5

Adding a New Dimension to Customer Experience, the Reality of 6th Senses – 5G and Beyond

Jeevarathinam Ravikumar[1] and Ramjee Prasad[2]

[1]Stanley Advanced Technology Solutions (SATS), UK
[2]Center for TeleInfrastruktur (CTIF), Aalborg University, Denmark

5.1 Introduction

The evolution of 2G to 3G and now the current 4G technologies have changed the user's expectations. The demand for providing the best user experience is ever increasing. The following terms; Customer Experience (CX) and User Experience (UX) are used interchangeably throughout this chapter.

5G and beyond are at an increased pressure of enriching the customer experience beyond what the current generation of technologies can offer. CX will continue to remain an important focus in defining and ultimately deploying 5G and beyond networks and associated solutions.

Consumer devices of today can offer the best in class voice, data and video communications connecting anyone from anywhere at any time. However, the devices of tomorrow will offer virtually all the features as much as a wireless network can offer that means users will have more autonomy in defining what they want and how they want it.

Looking into the evolution of UX amongst various technologies, it is clearly evident that the focus of wireless networking has been concentrated on the end user experience.

The UX evolution can be represented in a very simplified fashion,

$$\sum_{QoS}^{CX} \int f(Network)$$

The function of the wireless network will be fully focused on providing the best user experience. Hence, any evolution in the wireless network era should be built based on the way customer experience requirements will evolve from current to future needs. Evolution is not about quality of service rather it is all about customer experience.

Figure 5.1 shows how the experience has been changing along the wireless network evolution. It has been a paradigm shift moving from 1G to 5G wireless network evolution.

First generation mobile networks (1G), were a real revolution in providing wireless voice from anywhere but with a limited mobility. 2G with GPRS, and i-mode initiated another revolution in mobile communication providing data over wireless with a true mobility. SMS and roaming are also the major user experience revolution in 2G. Subsequently smartphones, especially iOS made a major revolution in user experience by not only introducing a gesture based UI but also introduced the App Store which vastly expanding the functionality of the device. Android and the Google Play Store have helped to penetrate mass markets and phones with larger screens have enriched multimedia applications. Users can enjoy a HD quality entertainment seamlessly while being mobile with LTE-A offering 300 Mbps speed [3].

As the device screen improves not only in size but also in terms of resolution, such as 4K video quality, creating a compelling need for high resolution projection from the customer device.

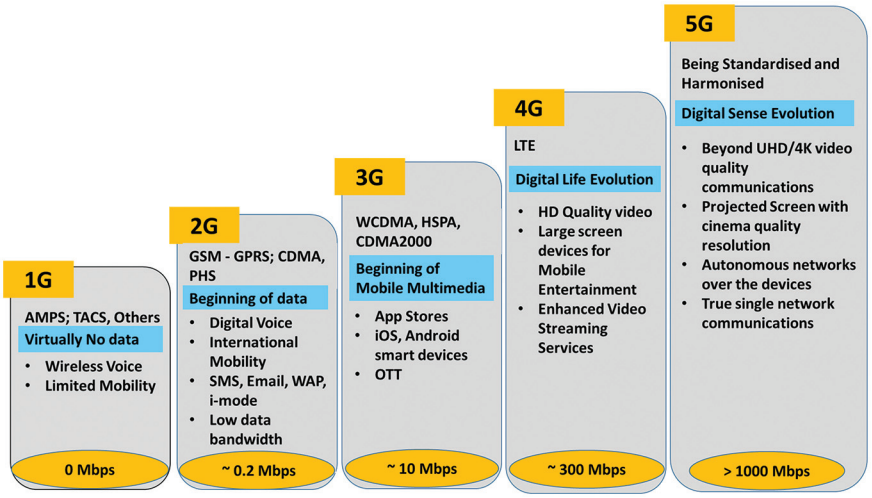

Figure 5.1 UX evolution along the wireless technology evolution.

5G and beyond will offer enormous bandwidth beyond 1 Gbps which can potentially create a demand for devices featuring high resolution video projection equivalent to a 100" virtual screen experience to become a commercial reality. Figure 5.1 shows how users had different experiences during development steps of the mobile communication systems.

