STUDY OF RECENT DEVELOPMENTS IN 5G WIRELESS TECHNOLOGY

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ABSTRACT

Even as LTE and LTE Advanced (4th Generation cellular systems) are being deployed, work is already starting on their successor: 5G. 5G Technology stands for 5th Generation Mobile Technology. 5G is a name used in some research papers and projects to denote the next major phase of mobile telecommunications standards beyond the upcoming 4G standards. Currently, 5G is not a term officially used for any particular specification or in any official document yet made public by telecommunication companies or standardization bodies such as 3GPP, WiMAX Forum or ITU-R. This paper describes the needs that demand continued development of mobile and fixed-line communications systems, and explains some background on who is involved and what is currently happening in bringing 5G from theory to reality.

Keywords – 5G, applications, developments, the players in 5G

I. INTRODUCTION

If we’re all to use our mobile devices to work and play anywhere, we want access to streaming services and all our own “stuff”, instantly, on devices as small as a smartphone or as large as the screen in an auditorium – properly formatted for the size of the screen, of course. We’re already socially networked, 24 hours per day, 7 days a week. We want to be able to share versions of our stuff – photos, video, data, whatever – with friends, colleagues, and customers – wherever they may be.

In the same way, we don’t want to buy software applications we don’t need. Instead, we want to rent the applications we need to process our data for just as long as we need them. This is the vision of true “cloud computing”, as opposed to just cloud storage, and its reality depends almost entirely on high-speed connectivity.

This need for high-speed connectivity is the common denominator as we look ahead to fifth-generation or 5G mobile networks. Achieving 24/7 access to, and sharing of, all our “stuff” requires
that we continue on our current path: going far beyond simple voice and data services, and moving to a future state of “everything everywhere and always connected”.

5G technology will change the manner in which cellular plans are offered worldwide. A new revolution is about to begin. The global cell phone is around the corner. The global mobile phone will hit the localities who can call and access from China to Germany’s local phone with this new technology. The way in which people are communicating will altogether upgrade. The utilization of this gadget will surely move a step ahead with improved and accessible connectivity around the world. Your office will shrink into your handset with this cell phone that is going to resemble PDA (personal digital assistant) of twenty first century. [1]

II. GOING BEYOND JUST VOICE

Before discussing the deeper technical concepts, I want to show you how 4G develop from 1G. The first generation, 1G wireless mobile communication systems, was introduced in the early 1980s and completed in the early 1990s. 1G wireless was analog and supported the first generation of analog cell phones with the speeds up to 2.4kbps. The second generation, 2G system, fielded in the late 1980s and finished in the late 1990s, was planned mainly for voice transmission with digital signal and the speeds up to 64kbps. The third generation, 3G wireless system, was developed in the late 1990s and might be well-done in the late 2000s. 3G is not only provided the transmission speeds from 125kbps to 2Mbps, but also included many services, such as global roaming, superior voice quality and data always add–on. The fourth generation (4G) is a conceptual framework and a discussion point to address future needs of a high speed wireless network that can transmit multimedia and data to and interface with wire-line backbone network perfectly just raised in 2002. The speeds of 4G can theoretically be promised up to 1Gbps. The beyond will be 5G with incredible transmission speed with no limitation for access and zone size.

The main distinguishing factors between 3G and 4G will be data rates, services, transmission ways, access technology to the Internet, the compatibility to interface with wire-line backbone network, quality of service and security. According to an article, “WCDMA and WLAN for 3G and beyond, HarriHonkasalo, the director of IPR for Nokia Corporation, states that “4G should support at least 100 Mbps peakrates in full-mobility wide area coverage and 1Gbps in low-mobility local area coverage . The speeds of 3G can be up to 2Mbps, which is much slower than the speeds of 4G. For the service, 3G marketing is difficult to roam globally and interoperate across networks, yet 4G will be a global standard that provides global mobility and service portability so that service provider will no longer be limited by single-system .

