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Unshackle the Dynamism of 5th Generation Technology (5G) in Smart Homes

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Abstract - Every generation of cell technology pledges to bring in advanced consumer experience and greater carrier innovation and 5g is no exception. Extra bandwidth, many connected gadgets, low latency and an array of cool new home equipments. Along with cell phone networks, 5G promises to reinforce millions of IoT applications and devices. To realize this goal, 5g depends on the network slicing concept along with some elemental 5G technologies like 5G spectrum, uRLLC, mMTC, eMBB which are not precisely inferred yet. This paper intents to show how 5g gratifies and favors smart home applications, the most trendy and prominent IoT application when compared to the preceding technologies like 4g and wifi. It also aims to understand and explore the technologies and concepts which 5G encompasses to help in bringing the smart home to their full potential.

Key Words: Smart Home, Network slicing, Enhanced Mobile Broadband, latency rates, Massive Machine-type Communication, Reliable network, Technology, 5g

1. NTRODUCTION

In the contemporary fast-moving and ultra-busy world, who wouldn't like a smooth life where prosaic tasks such as setting the room temperature or changing music stations can take away time from imperative chores during the day. Smart home technology which is also called 'home automation' brings into play the devices/gadgets in a house that can be linked by a network, most frequently it uses the internet, Bluetooth, Zigbee, and Z-wave. Smart home technology provides its users with the exquisite facility of monitoring and controlling their connected home equipments, handily from their smartphones. What's even more astonishing is the fact that users can control the connected devices even when they are far away from home. Despite all these advancements made in the field of Smart Homes, a recent study showed end-user frustration with the automation technology. End Users mentioning that they can't get their Smart home technology to connect to each device and talk to one another, that has been the biggest hindrance with the use of previous technologies, because of which a smart home is not truly a unified system. With 5g stepping into the world of breakthrough technologies, these shortcomings can be fixed along with the many others and can result in a consolidated system.

1.1 5G Smart Homes

Before we talk about 5G smart homes, it's probably a good idea to explain what 5G is. I think its safe to say that we've already come halfway through in our journey to better understand 5G since we already discussed a tiny bit about smart homes. In simple words, 5G can be considered as a boon to the wireless technologies of all time. Getting deeper to prove my point, I would like to mention that the next-generation mobile network is eventually going to demystify and consolidate the multiple confounding wireless standards, Making the devices to talk to one another and drastically decrease human interaction.5G is the 5th generation mobile network.

Qualcomm says: It's a new global wireless standard after 1G, 2G, 3G, and 4G networks. 5G enables a new kind of network that is designed to connect virtually everything and everyone together including machines and objects. 5G wireless technology is determined to deliver higher multi Gbps peak data speeds, ultra-low latency, more reliability, massive network capacity, increased availability, and a more uniform user experience to more users. Higher performance and improved efficiency empower new user experiences and connect new industries.

So, Here is where the 5G Smart Home justifies being distinctive from what we have experienced earlier.

Fig-1: 5G Smart Home [courtesy: EdgeProp.my]

Now let's answer the monotonous questions which arise with every new technology coming into the picture - How is 5G going to be any different from the previous technologies for home automation? Do wifi and 4G hold no future in the field of Smart Homes after the adoption of 5G? If it's genuinely going to make a big difference, What are the

extraordinary features with which 5G is endowed with? and many more.

1.2 Comparing 5G and 4G for Smart Homes

5G is a colossal system that incorporates software, hardware, and firmware. The elementary mission of preceding generations of mobile networks has been to simply offer reliable, speedy mobile data services to network users. 5G has widened this outlook to offer an extensive spectrum of wireless services dispatched to the end-user across multiple access platforms and multi-layer networks.

There are numerous reasons to say that 5G will be more preferable than 4G and wifi:

- 5G will be undoubtedly faster than 4G. It will be a little faster than our current wifi as data rates can reach practically up to 100mbps with 5G if not 20 Gbps as promised, this is because of the limitation on the penetration rates of higher frequencies of 5G.
- 5G has lower latency rates of less than 1ms when compared to 4G which has 10ms and with wifi, it depends on the equipment in use and the load on that equipment, which can be practically up to 4-6 ms.
- 5G will provide a unified platform that is more capable of having many devices connected to it at once.
- 5G utilizes spectrum better than 4G and wifi which is discussed in the latter part of this paper.

Fig - 2: Comparing 5G and 4G for Smart Homes

It's also true that the full potential of 5G can be utilized only if it's fully standalone which will require certain architectural changes. It's important to know that 5G just isn't about speeds. It's vastly more efficient in how it approaches things. Present-day networks bank on 250 feet tall towers to cover vast areas with signals, there are approximately about 25 thousand such towers in the US. When compared to this there will be far more cell sites, each covering smaller areas when it comes to 5G.