5.2 Does the Bandwidth Matter?

Advances in processing power, computing engines, machine learning, nanotechnologies and beyond, and increasing variety of applications in diverse fields will contribute to a demand for increased bandwidth. Eventually, bandwidth evolution in mobile communications will progress towards terabit mobile communications. Today's 4G – LTE user devices offer 300 Mbps speed on a LTE-A compliance handsets.

However, for seamless continuity of HD/UHD video streaming over the air, the network needs to adapt to provide a cinematic standard of streaming that can be beamed over a larger screen or wall or to provide a virtual reality experience. Video bandwidth requirements will be ever increasing as the number of associated devices for each individual increases and as everyone and everything becomes more closely connected. Cinematic quality of video will have a major application in medicine [6].

Referring to Figure 5.2, associated things will demand more bandwidth as most of the associated devices will evolve from low bit rate sensors of today to high bit rate sensors of tomorrow. For example, if the contents of a home fridge are to be seen in real-time for the purpose of updating food stocks, a high resolution video content needs to be transmitted. Increasingly associated things will bring about a major change in human life and way of living, way of working and will also make a major impact on the way business is conducted.

It is now becoming a necessity to be able to deploy a single but fully converged network pipe to match the bandwidth demands and provide seamless wide area coverage. This will eliminate the need for multiple telecom networks and will evolve into a single 5G and beyond network that will ultimately connect everything together from end to end. This will ultimately open up the single wireless conduit from the end users or end nodes and it will eliminate the need for any disparate last mile wired/wireless networks. For example, the video content of the fridge can be directly transmitted over the wide area network of 5G and beyond rather going through a WiFi home network or through a wired Ethernet.

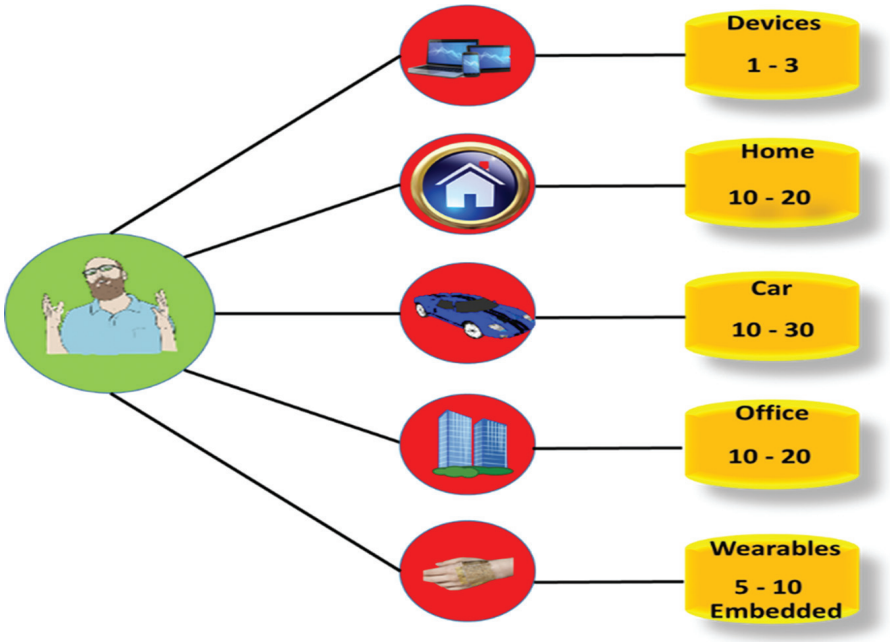

Figure 5.2 Associated things.

- Person with chain of association
- Associated things will be touching close to a trillion in the next decade

5.3 CX of Today

CX of today is still predominantly focused on the network behavior experience rather than the experience at the end user device or the node. Obviously smartphones have more powerful processing capabilities and features that enhance the customer experience of today. Social networking has changed the traditions of human networking to a great extent.

Referring Figure 5.3, the devices of today still do not have much autonomy in offering network functions as a standalone device.

