Proceedings of International Conference
on Mechanical, Electrical and Medical Intelligent System 2017
Invited Paper

Past, Present and Future of Wireless Communication, The World 6G makes

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Keywords: wireless communication, 6G, 2030, Life style

Abstract. The commercial based wireless communication service started in 1979, and the system has being replaced by new technologies every ten years. The 5th generation of wireless communication service will start immediately. Here in this article, we look back the history of wireless communication system briefly, after that we try to tell the expectation of future wireless communication style in 2030, when the 6G will start. The progress of wireless communication system has led various kinds of change in our society. At beginning, communication in voice was the main application, and next, e-mail like network related service started. These days, usage of wireless communication isn't limited among human communication. IoT, VR and AI will become the new key-words of wireless communication.

1. Introduction

Before 1st generation wireless communication service as cellular phone begun, wireless communication was available only for the professionals who were trained for the special skills. But after 1979, when 1st generation services started, it became possible to use wireless communication for the ordinal people without special skills. After that, the rapid progress of semiconductor technologies allowed us to enjoy the results of rich spreading of wireless communication system.

In table1, we show the comparison among generations for wireless communication service.

Table 1The comparison among Generation of Wireless communication service

Gen.	Start	Key Technology	Killer Application
1G	1979	cellular system analog	Business call
2G	199X	Digital Packet	Mobile Internet(E-mail, SMS) Personal call
3G	2000	IMT-2000 International roaming	Game, Twitter, Facebook, YouTube・Web
4G	201X	Smart phone IP Based Network 100Mbps- 1Gbps	Web-based applications LINE・SNS・YouTube Social-network game

5G	202X	Data rate>10Gbps speed Mobility:500km/h Latency<1ms Energy Saving 1/n x Capacity>1000 x 10000 device/cel connected	IoT, CPS ,M2M,ITS,4K/8K
6G	203X	Mobile & satellite network. Nano Communication module & Antennas SDx (Software Defined x)	embedded system ubiquitous system mission critical service

2. History of Wireless Communication Service

2.1 1st Generation wireless communication service (1979-)

1G, which was introduced in 1980s, is the first generation of commercial wireless telephone system using Analog based technologies. It was called "mobile" telephone system, comparing with "fixed" or "wired" telephone system. The total cost of maintenance was relatively high, the main usage of the system was business call, and main customers were so called VIPs.

The rechargeable battery of this generation wasn't sophisticated enough that the personal terminals were relatively large, and used mainly in automobiles.

2.2 2nd Generation wireless communication service (199x-)

2nd Generation wireless communication system was constructed with Digital technologies.

The size of personal terminal became smaller than that of 1st Generation, thus it was possible to carry in hand. And the cost for personal usage became reasonable.

Just before the beginning of 3rd Generation, 2.5 Generation networks started in 1999, which supported not only voice communication, but mobile internet services such as e-mail and Web access. At this generation, mobile wireless communication was spread widely, thus even ordinal high school students could have their own mobile terminals. Many people must remember "i-mode" as the key-word of 2.5 generation.

2.3 3rd Generation wireless communication service (2000-)

3rd Generation of wireless communication service system could treat high-speed data communication. The main usage wasn't voice communication but connection to Internet. There were several kinds of international standard, and they could cover wide area on the earth, thus it made us possible to international roaming. I addition, the cost of handy terminals became almost negligible, and new terminal released in every season. The key-word of this generation was "FOMA", and so on.

2.4 4th Generation wireless communication service (201x-)

The key-word of 4th generation of wireless communication service was "broabband", which was based on IP technology. The communication speed of this system can be achieved 100Mbps - 1Gbps in theory and this performance is very close to that of Optical network.

From the point view of personal terminal, “Smartphone” became the standard device. The terminal has very sophisticated human interface, fine graphic display and finger touch operation, so it is easy to use newly developed Internet related services like SNS, YouTube and so on.

The other key-word of this generation is IoT, Internet of Things. Because the cost of semiconductor devices became very low, every device in our life, home-keeping equipment, sensor, even automobile can be built-in Internet access ability. It isn’t suitable to call this generation of wireless communication as “cellular phone”.

2.5 5th Generation wireless communication service (202x-)

Strictly speaking, 5G which will start in 2018, is neither the past system nor the present system. But the preparations for 5G have been done, thus it can be said that 5G is the existing system, at least from the point of view of technologies.

The torch relay of Winter Olympic Games in PyeongChang just began in November 1st 2017.
At the same time of this Olympic Game starting, 5G services will start in Korea.
Verizon will also start service in the US, and Vodafone has the schedule to start in Europe, both in 2018. And in Japan, we will also start the service according to the Olympic Games in Tokyo in 2020.

The most significantly change in the 5th Generation from the 4th generation is the change of main actor who drives wireless communication. Roughly speaking, before 5G, main actor was engineering technologies, which decided what application can operate. But in 5G, technologies becomes highly sophisticated, in other word mature, so the new main actor is “services and applications” from the beginning. After considering about the detail of new services, we decided what kind of technologies we need to develop.

