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Transformation

Next Gen Tech: Communication

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Key takeaways

- The world is experiencing an exponential jump in data creation, and when combined with rising complexity and more data-heavy applications, mounting pressure will be placed on existing communication technologies and require the adoption of new ones.
- Here, we discuss four such evolving technologies that have the potential to address the challenges ahead: miniaturized satellites, Wi-Fi 7, 5G Advanced and 6G.
- Bank of America Institute's 'Next Gen Tech' series explores 30 breakthrough technologies across artificial intelligence (AI), computing, robots, communication, healthcare, energy and mobility, that are about to alter our lives. Join us as we discuss what's next on the tech horizon.

This publication is part of Bank of America Institute's 'Next Gen Tech' series – focused on sharing 30 breakthrough technologies that could transform the world. The series will highlight seven categories (artificial intelligence, computing, robots, communication, healthcare, energy and transport), and share advancements within each, so stay tuned for more.

Communication: The scarcity of bandwidth

In our series introduction, Next Gen Tech: Breakthroughs that will transform the world, Bank of America Institute discussed how rapid shifts in innovation are transforming businesses and the world. In fact, we noted that the fastest transformation in human history is ahead of us. First, we discussed innovations in AI, followed by computing and robots, and here, we'll share the fourth of seven categories – communication technologies.

The digital universe has reached the level of the yottabyte (equal to 2^80 bytes, or approximately a million trillion megabytes), with 90% of the world's data having been created in the past two years.[1] As of the end of 2023, there were 8.6 billion mobile phone users worldwide, of which about half used smartphones.[2] And by 2027, we will create more than a sextillion (billion trillion) bytes of data every day.

This exponential jump in data creation, combined with rising complexity and more data-heavy applications, will put mounting pressure on existing communication technologies and require the adoption of new ones. Here, we discuss four such evolving technologies that have the potential to address the challenges ahead.

1) Miniaturized satellites

Satellite technology is a key pillar of communication. In fact, in recent years, more broadband services have been based on this technology and BofA Global Research believes it will ramp up dramatically in coming years, as smaller satellites provide more affordable access to space and universal satellite internet access.

Communication is the main need, and miniaturized satellites are the key solution

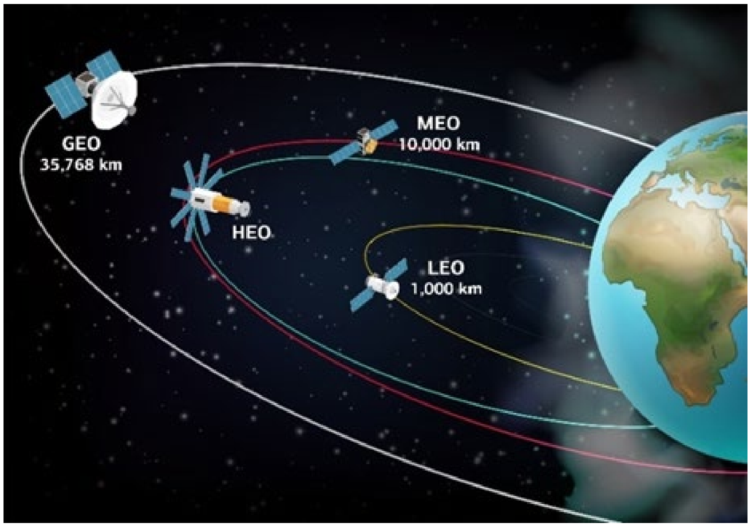
Miniaturized satellites mostly refer to those in low earth orbit (LEO), weighing up to 100kg (kilogram). The two main categories are microsatellites (10-100kg), also known as microsats, and nanosatellites, also known as nanosats, or sometimes CubeSats due to their conventional 10x10x10cm cube shape, weighing up to 10kg. The small size of both micro- and nanosatellites offers advantages in terms of economics, capacity and coverage, but they are not suited to every mission and usually have a shorter lifespan than larger satellites.

According to the Satellite Industry Association (SIA), the total satellite market generated $384 billion in revenue in 2022, with commercial satellites accounting for 73% of this ($281 billion) – and demand is only increasing with greater broadband

[1] IBM
[2] World Economic Forum (WEF)

communication and data needs. According to Orbiting Now, as of the beginning of 2024 some 9,368 satellites were orbiting our planet. The vast majority of these (89%) are LEO satellites, operating at an altitude of 160km-2,000km above Earth.

