5G MOBILE NETWORKS: AN INSIDER'S GUIDE

By James Sanders

TechRepublic.

INTRODUCTION

With the advent of widespread Internet of Things (IoT) adoption in enterprise applications, including manufacturing, agriculture, and healthcare—alongside an increasing dependence on smartphones and always-connected computers—the constraints of 4G LTE technology are prompting mobile network operators to embark on an accelerated rollout of 5G communications to keep pace with the network demands of today and the very near future.

This cheat sheet is an introduction to 5G mobile networks, the communication standards included in 5G, and the new types of devices that use 5G networks.

WHAT IS 5G?

5G refers to the fifth generation of mobile phone networks. Since the introduction of the first standardized mobile phone network in 1982, succeeding standards have been adopted and deployed approximately every nine years. GSM, the 2nd generation standard, was first deployed in 1992, while a variety of competing 3G standards began deployment in 2001. The popular 4G LTE standard was deployed by mobile network operators in 2010. Now, technology companies and mobile network operators are preparing their infrastructure and customers for the transition to 5G.

Principally, 5G refers to "5G NR (New Radio)," which is the standard adopted by 3GPP, an international cooperative responsible for the development of the 3G UMTS and 4G LTE standards. Other 5G technologies do exist. Verizon's 5G TF network operates on 28 and 39 GHz frequencies and is used only for fixed wireless internet service, not in smartphones. Verizon's 5G TF deployments will be transitioned to 5G NR in the future. Additionally, 5G SIG was used by KT for a demonstration deployment during the 2018 Winter Olympics in Pyeongchang.

5G NR allows for networks to operate on a wide variety of frequencies, most notably recycling the frequencies vacated by decommissioning previous wireless communications networks. The 2G DCS frequency bands, the 3G E-GSM and PCS frequency bands, and the digital dividend of spectrum vacated by the transition to digital TV broadcasts are some of the bands available for use in 5G NR.

5G standards divide frequencies into two groups: FR1 (450 MHz - 6 GHz) and FR2 (24 GHz - 52 GHz). Most early deployments will be in the FR1 space. Research is ongoing into using FR2 frequencies, which are also known as extremely high frequency (EHF) or millimeter wave (mmWave) frequencies. Discussions of the suitability of millimeter wave frequencies have been published in IEEE journals as far back as 2013.

While millimeter wave frequencies allow for faster data speeds, they do come with disadvantages. Because of the short distance of communication, millimeter wave networks have a much shorter range; for densely populated areas, this requires deploying more base stations. (Conversely, this makes it well suited to densely populated places such as arenas and stadiums.) While this would be advantageous in certain use cases, it would be a poor fit for use in rural areas. Also, millimeter wave communication can be susceptible to atmospheric interference. Effects such as rain fade make it problematic for outdoor use, though even nearby foliage can disrupt a signal. Laboratory testing of early 5G modems for use in smartphones has brought thermal challenges to the forefront, as prototypes have experienced issues with generating excessive heat, which in turn depletes batteries faster.

It is vital to remember that 5G is not an incremental or backward-compatible update to existing mobile communications standards. It does not overlap with 4G standards like LTE or WiMAX, and it can't be delivered to existing phones, tablets, or wireless modems by means of tower upgrades or software updates. Mobile network operators are deploying upgrades to their LTE infrastructure, including technologies like LTE Advanced and LTE Advanced Pro, which allow for download speeds over one gigabit on smartphones. While these are worthwhile and welcome advances, these are ultimately transitional 4G technologies and do not provide the full range of benefits of 5G NR.

For an overview of when 5G smartphones are being released, as well as the benefits and drawbacks of 5G smartphones, check out TechRepublic's cheat sheet for 5G smartphones.

Additional resources

- The 5G revolution: 3 things business leaders need to know (TechRepublic)
- 5G standards approved as tech industry signals accelerated deployment (ZDNet)
- 5G specs approved, sets stage for next-gen business mobility (TechRepublic)
- Ericsson raises $370m for 5G research (ZDNet)
- Report: 5G will cover 20% of the world's population by 2023 (TechRepublic)
- Fujitsu unveils small cell mmWave 5G tech (ZDNet)

WHAT CONSTITUTES 5G TECHNOLOGY?