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<thead>
<tr>
<th>ITEMS</th>
<th>3G</th>
<th>4G</th>
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<tbody>
<tr>
<td>speed</td>
<td>Up to 2Mbps</td>
<td>Full-mobility: up to 100Mbps Low mobility: up to 1Gbps</td>
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<tr>
<td>services</td>
<td>Difficulty of global roaming</td>
<td>Roaming smoothly</td>
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<td>Core Network</td>
<td>Wide-area concept Circuit and packet switching</td>
<td>Broadband IP-based Entirely packet switching</td>
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<td>Technologies</td>
<td>WCDM, CDMA2000, TDSCDMA</td>
<td>All access convergence including: OFDM, MCCDMA, LAS-CDMA, Network-LMPS</td>
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III. How 4G works

The 4G mobile system is an all IP-based network system. The features of 4G may be summarized with one word—integration. The 4G systems are about seamlessly integrating different technologies and networks to satisfy increasing user demands.

4G technologies shall combine different current existing and future wireless network technologies (e.g. IPv6, OFDM, MC-CDMA, LAS-CDMA and Network-LMDS) to ensure freedom of movement and seamless roam from one technology to another. These will provide multimedia applications to a mobile user by different technologies through a continuous and always best connection possible [2].

Current coverage of 4G/LTE:

![Current coverage of 4G/LTE](image)

Adoption of LTE technology as of June 26, 2013[3].
- Countries with commercial LTE service
- Countries with commercial LTE network deployment on-going or planned
- Countries with LTE trial systems (pre-commitment)

IV. Why is 5G Required?

5G is needed because of the explosive growth in video traffic, the acute shortage of spectrum, the growing need to minimise the energy requirements of web devices and network infrastructure and to cater to the insatiable desire for higher data speed rates.

For the customer, the difference between 4G and 5G technologies will be in higher speeds, lower battery consumption, better coverage, higher number of supported devices, lower infrastructure costs, higher versatility and scalability or higher reliability of communications.

V. Characteristics of 5G Technology

- The technology 5G presents the high resolution for sharp, passionate cell phone every day and give consumers well shape and fast Internet access.
- The 5G technology provides billing limits in advance that the more beautiful and successful of the modern era.
- The 5G technology also allows users of mobile phones, cell phone records for printing operations.
• The 5G technology for large volume data distribution in Gigabit, which also maintains close ties to almost 65,000.
• The technology gives you 5G carrier distribution gateway to unprecedented maximum stability without delay.
• The information from the data transfer technology 5G organize a more accurate and reliable results.
• Using remote control technology to get the consumer can also get a 5G comfort and relax by having a better speed and clarity in less time alone.
• The 5G technology also support virtual private network.
• The uploading and downloading speed of 5G technology touching the peak.
• The 5G technology network offering enhanced and available connectivity just about the world.
• 5G network is very fast and reliable.

VI. Applications of 5G

1) Real wireless world with no more limitation with access and zone issues.
2) Wearable devices with AI capabilities.
3) Internet protocol version 6(IPv6), where a visiting care-of mobile IP address is assigned according to location and connected network.
4) One unified global standard.
5) Pervasive networks providing ubiquitous computing: The user can simultaneously be connected to several wireless access technologies and seamlessly move between them these access technologies can be a 2.5G,3G, 4G or 5G mobile networks, Wi-Fi, WPAN or any other future access technology. In 5G, the concept may be further developed into multiple concurrent data transfer paths.
6) Cognitive radio technology, also known as smart radio: allowing different radio technologies to share the same spectrum efficiently by adaptively finding unused spectrum and adapting the transmission scheme to the requirements of the technologies currently sharing the spectrum. This dynamic radio resource management is achieved in a distributed fashion, and relies on software defined radio.
7) High altitude stratospheric platform station (HAPS) Systems. The radio interface of 5G communication systems is suggested in a Korean research and development program to be based on beam division multiple access (BDMA) and group cooperative relay techniques. [5]

VII. The Players in 5G

It is a commonly said sentence that “When the technology advances, the “next” upgrades must be in planning and development phases while its predecessors are being deployed”. This is exactly true with all mobile telecommunications.

