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## 5G- CONNECTING PEOPLE LIKE NEVER BEFORE

Everything is turning digital, from services to machines to cars and even cities. The digital economy is simply becoming **THE ECONOMY** and the future network infrastructure, 5G, will become **THE INFRASTRUCTURE**. Everybody and everything will use 5G, anywhere, at any time, that too always connected with almost zero latency and limitless capacity.

Each new generation of wireless technology has brought faster, more reliable cellular and internet connections. In the 1980's, first-generation technology made communication via cell phones. The next generation, 2G, allowed for more efficient and secure phone calls, and introduced text messaging. 3G ushered in the Smartphone era, and 4G gave us the high-speed connections that made it possible to stream high-definition videos on our phone. Now with introduction of 5G, the network as we know is going to get a major make over. At first, 5G will live beside and enhance your current 4G services, but soon enough 5G networks will be complete and stand-alone devices which will be available. With any type of 5G connection, you'll see faster network speeds, but the biggest changes will happen when carriers will deployed high-frequency millimetre band technology to tap radio wavelengths that have been unusable in the past.

Standalone 5G networks operating within very high frequencies (Around 30GHz) could easily achieve gigabit-plus browsing speeds as standard.

Significant features that fascinate people like online VR gaming, wider multimedia options, connectivity everywhere, zero latency and much more can be achieved with this technology. The advanced 5G infrastructure is expected to become the nervous system of the Digital Society, revolutionising and creating endless possibilities for the digital age we live in.

## COMING SOON !!!

### PULSE 2019
### "MECHATRONICS"

5G believes that one of the two key concepts of 5G consists in "Satisfaction of End to End(E2E) quality" required in all usage scenarios, making users feel satisfied with the quality, whatever applications are used anytime, anywhere. Achieving "Satisfaction of E2E quality" in 5G is an essential goal that differentiates 5G from preceding generations, which were designed based on "best-effort" scenario. Another key concept that 5G systems should have is the ultimate "Extreme Flexibility", in order to satisfy the E2E quality required in each use scene in a flexible manner, even if it is in the extreme.

In the previous generation systems, radio access networks were regarded as dominant bottleneck which determines the E2E quality of mobile applications and services, since the performance of radio access networks were limited by a number of constraints, such as radio propagation characteristics, available bandwidth, handset power, mobility, and so forth.

## MOST IMPORTANT PARAMETERS OF 5G

### 1. General:

5G is expected to satisfy E2E quality of services in wider range of use cases in flexible, secure and efficient manner. It is necessary that radio access and core networks should work jointly to realize the "Extreme Flexibility". The two key technologies identified are as follows in order to support the "Extreme Flexibility";
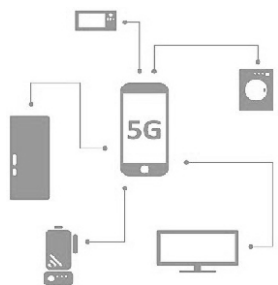
### a. Advanced heterogeneous network

The term 'Heterogeneous network' could have several interpretations or definitions depending on the context used. In some wireless communication networks, the term refers to network consisting of smaller cells laid over a larger cell in order to increase their system capacity by offloading traffic from a single large cell to these smaller cells.

In case of 5G, the idea of 'Heterogeneous network' should be enhanced to involve more than the idea described above and represents configuration of communication networks that organize all of its elemental network portions to serve variety of use cases.

### b. Network Softwarization and Slicing

Network Softwarization is an overall transformation trend for designing, implementing, deploying, managing and maintaining network equipment and/or network components by software programming, exploiting the natures of software such as flexibility and rapidness all along the lifecycle of network equipment/components. The basic concept of the Network Softwarization is "Slicing". Slicing allows Logically Isolated Network Partitions (LINP) with a slice being considered as a unit of programmable resources such as

network, computation and storage. Considering the wide variety of application domains to be supported by 5G network, it is necessary to extend the concept of slicing to cover a wider range of use cases than those targeted by the current SDN/NFV technologies, and the need to address a number of issues on how to utilize slices created on top of programmable software defined infrastructure.

### 2. Technology involved:
### a. New radio frequencies

The air interface defined by 3GPP for 5G is known as New Radio (NR), and the specification is subdivided into two frequency bands, Frequency range 1 FR1 (below 6 GHz) and Freguency range 2 FR2 (mm Wave), each with different capabilities.