Exhibit 1: More than 70% of all satellites are surrounding our planet in the LEO
Breakdown of different satellites orbiting Earth including LEO (low Earth orbit), MEO (medium Earth orbit), HEO (high Earth orbit), and GEO (geostationary Earth orbit)



Source: NASA, BofA Global Research

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These small satellites have the potential to make space more accessible and affordable, thereby improving profitability for an industry that is characterized by high capex and frequent delays. They are used across a wide range of applications – from Earth observation and communications to scientific research, technology demonstrations and education, as well as defense. Their lower cost means that companies are now looking to create mega-constellations in LEO to provide universal internet access.

The economic advantage

The appeal of satellite communication is primarily their lower cost compared with other telecommunication solutions. First, there is no need to deploy complex communication technology (fixed-line, towers, fibre etc), especially in areas where affordability is low.

Secondly, the small size and weight of miniaturized satellites, especially nanosatellites, also bring an economy of scale advantage. Yes, we will need more of them, ground equipment is expensive, and their coverage is smaller compared to larger satellites, but with economy of scale, lower launch costs and cost reduction, they will gain more economic advantage in coming years. Because they are often deployed together in constellations, miniaturized satellites often allow for better coverage and effective service. Additionally, their scalability could make them more useful than having a few larger satellites for certain purposes, especially communication coverage. And scalability is key, especially in terms of lowering costs.

Communication is key for economic and social progress

Nano- and microsatellites have great potential to meet our communication needs thanks to their lower cost, smaller size, relatively simple design and ability to work in constellations, which when combined, offer affordable vast communication services. Constellations of nanosatellites could provide a broadband network anywhere on the planet. Until recently, satellite internet was used only in rural areas to connect those without access to terrestrial internet technologies (e.g., cell towers, cabling). New satellite constellations could provide competition in areas with lower population density and GDP generation.

Globally we are making huge progress on providing communication services, but as of 2023 still around a third of the planet (2.6 billion people) do not have access to any means of communication, whether voice or data[3] – a challenge as access to communication is key for economic and social progress.

2) Wi-Fi 7

The race to fight “bandwidth scarcity” will not bypass short-range communication. Wi-Fi-7 is the revolution in that space and will be a key pillar in the next generation of communication. Developed by the Wi-Fi Alliance and officially launched this year, Wi-Fi 7 (or its professional name: IEEE 802.1) is the next generation of Wi-Fi 6, offering five times more speed, leapfrog capacity and a 75% drop in latency compared to the previous Wi-Fi generation.

[3] International Telecommunication Union (ITU)

As we have witnessed in mobile communication technology, applications require ever-more speed and bandwidth, which previous Wi-Fi generations can no longer support, clogging up the network. The need for reliable networks with minimal latency for certain applications was also more challenging for the previous generation. Wi-Fi 7 protocol will provide the solution for applications like AI, the internet of things (IoT), the cloud, home entertainment and XR (extended reality). It will address the challenges of Wi-Fi 6, such as limited spectrum resources, high interference and complex network management. Wi-Fi 7 also supports new features like multi-link operations with up to 320MHz (megahertz) bandwidth, which is double that of Wi-Fi 6.

What is different this time?

- **Speed**: Wi-Fi 7 can offer almost 50Gbps (gigabits per second) speeds on max spatial (more than two dimensions) streams, which is five times the speed of Wi-Fi 6 (or almost seven times Wi-Fi 5, which is the technology used by most homes today).

- **Latency**: Wi-Fi 7 latency could be as low as 1ms (millisecond), which is 75% below Wi-Fi 6 (2-6ms) and 92% below Wi-Fi 5 (up to 10ms).[4] Like the higher speed, the lower latency could be achieved through a combination of technologies, allowing wider channels and multi-link operations (see below).

- **Wider channel size**: Wi-Fi 7 still uses the same three bands as Wi-Fi 6 (i.e., 2.4GHz, 5GHz and 6GHz), however, unlike Wi-Fi 6, it can double the channels' bandwidth. Wi-Fi 6 bandwidth can be as wide as 160 MHz and Wi-Fi 7 supports channels that double that size, up to 320 MHz wide. Why is this important? The wider the channel, the more data it can transmit, and the lower the latency.