2.6 Comparison of main actors among Generation of wireless communication

In Figure 1, we show the comparison among generations for wireless communication.

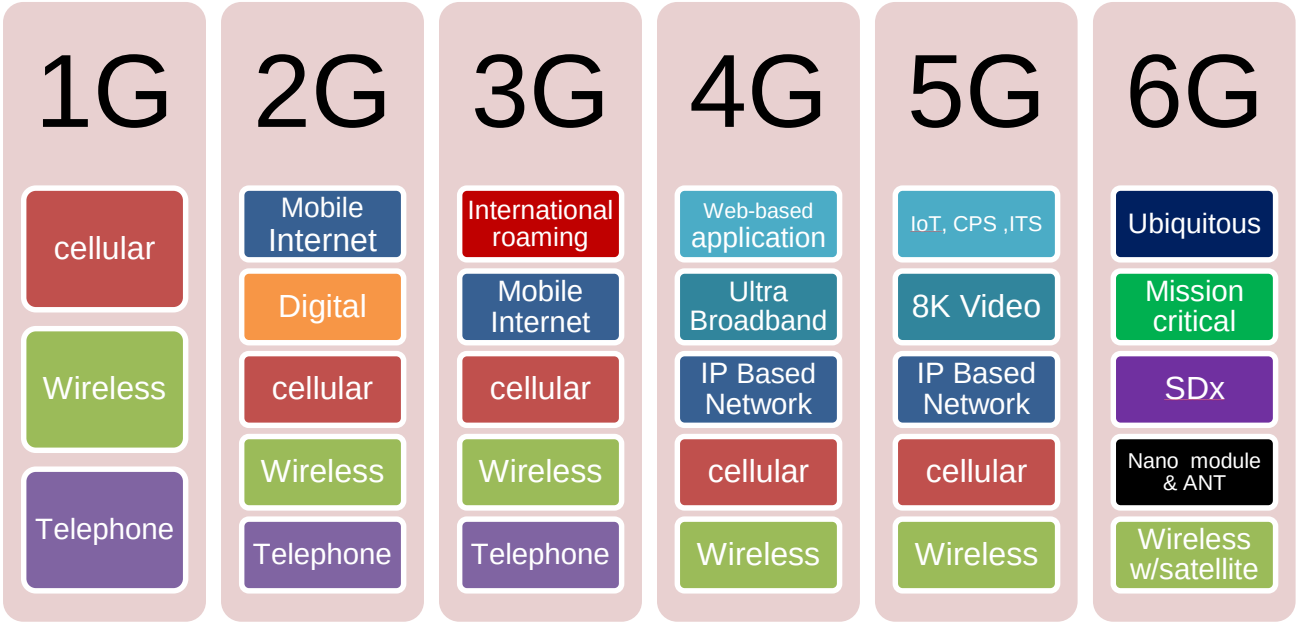

Figure 1 Comparison of main actors among Generation of wireless communication

3. Summary of the Change of Society caused by Past Wireless Communication System

We propose the one word to describe this change, “Border-less”.

First of all, the border between the professional of wireless communication and other people has been disappear, namely everybody can use without learning theory of operation.

We also find the similar change in the field of "Broadcasting". In order to spread the message movie into society, using broadcast station is NOT the only way, but now we can use You-Tube like service.

This phenomenon has also changed the leading actor from engineering technology into application.

The second border is that existed between wireless communication and Internet connection.
At beginning, wireless communication was used for the message in voice, thus it has been used for various kinds of digital data, for example, photo, movie, music and so on.

As for technology side, we can find other border-less going on.

There is no border between fixed communication and mobile communication, in other word, the boarder between Wired and Wireless communication. These technologies complement each other.

It is also important change that the border between hardware and software has been disappeared. These days, the equipment for wireless communication is made with "Software Defined Radio" technologies.

4. Future wireless communication, 6th Generation wireless communication service (203x-)

As for the hardware for 6G, we expect that we won't find any epoch-making technologies, but the 6G system will be constructed with the combination of known technologies. In the other hand, various kinds of new usage of wireless communication must be proposed at that time.

One expectation is the change in every aspect of our daily life.
For example, combined with virtual reality technologies (VR), we can feel the friend who stands far away, exists just beside you. Or, even if you don't go to Paris for French cuisine, you can enjoy completely same feeling at Kiryu, including taste and the atmosphere of the restaurant in Paris.

It is the other expectation that wireless communication system will support the progress of Artificial Intelligence (AI) greatly. After 5^{th} generation, the infrastructure for wireless communication will become very easy to use, not only for human being, but also for AI. Thus Ai will be able to gather any kind of information automatically.

5. Conclusion

We mentioned the history and future expectation of wireless communication in this article. The progress of wireless communication has been changing the human society, and it will continue in 2030's.

Technology itself has become supporting role, and everyone without hard technical training, including AI, can use highly sophisticated wireless communication.

The future society in 2030's, might become more exciting than you can image.

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