5G and Wi-Fi 6 – Evolution & Revolution

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One of the few constants in technology is change. Scott Gurvey writing for Cisco provides a detailed, but not overly technical overview about two upcoming changes in the way data is handled wirelessly. When fully developed these technologies will make possible what is not possible today, change the face of mobile technology, and will fully connect the world.

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As you can tell by all the marketing hype, 5G is upon us. The mobile telephone carriers are touting their plans to roll out 5G, the Fifth Generation of wireless service, although specifics about the timetable, fees and applications are difficult to come by.

Wi-Fi 6 is somewhat more obscure. That's because the branding has never really caught on with the equipment makers who instead opted to describe their gear with the string of numbers and letters referencing the IEEE standard which defines the technology. Wi-Fi 6 is 802.11ax. And that is a mouthful for consumers to remember.

5G and Wi-Fi 6 are different sides of the same coin. Both are means of communicating without wires and both are necessary to support the revolution promised for the next generation of devices and applications. Both promise great increases in the data handling capabilities of the system, enabling a new generation of applications.

5G refers to the technology the commercial cellular carriers use. It operates over regulated spectrum, purchased at great cost. There is also a considerable investment in infrastructure. Wi-Fi 6, the new branding for 802.11ax brings the same increase in bandwidth to the Wi-Fi market. Unlike 5G, Wi-Fi uses unregulated spectrum, basically a set of channels shared by equipment manufactures. It operates on low power with very limited range. None the less, it has served so well it is ubiquitous and even the obscure 802.11 terminology is familiar to anyone who has purchased a router for a home or office.

Also familiar to most people with "smart" phones is the technique of combining these two technologies to form an end-to-end solution. Outside our homes we most often use the cellular technology networks to make both data and voice connections. These typically incur data usage charges and the expenses can really add up. Inside our home we program our smart phones to recognize our home Wi-Fi networks and to seamlessly switch as soon as we walk inside.

We now frequently find Wi-Fi "Hot Spots" available outside our homes. These can be free, such as those found in some government buildings, restaurants and stores. Or they can require a login, such as those associated with a specific cellular or cable service provider.

The first-generation technology had its hands full bringing wireless telephony to the masses. There was actually a non-cellular predecessor, call it generation zero, for radio-telephones. I remember one we had at CBS Chicago for our first-in-the-city "mini-cam" truck. The entire city-wide system could handle 25 calls at a time.

2G added messaging to the mix. This was the text messaging also known as SMS. The Apple iPhone in 2007 sparked a real revolution on the hardware side and led to 3G, which brought us access to the world-wide web and email using the true mini-computers we now call "smart phones". With 4G the data handling capability of the system had improved so much that video streaming became possible. And we

also began to see new applications like true turn-by-turn navigation.

Evolutionary expectations

It is important to note that 5G is not one single advance, but rather a series of advances on the technology side. An analogy the engineers often use talks about increasing the number of cars that can squeeze into a single lane highway, as well as adding lanes to the highway, as well as building completely new highways. So, part of what will result from the fifth generation will be evolutionary. For example, video will move to high definition. Navigation will become more responsive. Broadcast distribution will become easier. And security will become more robust end-to-end.

Revolutionary expectations

But it is the revolutionary possibilities which are most fascinating, and of course more speculative. We have been talking for several years about the Internet of Things. With IoT, our connected world is extending to the point where everyday objects are instrumented and embedded with electronics giving them a wide range of capabilities. These devices communicate and interact and can be remotely monitored and controlled.

5G/WiFi6 provide the network infrastructure which has been missing to make IoT a reality and this should open a wide range of new frontiers.

Transportation

Carla Chiasserini, an Associate Professor with the Department of Electronic Engineering and Telecommunications, Politecnico di Torino and Anthony Magnan, a Senior RF Planning Engineer at an automobile manufacturer in Detroit and a contributing member of the Wi-Fi Alliance talk in a **white paper for the IEEE** about the new services they say will be game changers for the automotive sector. They predict:

- vehicle platooning: vehicles dynamically forming a group, driving together, and proceeding at a very short distance from each other;
- advanced driving: vehicles sharing driving intentions, sensor data, and videos gathered through onboard cameras with roadside infrastructure, other vehicles, pedestrians and network servers, for safety and traffic efficiency applications, as well as semi- or fully-automated driving;
- remote/cloud computing driving: a remote driver that operates a vehicle traveling in dangerous environments, with impaired passengers onboard, or public transportation vehicles.