### b. Frequency range 1 (< 6 Ghz)

The maximum channel bandwidth defined for FR1 is 100 MHz, due to the scarcity of continuous spectrum in this crowded frequency range. The band that is most likely to be universally used for 5G in this range is around 3.5 GHz.

### c. Frequency range 2 (> 24 Ghz)

The minimum channel bandwidth defined for FR2 is the 50 MHz and the maximum is 400 MHz, with two-channel aggregation supported in 3GPP. The maximum Physical layer (PHY) rate potentially supported by this configuration is approximately 40 Gbit/s. There is no particular band that is likely to be universally used for 5G in this range, though there are some regional proposals that do converge around certain bands.

### d. Massive MIMO

Massive MIMO (multiple input and multiple output) antennas increases sector throughput and capacity density using large numbers of antennae and Multi-user MIMO (MU-MIMO). Each antenna is individually-controlled. Nokia claimed a five-fold increase in the capacity for a 64-Tx/64-Rx antenna system. The term "massive MIMO" was coined by Nokia Bell Labs researcher Dr. Thomas L. Marzetta in 2010, and has been launched in 4G networks, such as Softbank in Japan.

### e. Edge computing

Edge computing is a method of optimizing cloud computing systems by taking the control of computing applications, data, and services away from some central nodes (the "core area"). In a 5G network, it would promote faster speeds and low-latency data transfer on edge devices.

Edited by-
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# APPLICATIONS OF 5G

## FASTER SPEED

Data transfer speeds are projected to be about 10 times higher with 5G than it is possible with 4G. Cell towers equipped with 5G technology would have greatly increased capacity over 4G/LTE. That means more people and more devices should be able to communicate at the same time.

## REMOTE SURGERY

Beyond speed, the biggest benefit of 5G is its low latency, or the short lag time between a device pinging the network and getting a response. While not necessarily noticeable, there is a lag with 4G LTE. A 5G network virtually eliminates it, meaning a surgeon may not need to be in the same room as a patient in the future.
Without the real-time 5G connection, the whole setup would be impossible.

## SELF-DRIVING CARS

While companies like Google and Uber are investing in self-driving cars now, many in the industry don't believe a fully autonomous vehicle is possible without a 5G network.
That instantly responsive network and ubiquitous coverage means the cars will be able to use 5G to talk to other cars and sensors built around the city, from street lamps to gas stations.

## INTERNET OF THINGS

Internet of Things (IoT) is another broad area for development using supercharged 5G wireless network. Internet of Things will connect every objects, appliances, sensors, devices and applications into Internet.
IoT applications will collects huge amount of data from millions of devices and sensors. It requires an efficient network for data collection, processing, transmission, control and real-time analytics.

## CONNECTED VEHICLE

Your alarm goes off in the morning, same as always. But that alarm was the trigger to turn on the water boiler and to set in motion your morning routine.
In leaving the house for your daily commute, you get into your car and it pulls out of the driveway…by itself. You will probably feel much safer with autonomous vehicles because with the power of 5G technologies.
Your car will be able to see around corners with new technology that allows for non-line-of-sight sensing. The car realizes that a couple miles ahead there is a blockage and automatically reroutes to avoid it.
V2V (Vehicle to Vehicle) communication allows vehicles to be aware of where they stand in relation to their fellows. This real-time communication will allow vehicles to essentially be able to see around corners because they will be able to view live footage from nearby vehicle cameras.
V2P (Vehicle to Person) will allow vehicles to know how we are moving, so that they could sense in advance if nearby pedestrians are about to step into the road. These



new technologies will improve the lives of everyone. Whether you live in the city or in rural areas, the beautiful thing about 5G is that it is incredibly diverse.
A farmer can monitor their crops using drones, and get real time data regarding the health of the crops.
A distribution company can monitor the trucks it has in the fleet to make sure that everything is going smoothly.
In order for everything to be quicker and more efficient, Qualcomm has been developing optimized OFDM-based wavelengths as part of 5G NR (New Radio) which will allow for specialized data connections based on the device. So, an IoT device will have a better optimized wavelength, different from the wavelength of a phone, which allows it to be more efficient. In addition, having devices spread out across diverse wavelengths will make everything faster.

