ANALYSIS OF THE POSSIBILITIES OF IMPLEMENTING FREE WIRELESS ACCESS TECHNOLOGIES IN PROVIDING THE LINKAGE BETWEEN THE DIGITAL ECONOMY, INDUSTRIAL STRUCTURE AND THE GREEN ECONOMY

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5G Spectrum is matter. 5G NR operates in two main frequency ranges, known as FR1 and FR2. FR1 consists of sub-6 GHz frequencies, while FR2 comprises millimeter wave (mmWave) frequencies ranging from 24 GHz to 100 GHz.

FR2, mmwave plays key role for FWA deployments, here is the why:

1. High Bandwidth: Millimeter wave technology offers significantly higher bandwidth (24 GHz to 100 GHz) compared to other wireless technologies, allowing for faster internet speeds and better performance for fixed wireless access. Higher frequency corresponds to shorter wavelengths. Furthermore, higher frequencies translate to faster wireless data transmission. This is because signal-bearing electromagnetic waves move faster in higher frequencies and shorter wavelengths.
2. Low Latency and throughput: When compared with Sub-6 GHz 5G and other network technologies used in Long-Term Evolution or LTE, fourth-generation or 4G, and 3G networks, fifth-generation networks that use the millimeter-wave spectrum are considerably superior. The technology has a theoretical data transmission speed of between 200 Mbps to 1 Gbps. 5G that uses the Sub-6 GHz spectrum has a theoretical speed of between 50 Mbps to 200 Mbps while the real-world performance of LTE Advance averages around 50 Mbps. Latency in mmWave networks is fewer than 10 milliseconds while having a bandwidth of around 1 Gbps. Sub-6 GHz networks have somewhat closer but smaller values. The latency of LTE and LTE Advanced networks is around 20 to 30 milliseconds.
3. Interference and congestion: Millimeter wave technology operates in a relatively uncrowded frequency band, reducing the potential for interference and congestion compared to other wireless options.
4. Potential for 5G: Millimeter wave technology is a key component of 5G networks, providing the potential for future upgrades and compatibility with the latest wireless technology standards.

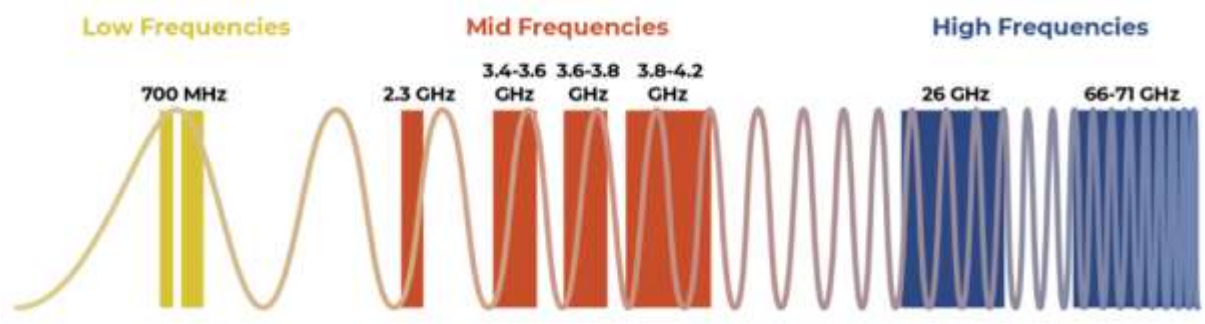

Figure 1 (5G Spectrum Mapping identifies the different frequencies used)

5G mmWave, or millimeter wave technology, comes with numerous advantages like high speed, increased capacity and reduced latency. However, there are also several disadvantages that are associated with this technology:

1. Limited Range: MmWave signals are unable to travel long distances. Buildings, trees, and even rain can weaken or block these signals.
2. Line of Sight: MmWave requires a direct line of sight between the device and the transmitter. If there's an obstacle between them, the signal will likely be interrupted.
3. Infrastructure Needs: To overcome the range limitations, a very dense network of base stations or antennas are needed, meaning a significant amount of infrastructure needs to be built.
4. Compatibility Issues: Not all devices are compatible with this new technology. This means that significant upgrades or replacements might be needed.
5. Health Concerns: Although still under investigation, some worry about the potential health risks of exposure to high-frequency mmWave radiation.
6. High Costs: The deployment of 5G mmWave technology is very expensive, including the costs of new infrastructure and maintenance. There is a high cost involved in designing and implementing millimeter-wave 5G networks. To address the network coverage and signal range limitations, network carriers must place smaller cells or base stations in strategic locations. Sub-6 GHz 5G networks are more practical to deploy because they do not require the same number of cells. In fact, these networks can be implemented using the existing infrastructure of LTE and 4G networks; albeit with some hardware upgrades and modifications.
7. Energy Consumption: 5G networks, due to their increased speed and capacity, are expected to result in significant energy consumption, which could have negative environmental impacts.