2. Fundamental Core components of 5G and how they benefit the Smart Home applications.

After knowing about the magical Homes 5G can evolve, let us get to know about the core components basically needed for this prophecy to come true.

2.1 The 5G spectrum

Now we'll briefly see how Smart Home applications make use of the 5G spectrum. 5G, unlike LTE, operates on 3 different spectrum broadbands: which are.; the low-band spectrum, the mid-band spectrum, and the high band spectrum. Each band of the spectrum comes with its own advantage, which implies that it can be as fast as it needs to be depending on the device that is connected to it. This assists in freeing up capacity for the users in busy areas and reduces slow down at peak times.

Fig - 3: The 5G spectrum [source: Qualcomm]

➤ Low-frequency Spectrum, particularly below 1 GHz, enables 5G coverage to wide areas;

➤ High-frequency Spectrum with comparatively larger bandwidths but below 6 GHz, provide the much-needed capacity to support a high number of connected devices and enables higher speeds to synchronously connected devices; this range helps in connecting a large number of smart home devices.

➤ Very high-frequency Spectrum above 24 GHz (e.g. millimeter wave) with very large bandwidths, providing very low latency and ultra-high capacity. The Cells at these frequencies will have smaller coverage (between 50-200 m) and it is likely that 5G networks in millimeter-wave bands will initially be focused on areas with high traffic demand or to specific premises or locations requiring services with high capacity and peak data rates (Gbps). The Smart Home stands in need of higher security requirements. For example, the security camera system needs to keep updating their status as quickly as possible.

2.2 The 5G towers and Small cells

It's all a matter of convenience when we talk about 5G and the things related to it. While most of them will be thinking that 5G might need huge base stations and monstrous towers, let me prove you all wrong. The 5G cells are actually our street lamps, our utility poles and to keep it simpler it can be any slim poll and mind you, they need not be 200 feet tall towers which our 4G requires and yet with 4G there comes network connectivity issues. Compared to conventional base stations, a large number of small cell units are required to cover a larger area. Nonetheless, it can provide low latency network coverage and higher data rates for the Smart Home users under each unit.

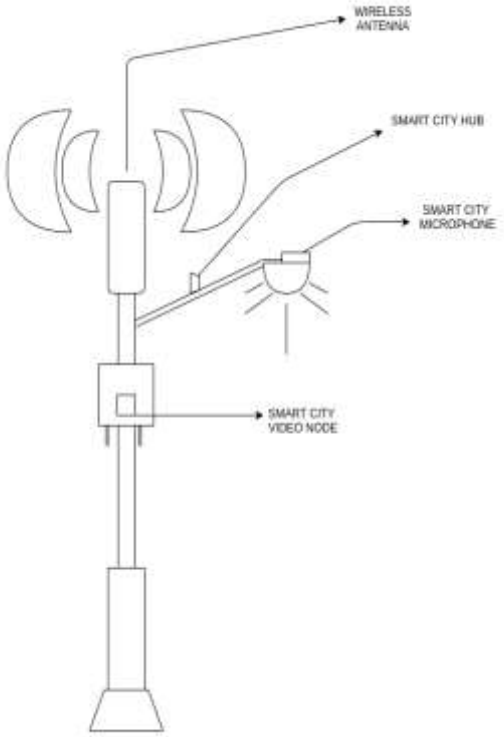
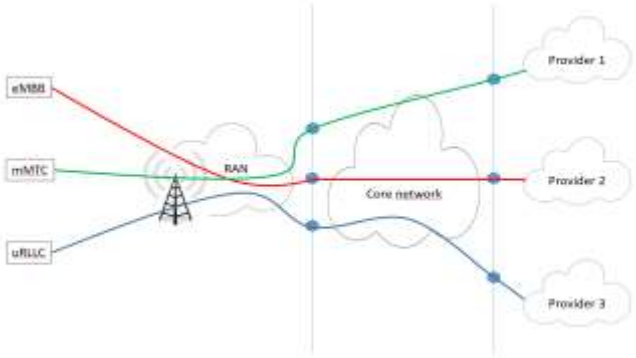


Fig - 4: Streetlamp (well actually a 5G cell tower)

3. 5G Network Slicing for Smart Homes

Talking about the extraordinary features with which 5g is blessed with, I would like the mention the network slicing concept which basically suggests that 5G has different slices with different functionalities for different operations. Keeping the discussion strictly about home automation applications. Let's see the main slices which hold importance to smart homes.



3.1 Massive Machine Type Communications (mMTC)

MTC is a communication paradigm in which connected machines and devices communicate with each other with little to no human interaction. It is a machine to machine communication. Well, isn't it something we all were waiting for! For our smart home devices to understand and communicate with each other we certainly need 5G at the earliest.