For mobile network operators, the 3GPP has identified three aspects for which 5G should provide meaningful advantages over existing wireless mobile networks. These three heterogenous service types will coexist on the

same infrastructure using network slicing, allowing networks operators to create multiple virtual networks with differing performance profiles for differing service needs.

eMBB (Enhanced Mobile Broadband)

Initial deployments of 5G NR focus on eMBB, which provides for greater bandwidth for improved download and upload speeds, as well as moderately lower latency compared to 4G LTE. eMBB will be instrumental in enabling rich media applications, such as mobile AR and VR, as well as 4K and 360° video streaming.

URLLC (Ultra Reliable Low-Latency Communications)

URLLC is targeted toward extremely latency-sensitive or mission-critical use cases, such as factory automation, robot-enabled remote surgery, and autonomous driving. According to a white paper (PDF link) by Mehdi Bennis, Mérouane Debbah, and H. Vincent Poor of the IEEE, URLLC should target 1ms latency and block error rate (BLER) of 10-9 to 10-5, although attaining this "represents one of the major challenges facing 5G networks," as it "introduces a plethora of challenges in terms of system design."

Technologies that enable URLLC are still being standardized; these will be published and deployed in future 3GPP releases.

mMTC (Massive Machine Type Communications)

mMTC is a narrowband access type for sensing, metering, and monitoring use cases. Some mMTC standards that leverage LTE networks were developed as part of 3GPP Release 13, including eMTC (Enhanced Machine-Type Communication) and NB-IoT (Narrowband IoT). These standards will be used in conjunction with 5G networks and extended to support the demands of URLLC use cases on 5G networks and frequencies in the future.

The ways in which 5G technologies will be commercialized are still being debated and planned among mobile network operators and communications hardware vendors. As different groups have differing priorities, interests, and biases, including spectrum license purchases made with the intent of deploying 5G networks, the advantages of 5G will vary between geographical markets and between consumer and enterprise market segments. While many attributes are under discussion, 5G technology may consist of the following (listed in no particular order).

Proactive content caching

Particularly for millimeter wave 5G networks, which require deploying more base stations compared to LTE and previous communications standards, those base stations in turn require connections to wired backhauls

to transmit data across the network. By providing a cache at the base station, access delays can be minimized and backhaul load can be reduced. This has the added benefit of reducing end-to-end delay. As 4K video streaming services—and smartphones with 4K screens—become more widespread, this caching capability will be important to improve quality of service.

Multiple-hop networks and device-to-device communication

In LTE networks, cellular repeaters and femtocells bridge gaps in areas where signal strength from traditional base stations is inadequate to serve the needs of customers. These can be in semi-rural areas where population density complicates serving customers from one base station, as well as in urban areas where architectural design obstructs signal strength. Using multiple-hop networks in 5G extends the cooperative relay concept by leveraging device-to-device communication to increase signal strength and availability.

Seamless vertical handover

Although proposals for 5G position it as the "one global standard" for mobile communications, allowing devices to seamlessly switch to a Wi-Fi connection, or fall back to LTE networks without delay, dropped calls, or other interruptions, is a priority for 5G.

Additional resources

- FCC's Ajit Pai wants to put $500M towards rural broadband access (TechRepublic)
- Trump signs executive order to boost broadband internet development in rural US (TechRepublic)
- Google's Project Loon will use balloons to bring cell service to Puerto Rico (TechRepublic)
- Terahertz wireless could help cover the planet with internet that's 10X faster than 5G (TechRepublic)
- How Facebook wants to redefine urban wireless connectivity with Terragraph (TechRepublic)

WHO DOES 5G BENEFIT?

Remote workers/offsite job locations

One of the major focuses of 5G is the ability to use wireless networks to supplant traditional wireline connections by increasing data bandwidth available to devices and minimizing latency. For remote workers, this greatly increases flexibility in work locations, allowing for cost-effective communication with your office without being tied to a desk in a home office with a wireline connection.