- **Multi-Link Operation** (MLO): Every previous Wi-Fi standard has established a connection between two devices on a single band. MLO can combine several frequencies across bands into a single connection – meaning it supports more connections simultaneously, implying more efficient use of the bandwidth and parallel transmission.

- **In-building coverage:** 5G, 5G Advanced and even 6G often fail in in-building coverage because of the lower penetration, higher frequency spectrum. In that aspect, Wi-Fi 7 technology could be the ultimate complimentary tech to be used alongside 5/6G iterations.

3) 5G Advanced

Every industry is being transformed by AI, and the telecom industry is no different. Three aspects for telecommunications or communication service providers to consider include the sheer amount of data, the complexity of the data, and the need for "data-hungry" applications putting pressure on current mobile networks.

5G Advanced refers to the next phase of development and deployment of 5G wireless technology and networks. Usually, it refers to the 18th and 19th releases of the 5G architecture protocol, as defined by the 3GPP (3rd Generation Partnership Project organization). 5G Advanced is the first mobile network with embedded AI, dramatically increasing capabilities and decreasing costs. It builds on early 5G networks and aims to deliver faster speeds, lower latency, increased capacity, and more uniform coverage. Target performance goals include speeds of up to 10Gbps and latency under one millisecond.

5G Advanced is not a revolution but an evolution of the 5G technology and broadly based on common architecture. However, the improvement in the architecture and technology not only drives continued system enhancements but could also be the foundation technology to: 1) increase the number of use-cases, 2) support high-data, low-latency demanding applications like holograms, XR and autonomous vehicles, and 3) even lay the technical foundations for 6G.

What is different?

- **5G Advanced is the first native AI support communication technology.** It will integrate AI and machine-learning (ML) capabilities into the network, which will allow optimization of process and automation, including in areas like automated traffic routing, automated infrastructure management and maintenance, and personalized user experience. With AI-defined management, machine-learning algorithms could help to fully automate the network, offer constant analyzed feedback in real time, and set resource allocation or channel data traffic based on optimization analysis. AI can also assist in communications, such as beamforming (a signal processing technique), predictive resource allocation between network slices, automated cyberthreat response, intelligent traffic routing, and channel status predictions.

  Cyber is the top risk for mobile communication and AI-embedded capabilities can monitor data traffic and anomalies in real time. On-device and edge ML algorithms can also tailor 5G experiences to usage patterns, locations and applications,

[4] Institute of Electrical and Electronics Engineers (IEEE)

creating personalized experiences, for example tweaking virtual reality (VR) image rendering based on head movements or refining content recommendations.

- **It has ten times the speed, and one third of the latency**. 5G Advanced is designed to provide up to 10Gbps, compared to the 1-2Gbps traditional network speeds. At the same time, it aims to have lower latency. Where the current 5G offers an average latency of 15-30ms in ideal conditions, 5G Advanced aims to reduce this to as low as 10ms, with a future goal of as little as 5ms, and some researchers even calling for 1ms theoretical latency to be used in mission-critical applications.[5] This target will probably be achieved with 6G architectures.

- **5G Advanced aims to utilize a larger bandwidth for more capacity and speed.** It is designed to use high radio frequencies at the 100GHz range, compared to traditional 5G, which uses sub-6GHz frequencies. Higher-frequency bands offer much higher speeds, but with a shorter range and distance – hence the network should be more dense.

- **It offers new architecture to maximize capabilities**. In fact, 5G Advanced architecture should work much better than other technologies with high frequencies, with a strong signal indoors and greater reliability. How? The network architecture is based on technologies like precise beamforming, advance antenna solutions, and AI-based network redundancy analytics. These should help 5G Advanced to target 99.999% reliability (five minutes or below of network downtime).

- **5G Advanced targets up to 10cm accuracy compared to the room accuracy of traditional 5G.** These precise positioning capabilities can offer better usage of resources and lower costs.

