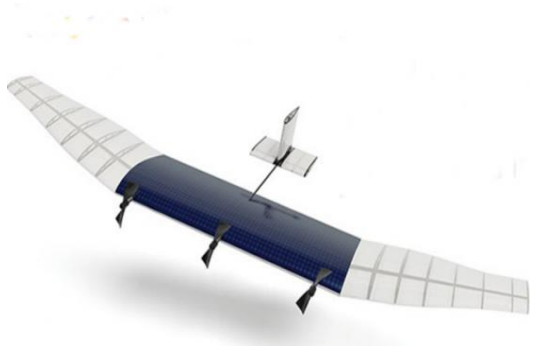

Fig.5 Drone Model for the SKYBENDER project

If the recent reports from "The Guardian" is to be referrered Google is experimenting a internet-over-sky project called as "Project SKYBENDER" which will aim at providing 5G internet access using Solar Drones. This Drones are flying objects similar to an aircraft which are supported by Solar Panels.The drone is named as "Centuar". The Drone's hardware consists of millimetre wave-transreceiver. According to the reports, Google is carrying out this project around the airspace of SpacePort America in New Mexico. Millimetre waves lie in the Extremely High Frequency (EHF)Range Millimetre waves occupy the frequency spectrum in the range of 30GHZ to 300GHZ.Hence can be used in data transfer with speed in gigabytes. Millimetre waves will provide an entirely new frequency spectrum for 5G mobile communication,which is better option then the already crowded 3Gand 4G network spectrum .Millimetre waves can speed up the data transfer by about 40 times the LTE and can be used as the background for 5G internet

However the issue with millimetre waves is that is the wavelength.The wavelength of millimetre waves is in 1mm to 10mm range.The range of millimetre waves is short-distanced less than the mobile's signal range Also millimetre waves cannot penetrate thick walls which challenges the idea of using millimetre waves in 5G communication

V. ARTEMIS NETWORK'S "PCELL"

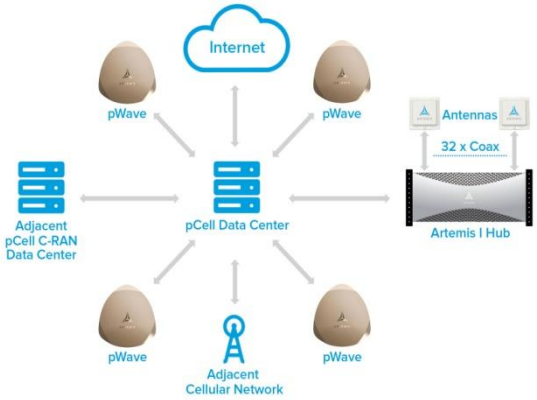

Fig.6 pCell architecture

Artemis Networks is a technological firm which have put forth software-defined pcells and pwave.Steve Perlman is the CEO of Artemis Networks

PCELL(Parametrized Cell) technology is capable of attaining higher speeds for data transmission in wireless communication.The pCell technology claims to permit all the equipped mobile devices within a pcell range,each of the devices can access all most the entire available bandwidth capacity.The technology also claims that it does not require increased spectrum to accommodate increased number of users.The software-defined pCell attains interference by creating virtual cells for each of the wireless users.By properly controlling and co-ordinating the transmissions from each cell transmitter.At the user-end inter cell interference is cancelled allowing deployment of hundred times the number of cell transmitters.As the network deployment has equal number of cell stations as the number of user then each user will have its own cell and would not need to share it with the other users

If the experimenting and testing goes well, pCell can provide an alternative to 5G or rather could be associated with 5G technology to achieve better results.

Recent reports state that Ericsson has teamed up with IBM to research on the design of **Phased-Array** 5G Smart Antennas.Ericsson noted that phased array designs allow more directional antennas. It also claims that integration of such antennas will be possible to integrate hundreds of antennas and radios on a single chip with a size smaller than the credit card allowing it to be used in small cells with efficiency.

Nokia Networks is planning to join hands with wireless start-up firm Artemis Networks to jointly Test Artemis pCell technology with wireless carriers, according to the reports by Phil Goldstein.

Ericsson has tested its first 5G handset to support 5G, However it is so big that it comes with its own cart to move around

VI. CONCLUSION

With every coming year future prediction is getting difficult because of the ever growing technological enhances. Using 5G along with Artificial Intelligence would help in bringing IOT into reality.5G will give users a real-life experience. However security threats do prevail which remain the main point of research for researchers worldwide. The pCell technology if proved successful can become the base technology for 5G.Also recent reports on the on Google's Skybender Project gives a view of flying drones in the sky providing high speed internet.

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