The difference between Sub-6 GHz and mmWave technologies also means that the former is more suitable in rural areas with dispersed structures and scattered populations, while the latter is more appropriate in high-density urban areas. But again it all depends on MNO (Mobile Network Operator) network design and strategy.

Coverage - throughput comparision between sub6 and mmwave. Both sub-6 GHz and mmWave bands are used in 5G technology, but each offers a different balance of speed and coverage distance. Sub-6 GHz, which encompasses frequencies below 6 GHz, has broad coverage and can penetrate walls and other common obstructions. In ideal conditions, the coverage radius of a sub-6 GHz 5G connection can reach up to 10 kilometers (or about 6.2 miles). However, the exact distance can vary based on a number of factors like antenna height, hardware used, and the geography of the area.

Millimeter wave (mmWave), on the other hand, operates at much higher frequencies (between 24 and 100 GHz). This delivers incredibly fast speeds and high capacity. However, the trade-off for these benefits is the significantly diminished coverage area and poor obstruction handling. In ideal conditions, a single mmWave base station might cover up to 1 kilometer (or about 0.62 miles) in radius. Just like with sub-6, the actual coverage can vary based on hardware, antenna placement, and the surrounding environment.

While sub-6 GHz provides wider coverage and better building penetration, mmWave offers significantly higher speed and capacity but has a much shorter range and requires line of sight operation.

Figure 2 (speed and coverage area comparision sub6 vs mmwave)

Extended range for FWA

10 November, 2022, UScellular, Qualcomm Technologies, Inc., Ericsson and Inseego announced the companies have successfully achieved a 5G extended-range milestone over millimeter Wave (mmWave) on a commercial network.

It was significant job done by Ericson team and this milestone was accomplished at a distance of 7 km, the farthest 5G mmWave Fixed Wireless Access (FWA) connection in the United States, with sustained average downlink speeds of ~1 Gbps, sustained average uplink speeds of ~55 Mbps and instantaneous peak downlink speeds recorded at greater than 2 Gbps. Additionally, at a distance of 1.75 km with no line of sight, the companies achieved sustained average downlink speeds of ~730 Mbps and sustained average uplink speeds of ~38 Mbps.

Two aspects must be addressed to operate an FWA network in mmWave spectrum over long distances: maximizing the received signal strength and accommodating long propagation delay.

Huawei:

Huawei's 5G Fixed Wireless Access (FWA) Solution aims to offer high-speed broadband connectivity using wireless 5G networks in lieu of traditional wired connections. It is particularly designed for areas where laying cables is challenging. Here's an overview:

1. High-Speed: Huawei's 5G FWA can provide ultra-fast download speeds owing to the use of 5G technology, providing an enhanced experience for customers in terms of browsing, streaming, and downloading.
2. Easy Deployment: As it operates wirelessly, Huawei's 5G FWA provides high-speed internet connectivity with easy installation and low-cost operations. This is particularly beneficial in rural or remote areas.
3. Optimal Coverage: Huawei's solution uses Massive MIMO and beamforming technology to optimize network coverage, vastly improving user experience even in densely populated urban areas.
4. Advanced CPEs: Huawei also offers Customer Premises Equipment (CPE) with their FWA solutions. The CPE Pro, for example, supports 5G and 4G networks and implements Wi-Fi 6 technology for improved connection and performance further cementing their edge in terms of wireless broadband solutions.
5. Future-Ready: With 5G technology fueling the solution, Huawei's FWA ensures consumers and businesses are ready for the widespread adoption of 5G, providing a pathway to seamless integration with new technology trends.

Huawei's 5G FWA solution is a compelling choice for reliable, high-speed internet particularly considering its ease of deployment and future-readiness in terms of 5G adoption

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