CX of today is focused more on:

- Quality of Experience
- Quality of Service
- Bandwidth

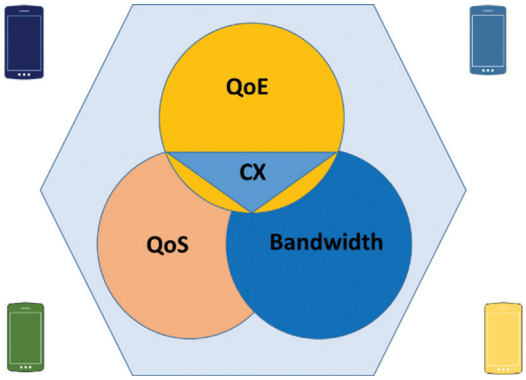

Figure 5.3 CX of today.

5.4 CX of Tomorrow

CX of today has been aimed at delivering experiences limited to a human's five senses, but CX of tomorrow shall go beyond the five senses.

What can be expected beyond the five senses?

A digital sense termed the sixth sense (6th Sense) that will not only predict and prescribe but also provide

- On-demand wisdom provisioning
- Rapid analysis of a situation
- Privacy and Personalization

6th sense and Digital sense will be used interchangeably throughout this chapter.

Referring to Figure 5.4, the network of tomorrow will pass on some network functionality to the device. Devices will have network functions in a way that a smart device can form an autonomous network around the associated things and multiple devices. Hence a complete chain of networks can be formed to provide seamless communication even during an outage due to natural disasters or similar emergency conditions. Essentially, it will be a type of UserCell which provides most of the base station functionality.

CX of tomorrow shall be focused on

- Distributed network capability
- Autonomous CX
- Advanced features with augmented reality (AR) and more

There is going to be an enormous potential for CX and it will grow beyond imagination as the CX will be the only continuing killer application over the

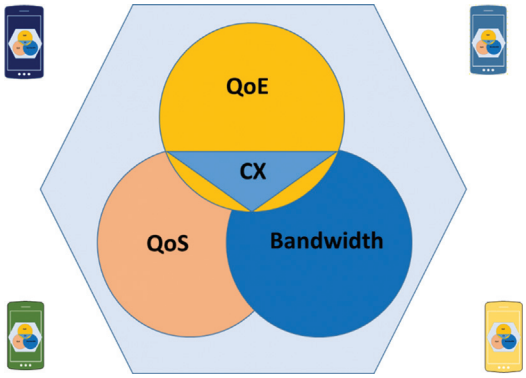

Figure 5.4 CX for tomorrow.

communication networks. Reliable Gigabits bandwidth will be required for a real time high resolution AR platform.

5.5 CX Applications

This section discusses a few of the CX applications that will open up a new era in customer experience. Availability of larger bandwidth on demand, speed, display, and multimedia technologies shall make the user devices much more powerful on top of the autonomous network capabilities built in.

Devices of today offer seamless communication over voice, video and data with the mushrooming of many messaging applications such as iMessage, Whatsapp, Viber, Skype etc. Unfortunately, the quality of the video and the experience of being together still feels incomplete over the channels of today.

Networking needs to go beyond the simpler social networking of today to a greater extent of being "Globally together", regardless of whether it is networking between friends, family or corporations. Hence there is a need for a seamless, simple and instantaneous Globally together ENhanced with Digital Sense (GlobENDS). GlobENDS will virtually end the borders of this world and shall be a lution in human communication.

5.5.1 Virtual World – Home without a Border

Imagine a cooking lecture conducted at America with virtual class rooms in Africa and India. Figure 5.5 depicts the scenario of HD quality live networking

directly from a user device. A person sitting in Australia projecting all the video feeds directly from his phone to the three sides of the wall in his room. This is live networking using a 5G and beyond smart device with optical beam projection features. This requires very high resolution video as well as seamless cross-switching.

The same concept can be applied to family networking. Now imagine a scenario involving an extended family with parents, sisters, brothers and families living far apart.

With the advancement in the digital eye wear, a virtual screen of over 100" will make the projection better suited for personal communications.

With GlobENDS, users should be able to have their breakfast together and discuss family matters over the dinner table whilst being in their own place across continents.