Factories of the future

Today, communication standards in factory environments are mostly “wired” rather than “wireless”. The wired deployment prohibits flexible adjustments of production lines and are more sensitive to problems. Part of the explanation for this has been the lack of standards to facilitate communication between the myriad different devices from many manufacturers.

But there is also the issue of “latency,” the delay in a network between the issuance of a request and the receipt of a response. In a strictly sensing or monitoring situation a small lag may not be critical. But in a manufacturing process where one piece of equipment must interact with another, and possibly do so under the direction of a central control intelligence, latency becomes a limiting factor.

5G and especially WiFi6, which is usually what is employed on a factory floor, promises to greatly decrease the latency between data exchanges. Analyst Gabriel Brown says:

> 5G does not itself redesign factory production lines or define industrial processes; it can, however, be an enabler of new operating models. To be successful in this, 5G must become embedded in the industrial automation process. In the first instance, this means replicating the functionality of today's wired industrial Ethernet systems to support existing controllers, switches, sensors and actuators. In the second, there is an

opportunity to make 5G integral to the evolution of industrial IoT as machines and production lines are themselves re-designed, improved and automated:

Considerable effort has gone into codifying these concepts in what many call “Industry 4.0.” Bernard Marr, author of Artificial Intelligence in Practice: How 50 Successful Companies Used AI and Machine Learning to Solve Problems, defines a smart factory as one which includes:

- Interoperability — machines, devices, sensors and people that connect and communicate.
- Information transparency — systems create a virtual copy of the physical world through sensor data in order to contextualize information.
- Technical assistance — both the ability of the systems to support humans in making decisions and solving problems and the ability to assist humans with tasks that are too difficult or unsafe for humans.
- Decentralized decision-making — the ability of cyber-physical systems to make simple decisions on their own and become as autonomous as possible.

Germany has gone to far as to make the transition to Industry 4.0 a government industrial goal, reasoning that the more fully automated factory is essential to enable manufacturing to compete with countries that have lower labor costs.

The 5G home

We are all familiar with the range of connected products being sold for use in the home. The promise has not exactly lived up to the hype. But most analysts believe 5G/WiFi6 will allow many of those products to exceed expectations.

With the security and interoperability provided by the WiFi6 technologies in the home, the smart TV and smart phone devices will be able to serve as controllers tying together temperature and security sensors and accessing the various “voice assistant” products already in the market to allow a homeowner to have total control of the home environment, even while at a remote location.

5G healthcare

The growing number of medical monitoring devices, both wearable and implantable, have provided tantalizing glimpses of a future where medical services can monitor people and detect health problems before they reach a critical stage. Already being used on a limited basis for the most at-risk individuals, 5G systems provide the capability to handle the tremendous volume of data these IoMT (Internet of Medical Things) devices generate and to transmit that data in a secure and reliable manner.

A report by Allied Market Research predicts the IoMT market will generate $137 billion world-wide by 2021. As the devices get more sophisticated, they will not only send information to healthcare provides who can sound the alarm when a medical emergency is detected, they will also be able to trigger intervention devices which can administer medications or trigger other treatments automatically. The data they provide will also provide input for regular doctor-patient consultation, with a goal toward designing patient specific plans to deter medical problems in advance.

The unknown

The most dramatic advances to result from the 5G/WiFi6 revolution are probably ideas which haven’t been hatched yet. I noted above the ability of the new network technologies to handle the massive amount of data generated by IoT devices. But it also significant that this is a two-way street. The new technologies put the resources of the cloud at the beck and call of every small IoT device, enabling it to function with an intelligence far beyond its own limited range.

That cloud intelligence is clearly invaluable for the medical devices intervening to save a life when seconds count. It is also necessary in the transportation domain, giving the smallest of devices a situational awareness of a much larger environment. But what else will this next generation of communication technology bring? We shall see.