5G Emerging Technology

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Bill Gate’s is famously quoted as having said that “640kb is more than enough memory for a computer.” Back in the early 1980s it may have seemed that was enough because the use cases for personal computing had not matured to point we routinely see in 2019. A parallel exists in networking as we transition into the 5th Generation of Wireless Technology.

The big picture of 5G Wireless is that bandwidth will increase to terabyte per second rates, which will enable immediate access to enormous amounts of data for billions of devices. This will enable many scenarios such as IoT sensor networks, smarter Device-to-Device communications, and rich interactive video content (Prasad, 2014).

# Provide Necessary Background on Topic

According to IEEE Spectrum the describes these innovations will be driven by advancements in: Millimeter Waves, Small Cell Architecture, Massive Multi-in Multi-out (MIMO), Beamforming, and Full Duplex channeling (IEEE Spectrum, 2017).

## Millimeter Waves

For an increase in magnitude of both the speed and number of connected devices to be possible they need network channels to communicate across. Efforts are being made to increase the frequency range as high as 300ghz (Prasad, 2014). The challenge with using these high frequencies come is that they are fragile over long distances. For instance, they can be absorbed by trees and cannot penetrate through walls or other structures (IEEE Spectrum, 2017).

## Small Cell Architecture

Previous generations of wireless technology scaled by using large base stations that would cover large distances (Gupta, Jha, & and Jain, 2017). Due to the challenges of reliably sending millimeter waves over long distances; lots of small base stations are used in a honeycomb configuration (Prasad, 2014). The overlap of multiple small stations enables the device to maintain high quality of service (QoS) as its physically moves around obstacles (IEEE Spectrum, 2017).

## Massive Multi-in/Multi-out (MIMO)

The number of connected devices is expected to increase by a factor of 1000 (Prasad, 2014). According to IEEE, “a modern 4G base station has 12 antennas ports versus 5G will use closer to 100 ports. This will increase the capacity of each base station by factor of 22 or more (IEEE Spectrum, 2017).” MIMO also represents an evolutionary model over Single-in/Single-out antennas which are typically used today (Inzillo, Quintana, De Rango, & Zampogna, 2018). As the technology processes the connection density per antenna is expected to increase.

## Beam Forming

A challenge with simply adding more ports is that the signals will fan-out in all directions and fill up the available radio frequencies and cause interference (IEEE Spectrum, 2017). To mitigate this issue, advancements are being made to send the signal in only the direction of the connected device (Gupta, Jha, & and Jain, 2017).

## Full Duplex

As the number of devices increases the necessity to optimize each of the frequencies increases. IEEE describes how modern wireless with either use different frequencies for the sender and receiver or requires they take turns. Instead 5G will leverage fast network switches to enable both parties to send on the same channel fully duplexed.

# Detail the Findings from the Reading

There were two assigned reading for the week; “5G: 2020 and beyond” and “Extended Task Queuing: Active Messages in Heterogenous Systems.”

## 5G: 2020 and Beyond

The text begins with describing the evolution from the first to the fifth generation of wireless communication. As each generation has been released new features and capabilities have become available. This has largely been driven by the increase in bandwidth required to enable these scenarios. For example; 2G was limited to 9.6kb/s which was fast enough for text messaging, but it was not until 3G and it’s 384kb/s speeds that video chat was realized (Prasad, 2014).

Next it goes on to describe the Wireless Innovative System for Dynamically Operating Mega Communications (WISDOM). WISDOM is the holistic architectural changes that are required for 5G and its burst speeds of 1TiB/s (Prasad, 2014).

This connects into the Global Information Multimedia Communication Village (GIMCV) which is a mesh of macro, micro and pico-communication cells that are interconnected together (Prasad, 2014). The tiering allows for wireless technologies to span connectivity from an American office building to a rural part of Africa – full global coverage.

## Extended Task Queuing: Active Messages in Heterogenous Systems

The article describes a general framework for using remote memory and accelerator cards such as GPU, APU, or GPGPU. What makes this implementation novel over vanilla MPI is that it does not rely on the remote CPU to dispatch the task. This improves the efficiency of the invocation by 10-15% (LeBeane, M; et al, 2016).

Remote Direct Memory Access (RDMA) technologies are typically found on wired systems, as the networking latency can significantly impact the performance. LeBeane, et al describe targeted invocation speeds of 7 to 30 microseconds. However, with the availability of 5G and its terabit/s speeds – the wired requirement could be removed.

That would enable thin clients to leverage cloud resources and have virtually unlimited capacity. For instance, a game console could economically and efficiently use dozens of remote GPUs to render ultra-photorealistic graphics (Prasad, 2014) (LeBeane, M; et al, 2016).

# Identify the Process used By Each Resource

# Predict the Future Work in this Area

# Do you agree with the works Primary Findings