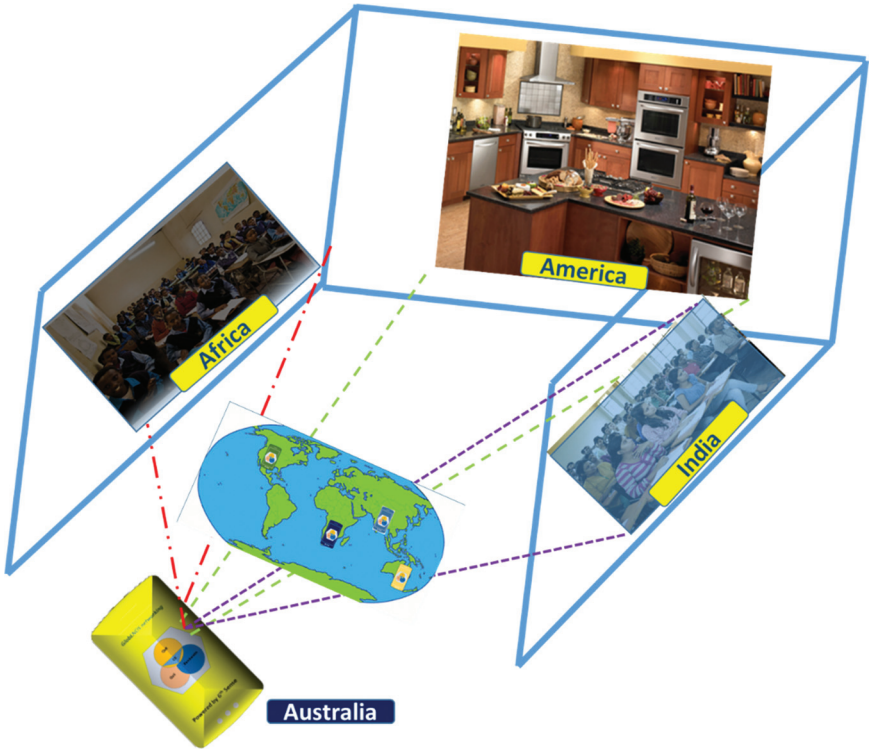

Figure 5.5 GlobENDS, Live HD networking across the continents with a Smart device projecting over three sides of the walls.

5.5.2 On-demand Digital Sense Provisioning

A Major dream for any human being is to obtain wisdom provisioned over the air. Wisdom provisioning shall be a major breakthrough in human evolution.

Wearable and implantable devices are becoming increasingly commercialized with the advent of Nano technologies, biomedical technologies and advanced medical research. With the evolution of advanced implantable devices and neurological research, it shall be feasible for wireless provisioning of wisdom in the near future.

6th sense of wireless provisioning shall open up all the possibilities of innovations in this century. By nature, humans are 'analog', with eyes, ears and mouths that are all processing analog signals which are digitally processed in the human brain.

Research over the possibility of reading the human brain is approaching reality with advancement in neuro science [4].

Figure 5.6 depicts the future possibility for the evolution of the Analog human to a Digital human. WiSense that shall basically enable wireless wisdom provisioning (WWP) through an on demand basis over wireless to the implanted device of the human. This will open up the convergence of Ear & Mouth with digital Senses & Reflections enabled by 6th sense, the digital sense [1, 5].

Application of WiSense shall open up a major revolution in treating intellectually disabled and other brain related conditions such as Alzheimer, Parkinson's etc.

5.5.3 Evolution of How things shall Communicate in the Future

Machine to Machine is not a new concept or technology but it has been around for decades. What makes communication amongst things different with the advancement in digital technologies? The following sections discuss and analyze the past and present.

5.5.3.1 Descriptive

When Alexander Graham Bell invented telephony, it was the first revolution in connecting people through machines but was over the wire – Interconnected over Wires (IoW).

When Marconi invented wireless communications, it was again the first revolution in connecting people through the machines but over wireless – Interconnected over Wireless (IoW).