- **It could lower costs and increase revenue streams.** Optimization of process, more efficient use of infrastructure, higher spectrum efficiency and constant seamless connectivity could lower network costs dramatically. This efficiency and better use of resources could also reduce network energy consumption. Better usage of network capabilities and real-time feedback should also help lower maintenance needs. Additionally, the use of advanced antennas like MIMO (multiple input, multiple output) could simplify the network itself and use less equipment. 5G Advanced could also increase revenue streams: more data-heavy applications that demand higher bandwidth and lower latency like XR, holograms or autonomous vehicles, could offer providers a new revenue opportunity.

The foundation of 6G?

5G Advanced is not just a natural progression of 5G technology, but a necessary evolution, which will lead us to the 6G revolution. As mentioned, 5G Advanced refers to the 18th and 19th releases of the 5G architecture protocol. But with the release of 20, according to Qualcomm, the 6G foundation will be laid, enabling new technologies like duplexing evolution, the use of new spectrum bands, integrated sensing, and communication, among others. All these technologies will be maximized to build 6G networks.

4) 6G

6G will be the successor to 5G mobile technology in the transmission of mobile data and is estimated to be commercially available before the end of this decade. 6G will offer 10-50 times higher speeds and bandwidth compared to 5G, with a much better latency ratio (up to 1/1000).

According to different estimates, 6G download speeds could reach 400-500Gbps or even up to 1Tbps (terabits per second) with close to zero latency, and still be able to handle ten times more data capacity than 5G. While the technology and protocols remain in development, 6G will use the higher bands of the spectrum like terahertz radio waves (terahertz = 1,000 gigahertz), which have greater capacity and are more stable, but cover shorter distances.

The speed is just a bonus

While 6G can offer faster speeds, looking at speed alone is misleading. Most people use regular applications that do not require a 1Tbps download speed. Instead, 6G should be seen as the technology that could have the capacity for all the data we are creating, could connect the digital world to the physical one, and could handle complex data.

To do so, 6G will be the first mobile technology to have AI capabilities embedded in it. What other technology could support the connectivity of all autonomous driving, Industry 4.0, one trillion connectable devices, smart city holograms, and the world of gaming, etc? More importantly, what other technology will allow all applications to “talk” to each other, creating even more data than the sum of each application as a standalone (i.e., complex data)?

[5] Qualcomm

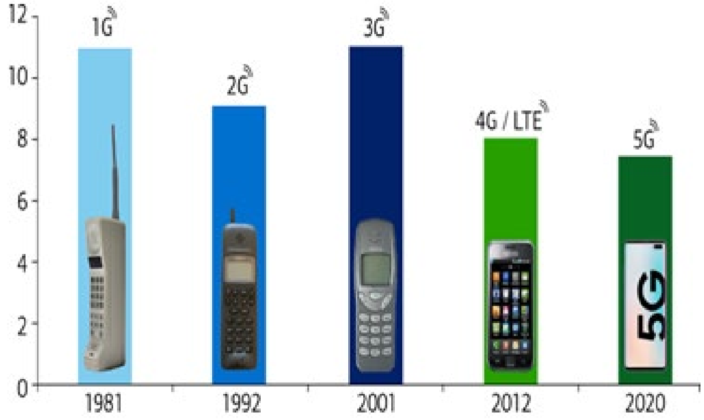
Why do we need 6G? Because nothing is linear when it comes to technology…

The idea behind 6G is to create a technology that will connect everything. This was also the bedrock of 5G, but new applications and the speed of data creation placed a question mark over its ability to support the "connected world" over time. Now, the data we are creating is increasing exponentially and will clog up 5G network capacity sooner than expected.

New applications are being developed all the time that require more data. Our Next Gen Tech series has mentioned holograms, the metaverse, brain computer interfaces, and even quantum computing, to name just a few. In short, data is going to grow far faster than initially expected in the coming years, well beyond the exponential growth we are currently seeing on mobile networks. Technologies will have to "talk" to each other and connect seamlessly with zero latency, placing even more pressure on the network.

Exhibit 2: The timeline for a mobile technology is usually c.10 years, but the explosion of data creation and complexity might push out 5G before that

Could 5G be the shortest-lived mobile technology?



Source: BofA Global Research

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Some might think it's too early to talk about 6G, when 5G is still being deployed and should become fully operational in most countries. While 5G was regarded as the ultimate solution to our current world needs, our colleagues in BofA Global Research believe these needs will change significantly before the end of the decade.

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