Automating building management is one of the crucial Machine to Machine applications aiming to implement more comfortable, user-friendly, and secure environments. By obliging proper sensors and actuators, various objects inside the building could be controlled to handle time-consuming operations or to manage energy efficiency. For example, inside fires can be detected by counseling the smoke sensors. Fire from the adjoining buildings can be detected by applying advanced video recognition patterns to the outside video cameras. Motion sensors can sense earthquake detection. All the data could be aggregated by an M2M gateway that can trigger corresponding actions such as:

- sending a dedicated audio alarm to alert the inhabitants of the house
- sending a quick message to the emergency authorities about the disaster type and location,
- Doing the preset actions like turning off the gas and electric appliances and turning on electric lights with accumulators.

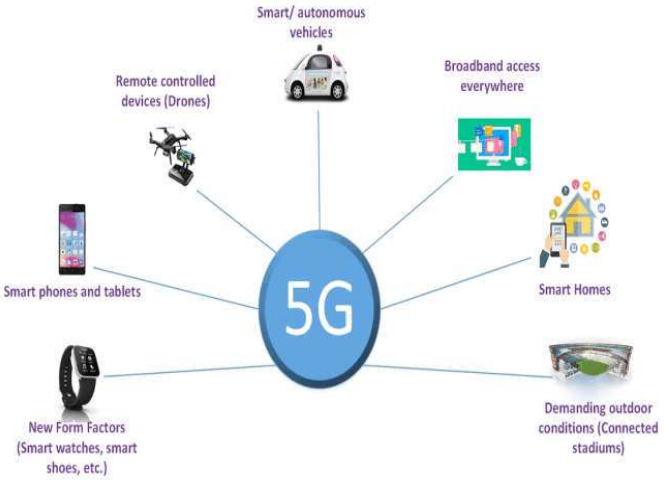


Fig - 5: Device to Device communication by 5G massive machine

3.2 Enhanced mobile broadband (eMBB)

The enhanced Mobile Broadband (eMBB) network slice will provide connectivity to devices with higher data rate demands like our mobile phones, laptops, tablets, cameras, etc. The access to this network slice can be incorporated into a total subscription for both home and mobile subscriptions for individual members or the whole household.

Within eMBB use cases there are three distinctive attributes 5G will be delivering and those are:

➤Higher user mobility: Moving vehicles, cars, buses and also planes can access mobile broadband services, which means we can stay connected to our homes and continue to keep getting notifications from our smart home.
➤Higher capacity: Broadband access even in densely populated areas such as stadiums, markets, and malls
➤Enhanced connectivity: broadband access should be available everywhere to provide a continuous user experience.

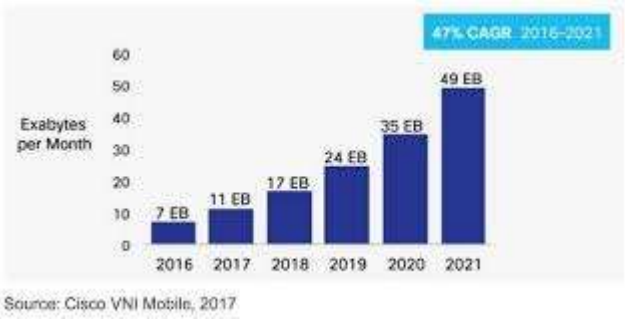


Fig - 6: Graph showing an increase in usage of wireless networks

3.2 Ultra Reliable Low Latency 5G (uRLL)

This network slice mainly concentrates on industrial automation where real-time data needs to be managed. This slice of 5G can be greatly beneficial to Smart Homes by transferring the real-time data from the sensors to the cloud. With the ultra-reliable network, there are no chances of failure whatsoever and the home automation will never shut down at the crucial times. Low latency will ensure the super-fast transmission of data from one endpoint to another.

4. Advantages of using 5G in Smart homes

5G has the ability to provide a more stable and consistent form of unified setup and guaranteeing that things are easier to get started. This makes a smart home far more accessible and intelligently designed persuading more users to enthusiastically take-up IoT.

1. truly unified system: our smart homes presently work in a fragmented fashion which includes wifi, Bluetooth, ZigBee, and other protocols.even though certain companies have tried to provide interfaces to bring devices together we haven't yet achieved true interoperability. But 5G will support more devices.
2. In contrast to 4G, 5G can work with low power devices leading to a much broader array of connected devices.
3. Any plugged-in device can directly connect to 5g because of a new wide area network.
4. 5G smart home devices can work automatically to manage power usage without any manual programming.
5. More reliable connections and lower latency will make our smart home devices to remain connected no matter how many people are using the internet at home at once.

All this results in much less burden on your house network and better stability with less downtime for IoT devices which were previously subjected to unpredictable performance of wifi and other networks.

5. CONCLUSION

This paper speaks about the concept of smart homes with revolutionary 5G technology. It showed how the features of 5G made smart homes a consolidated system. Much has been said about 5G being the future of mobile technology. All in all, it's the natural next step after 4G and assures to be substantially faster than anything we've seen before. Notably, in the case of the smart home, 5G technology has the potential to reform.

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