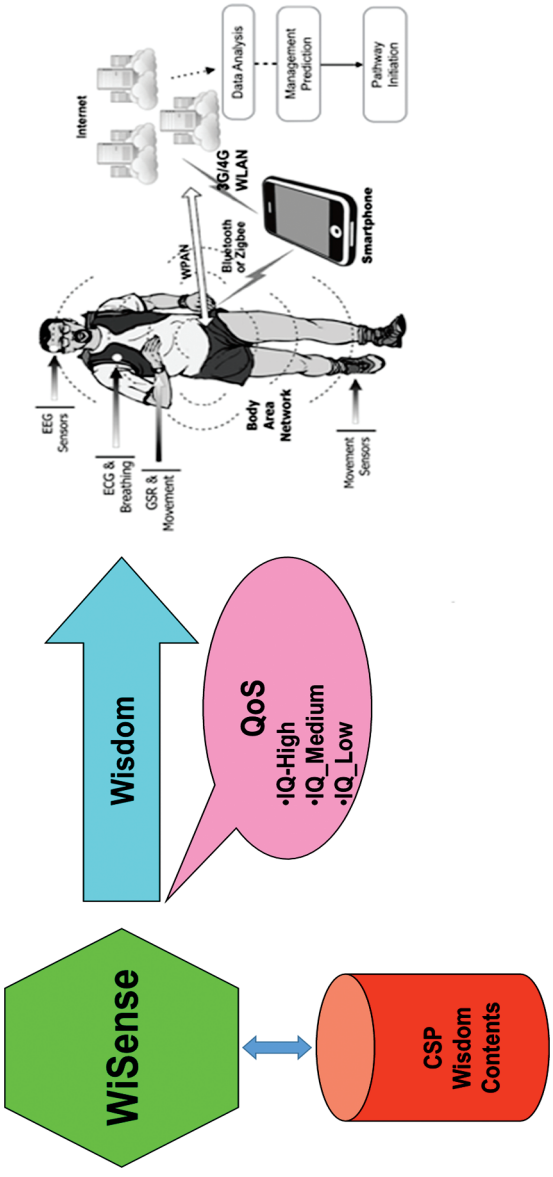

Figure 5.6 Wireless Wisdom Provisioning (WWP).

When NASA launched the first communications satellite, it was again the first revolution in making the possibility of connecting people globally – Interconnected over Satellite (IoS).

When ARPANET was created and subsequently adopted TCP/IP, it was again the first revolution in connecting networks – Internet of Networks (IoN).

When Mobile telephony was made and subsequently Cellular communications became popular, it was again a first revolution of communication from anywhere and anytime – Interconnected over Cellular (IoC).

Then came 1G, 2G and beyond, all predominantly voice communications transmitted through packet data communications which existed not for connected people but for connected machines. SMS and Global roaming are the highlights of GSM/CDMA networks. 2.5G paved the way for data communications over the cellular networks and Blackberry email became the first real killer application.

But Apple's iOS and App store created the major revolution in connecting people, the easiest way of using data over the cellular. This is a real IoS – Internet of Smartphones. Then came Android that made it possible to smartly connect most of the population of the world in a cost effective way. The App store and the Play store have become the killer applications, those who did not make it to the stores went out of business (of phones). Evidently Over The Top (OTT) services have started to dominate as connections are saturated but their attributes such as Speed and Services are continuing to evolve.

Today we have over 6 billion connected phones. Human communication is evolving towards high bandwidth, advancement and enrichment of customer experience. Connecting things and enabling the communication of things with humans shall open up enormous applications in the ever evolving digital space.

5.5.3.2 Predictive

The global population is not going to double anytime soon which means that there is a finite number of possible connections. Hence connections need to go beyond the people. IoT is connecting anything whether living or nonliving. If we associate 100 things to every individual per day and organize them into subsets of things, the potential connections are going to be beyond 600 Billion and possibly past trillions. Ultimately it will hit the Smart Dust dream. This opens up almost infinite possibility of connections. OTIoT – Applications and Services On Top of Internet of Things (OTIoT) shall play a major role and will change business models and the way business is conducted. This is nothing but the OTT of today but in a more powerful and multi-fold method.

5.5.3.3 Further enhancing CX with cross communication with things

Internet of human and things (IoHT) shall open up many applications. Figure 5.7 shows an application in which connected shoes can remind a person, "Don't wear me today since you need shoes with spikes as it is going to snow after two hours", or it might even become smart enough to be provisioned to be a spiky shoe for that period of the day!