Today many are using the mobiles to surf internets, movie downloads and for social networking. Internet connectivity will take only few seconds and movies can be downloaded in few seconds while we are using 5G.

So to achieve this many universities and companies are stepping in recently some of the major players are:

i. Wireless®MIT:

Also known more formally as the MIT Centre for Wireless Networks and Mobile Computing, this new organization pulls together more than a dozen MIT professors and their research groups to work on next-generation wireless networks and mobile computing.
The work done at the centre is designed to make an impact on technology users: Wireless@MIT boasts a "strong industrial partnership" with Microsoft, Cisco, Intel, Telefonica, Amazon, STMicroelectronics, and MediaTek -- and says it aims to influence standards and products. Research at Wireless@MIT is currently focused on four areas: spectrum and connectivity, mobile applications, security and privacy, and low-power systems.

METIS is an EU-funded, Ericsson-led, consortium of 29 organizations with a 27 million Euro budget and more coming from the European Commission is aimed at replicating Europe’s worldwide success with GSM and subsequent technologies. It will "develop a system concept that delivers the necessary efficiency, versatility and scalability... investigate key technology components supporting the system and.Evaluate and demonstrate key functionalities." The majority of participants are universities and mobile network operators, with industry partners including Alcatel-Lucent, BMW, Huawei, Nokia, and Nokia Siemens Networks (NSN).

METIS is co-funded by the European Commission as an Integrated Project under the Seventh Framework Programme for research and development (FP7). It will run for 30 months.

ii. Technical University of Dresden, Germany:
TU-Dresden previously pioneered 3G systems research in association with the Vodafone Chair Mobile Communications Systems, which is dedicated to cutting-edge research in wireless communication technology. Their vision for a next-generation system is user-centric, with required system attributes based on perceived future usage models: “The Internet of Things”. Their vision for 5G is to provide a new unified air interface to cover cellular, short-range and sensor technology that can deliver 10Gbps, 1ms latency and simple sensors with 10-year battery life.

iii. Centre for Communication Systems Research (CCSR), University of Surrey, UK:
The project has begun around mid-2013, and is expected to cost around £35 million ($56 million USD), where about £11.6 million will come from the UK government and the other £24 million will be provided by a group of tech companies, including Samsung, Huawei, Fujitsu Laboratories Europe, Telefonica Europe, and AIRCOM International. An expansion of the program is also being sought with further proposals going to the UK government.

It’s claimed that the new network will be spectrum-efficient and energy-efficient. It will also be faster, with cell speeds bumped up to a capacity of 10Gbps.

iv. Polytechnic Institute of New York University (NYU-Poly):
Researchers at Polytechnic Institute of New York University (NYU-Poly) have assembled a consortium of government and business support to advance beyond today’s fourth generation (4G) wireless technologies toward 5G cellular networks. The National Science Foundation (NSF) has awarded the team an Accelerating Innovation Research (AIR) grant of $800,000, matched by $1.2 million from corporate backers and the Empire State Development Division of Science, Technology & Innovation (NYSTAR), which supports the project through its longstanding partnership with NYU-Poly’s Centre for Advanced Technology in Telecommunications (CATT).

The 5G project will develop smarter and far less expensive wireless infrastructure by means of smaller, lighter antennas with directional beam forming to bounce signals off of buildings using the uncrowded millimetre-wave spectrum. It will also help develop smaller, smarter cells with devices that cooperate rather than compete for spectrum.

Professor Rappaport recently joined the NYU and NYU-Poly faculty and is launching the world’s first academic research centre that combines wireless communications with computing and medical applications.
v. China:
China’s Ministry of Industry and Information Technology has established a working group called “IMT-2020 (5G) Promotion Group” for 5G research in February 2012.

vi. Tokyo Institute of Technology and DOCOMO:
Tokyo Institute of Technology in a joint outdoor experiment conducted recently with NTT DOCOMO, INC. succeeded in a packet transmission uplink rate of approximately 10 Gbps. In the experiment, a 400 MHz bandwidth in the 11 GHz spectrum was transmitted from a mobile station moving at approximately 9 km/h. Multiple-input multiple-output (MIMO) technology was used to spatially multiplex different data streams using eight transmitting antennas and 16 receiving antennas on the same frequency.