# Mr. Shailesh Anthony

Excelling in his core-industry job, we are extremely pleased to interview Shailesh Anthony Sir who is a 1998 batch pass out student from VCET. He pursued Masters in Electrical Engineering. He has specialities in Analog Mixed signal flow Definition, Analog Mixed signals Design, PLL, DC-DC converters. He had worked as a Senior Design Engineer and then rose bar for himself by becoming Lead Application Engineer at Cadence Design Systems. He is currently designated as a Staff Application Engineer (Custom IC) - Cadence Design Systems.

**1. What made you chose the core –oriented job and how was your journey towards it?**

After my Bachelor's, I completed my Masters in Electrical Engineering. I took core courses in Custom IC VLSI design, semiconductor processing, RFIC's and Electromagnetics. I also had the opportunity to work in a Chip Fabrication Laboratory (0.6um, old technology in today's time). This core course work got me interested in semiconductor engineering and custom IC design. I did my share of research work and internships to support the same.

**2. Please enlighten us about your work and responsibilities as a Staff Application Engineer (Custom IC) - Cadence Design Systems.**

As I mentioned above my core job is in chip design to analyze and verify analog/mixed-signal circuits. I work with a wide array of Custom IC software. Cadence is an Electronic Design Automation (EDA) product company and Virtuoso (Registered) is the industry leader for analog IC design along with the Spectre (Registered) simulator. One of my responsibilities that I should highlight is that I create training material and teach other engineers.

**3. What was your share of work in Analog /Mixed Signal Design and Verification?**

Chips or I should say system on chips (SOC's) comprise of a vast array of different design blocks and requires engineers with specialization in different domains. Mine is design and analysis of analog/mixed-signal circuits such as PLL's, DAC's, RF Amplifiers, mixers, filters, and VCO's.

**4. What are various courses which the students can opt for after B.E?**

Depends on what you feel are your strengths and interests. VLSI design with a focus on analog/digital design, and/or verification methodologies are natural options. Also, Embedded design, PCB design, Sensor design (understanding of automotive, biomedical and aeronautical applications), RF design, networking applications, all of these are very good options. There are many standalone institutes; Online learning platforms can also offer you some Verilog/HDL courses with certification. Learning a HDL or modelling language is a very good asset to have.

**5. What is the scope of semiconductor and VLSI design in today's world?**

Again when we talk about a global business revenue of around $475 Billion USD in the last year, you can imagine the scope being quite significant in terms of not only monetary gains for companies but also how it has impacted us. Social media for instance, if you look at it from a broader perspective has taken off because of cell phone and network accessibility, which is directly proportionate to semiconductor and VLSI advancements.

**6. I am sure on this journey you must have had many obstacles, so how was your mind-set to cope with difficulties & stay motivated and move ahead?**

I feel that as an engineer you are socially, morally and technologically responsible for the future, as you build and impact tomorrow's world. Each set back offers an opportunity to introspect and learn. So, it's important to not look back, instead move ahead and build on what you learn. Also, each criticism when treated as feedback helps you to get better.

**7. Which new engineering-specialty skills have you developed during past years?**

It is very important in this field to be abreast of latest technological advancements. A BE degree in EXTC with all relevant course work will not always keep you afloat in the long run. I learnt RF design and analysis. I learnt to use EDA (Cadence Virtuoso, Spectre, etc.) tools to better assist me in my work. I learnt some circuit related design and modelling languages such as Verilog, and Verilog-AMS. Also, good communication skills are very important in today's global team framework.

**8. What is the most valuable lesson/skill you had learnt in your work experience?**

Nothing is constant in the world of technology, except change. You have to learn to adapt and learn constantly. I still read papers and relevant technology books to understand new advancements in design methodologies and chip integration.

**9. As it is said," Experience Makes a Man Perfect". Do describe an experience with a difficult working condition and how did you overcome it?**

Numerous to mention here, though one thing I should emphasize on. Try to ensure that you are surrounded by a good team and in turn be an active productive member of your team. Also, always be ready to listen to others. Treat all ideas as opportunities and look at them objectively because during crunch time help can come from the least expected places.

- As interviewed by Omkar Chaudhari and Nihal Kumar

- Designed by Avinash Gupta