Referring Figure 5.7, a dog can be digitally enabled to pre alert that there is a jam at exit A and so it may be better to take exit B as they will be communicating live! Practically anything and everything will start communicating and the level of smartness shall be provisioned by the OTIoT services.

Figure 5.7 Applications – Internet of Human and Things (IoHT).

Aakash Vaani, announcement from the heaven in ancient Indian mythology can be made a reality. A prediction can be made to such an extent that a person can be alerted so precisely, that if he or she takes a particular route at a particular time, he or she shall meet with an accident. This is because of all the things that are communicating and time synchronized with the traffic pattern & behaviour, making a scientific prediction of astrology a reality!

5.5.3.4 Prescriptive

GOD (Generator; Operator; Destroyer) made the living things. Man made the non-living thing, the machines such as aeroplanes etc.

Getting on to making the non-living things communicating among themselves and also with the living things, Man is becoming GOD of devices.

Hypothetically, man can make the corpses, the non-living things communicable and also can preserve the bodies with the wearable suit. With the historical data that have been collected over the living period can be made available to the wearable suit and can make the non-living body completely emulating the living body. It shall be nothing but a Human Disaster Recovery (HDR).

Additionally, extra knowledge can be provisioned to make it smarter than it was. In conclusions, a new sense is being created which is the Digital Sense that will eventually become the 6th sense of the human being. Although the 6th sense will be manmade, let us try to put this to good use to help make this world a happy connected, safe and more enjoyable place for all to enjoy. Digital innovation through connecting things should be embraced by everyone so as to stay connected with the growth of business in the new economy.

5.6 Conclusions

Digital Sense, the 6th Sense shall be the future of the digital evolution. 5G and beyond shall make the 6th sense a reality, eventually leading to major advancements in the human experience and create major applications in healthcare to home automation.

References

[1] N. Ravikumar, N. H. Metcalfe, J. Ravikumar, R. Prasad, "Smartphone Applications for Providing Ubiquitous Healthcare Over Cloud with the Advent of Embeddable Implants", Wireless Personal Communications, Volume 86 Issue 3, February 2016.

[2] R. Prasad, "Human Bond Communications (HBC)". Wireless Personal Communications, 87(3), 619–627, 2016.

[3] J. Ravikumar, R. Prasad, "Challenges in guaranteeing Lifestyle Enrichment while evolving towards 5G", 18th GISFI standardisation series meeting, New Delhi, 2014.

[4] Vikash Gilja, Paul Nuyujukian, Cindy A. Chestek, John P. Cunningham, Byron M. Yu, Joline M. Fan, Mark M. Churchland, Matthew T. Kaufman, Jonathan C. Kao, Stephen I. Ryu, Krishna V. Shenoy, "A high-performance neural prosthesis enabled by control algorithm design", nature neuroscience 15, 1752–1757 (2012).

[5] J. Ravikumar, R. Prasad, "Wireless 2020", CTIF, Aalborg University, 2006.

[6] E. C. Prakash, L. Qiang, A. Anwar, W. K. Chia, N. Ravikumar, and T. K. Chiong, "A Practical Surgery Simulator", Proceedings of the International Conference on Information and Automation, December 15–18, 2005, Colombo, Sri Lanka.

About the Author

Jeevarathinam Ravikumar is Technology Director (Europe) – Stanley Advanced Technology Solutions (SATS) with Stanley Security Europe of Stanley Black & Decker group.

He designed India's first wireless telephony for rural India and was involved in designing Digital Radio/Switches working for Centre for Development of Telematics, Government of India. He was one of the pioneers in starting WCDMA research in Singapore way back in 1998 while working for ASTAR, Singapore. He has been advising wireless telecom operators on 3G/4G deployment and mentoring technology startups. He has over 25 years of experience in wireless communications with the blend of technology and business expertise and worked for many multinational technology companies and also founded his own startups.

He has Masters in Communications and Computer networking from Nanyang Technological University, Singapore and Bachelors of Engineering from Annamalai University, India. He is a senior member of IEEE. He holds international patents in wireless coverage solution and published papers in Beyond 3G & 4G networks/services.