vii. Qualcomm’s 1000x Data Challenge Presentation:
The presentation “1000x Data Challenge” from Qualcomm discusses a three-fold evolution of today’s 4G standards. It proposes study items for 3GPP specification releases 12 and beyond relating to interworking, heterogeneous networks, self-organizing networks and steadily decreasing cell sizes.

viii. SAMSUNG:
Samsung Electronics recently announced it had made a breakthrough in wireless network technology, calling it "5G". Samsung said that its researchers "successfully developed the world's first adaptive array transceiver technology operating in the millimetre-wave Ka bands for cellular communications."

The transmissions used in the test were made at the ultra-high 28GHz frequency, which offers far more bandwidth than the frequencies used for 4G networks. High frequencies can carry more data, but have the disadvantage that they generally can be blocked by buildings and lose intensity over longer distances.

Samsung said its adaptive array transceiver technology, using 64 antenna elements, can be a viable solution for overcoming the weaker propagation characteristics of millimetre-wave bands, which are much higher in frequency than conventional wireless spectrum. The company said it "plans to accelerate the research and development of 5G mobile communications technologies, including adaptive array transceiver at the millimetre-wave bands".

ix. HUAWEI:
The telecommunications equipment maker has devoted hundreds of engineers to the research and development of such technology
Zhou Yuefang, executive vice president and chief operating officer of Huawei’s LTE business unit and mobile broadband technologies said that five years is usually required for new broadband technologies to become mainstream and be accepted by the mobile ecosystem. Therefore, as 4G is only beginning to gain traction, the natural progression of mobile broadband technology will likely result in the 2020 introduction of 5G.

Zhou believes that our fifth generation networks will have better spectrum management flexibility and indoor coverage will be improved due to the use of small cells installed within buildings.
VIII. Is It Even Real?

Let’s get one thing very clear: 5G is not around the corner, and it’s not even technically ‘in the works.’ There’s every reason to anticipate a serious need for a fifth generation technology, and plenty of research and analysis has been done on the subject. But as of yet, 5G is far more of a far-sighted speculation than a working model. Here’s what we know so far:

5G may be the wireless technology that ends the current confusion in which a single provider has both specific spectrum allocation and specific wireless technology. There would be a clear benefit in offering a unified global standard, and ‘smart radio’ technology would allow devices to simply hop on to any available spectrum.

IX. When will it arrive?

There’s a rough consensus that 2020 is going to be the year of 5G. On average, wireless generations have been spaced about a decade apart, analog wireless (1G) first appeared in 1981, 2G digital wireless in 1992, 3G began rolling out in 2001, and 4G started to become available in 2011. This makes an interesting exception to the usual increased frequency of technological advancement seen in most other fields.

X. The “Spectrum Crunch”

More importantly, there’s a very real worry that current wireless technologies will become insufficient to handle increasing consumer data demands. The popularity of mobile video is especially taxing on bandwidth, as is the general movement of data storage to a cloud-based model. Already major providers are fighting each other and the federal government for additional spectrum allocation and we may start to see a spectrum deficit as early as this year.

In a sense, anything that replaces 4G will be 5G. Seen from another angle, however, 5G may not be where we’re headed at all.

Going by the analysis of the wireless industry’s spectrum, there is simply not much more room to grow; we’re near maximum bandwidth and throughput already. We may be forced to develop a completely different approach, unrelated to the “G’s,” or utilize existing technology in very different ways.

XI. CONCLUSION

This paper describes the needs that demand continued development of mobile and fixed-line communications systems, and explains some background on who is involved and what is currently happening in bringing 5G from theory to reality. While the future is becoming more and more difficult to predict with each passing year, we should expect an accelerating pace of technological change. Though there are many obstacles and opportunities in 5G development, with much hanging on the outcome. But the concept also involves the challenges on which engineers thrive.

REFERENCES