For situations that involve frequently changing offsite job locations, such as location movie shoots or construction sites, lower technical requirements for 5G deployment allow for easily setting up a 5G connection so existing devices can connect to a 5G router via Wi-Fi. For scenes of live breaking news, 5G technologies can be used to supplant the traditional satellite truck used to transmit audio and video back to the newsroom. Spectrum formerly allocated to high-speed microwave satellite links has been repurposed for 5G NR communication.

Internet of Things (IoT) devices

One priority for the design of 5G networks is to lower barriers to network connectivity for IoT devices. While some IoT devices (e.g., smartwatches) have LTE capabilities, the practical limitations of battery sizes that can be included in wearable devices and the comparatively high power requirements of LTE limit the usefulness of mobile network connectivity in these situations. Proposals for 5G networks are focusing on reducing power requirements, making the use of IoT devices more feasible.

City centers, office buildings, arenas, and stadiums

The same properties that make 5G technologies a good fit for IoT devices can also be used to improve the quality of service for situations in which large numbers of devices make extensive use of the mobile network in densely populated areas. These benefits can be realized easily in situations with variable traffic—for instance, arenas and stadiums are generally populated only during sporting events, music concerts, and other conventions. Large office towers, such as the 54-story Mori Tower in Tokyo's Roppongi Hills district, are where thousands of employees work during the week. Densely populated city centers can benefit from the ability of 5G networks to provide service to more devices in physically smaller spaces as well.

Additional resources

- Half of connections in North America will be on 5G by 2025, GSMA says (ZDNet)
- Verizon customers may be getting 'full-scale commercial' 5G by the end of 2019 (TechRepublic)
- Australia facing 'urgency' on 5G spectrum bands: AMTA (ZDNet)
- Why 5G will revolutionize college campus technology (TechRepublic)
- Rise of the digital nomad: Why working remotely could draw more millennials to the tech industry (TechRepublic)
- CES 2018: 5 trends that will have a massive impact on business travel (TechRepublic)
- Remote access policy (Tech Pro Research)

WHEN AND WHERE ARE 5G ROLLOUTS HAPPENING?

Technical demonstrations

The first high-profile 5G rollout was at the 2018 Winter Olympic Games in Pyeongchang, South Korea. KT, a major mobile network operator, Samsung, and Intel collaborated to deliver gigabit-speed wireless broadband and low-latency live streaming video content. During the games, 100 cameras were positioned inside the Olympic Ice Arena, which transmitted the video to edge servers, then to KT's data center to be processed into "time-sliced views of the athletes in motion," and then transmitted back to 5G-connected tablets for viewing. This demonstration used prototype 5G SIG equipment, which is distinct from the standardized 5G NR hardware and networks being commercialized worldwide.

Similarly, Intel and NTT Docomo have announced a partnership to demonstrate 5G technology at the 2020 Tokyo Olympic Games. The companies will use 5G networks for 360-degree, 8K-video streaming, drones with HD cameras, and smart city applications, including "pervasive facial recognition, useful for everything from stadium access to threat reduction."

Additional 5G tests and rollouts have occurred worldwide. Ericsson and Intel deployed a 5G connection to connect Tallink cruise ships to the Port of Tallinn in Estonia. Huawei and Intel demonstrated 5G interoperability tests at Mobile World Congress 2018. In China, ZTE conducted tests in which the company achieved speeds in excess of 19 Gbps on a 3.5 GHz base station. In tests of high-frequency communications, ZTE exceeded 13 Gbps using a 26 GHz base station, and a latency of 0.416 ms in a third test for uRLLC.

US

Verizon Wireless started deployments of its 5G fixed wireless internet service on October 1, 2018, in Sacramento and Los Angeles, Houston, and Indianapolis. Verizon's initial 5G network deployments use its proprietary 5G TF hardware, though the company plans to transition these networks to 5G NR in the future. Verizon's 5G TF network is used only for home internet service, not in smartphones. Verizon will deploy smartphone-compatible 5G NR networks in 2019.

AT&T plans to deploy 5G NR in Dallas, Houston, San Antonio, Waco, Charlotte, Raleigh, Atlanta, Oklahoma City, New Orleans, Jacksonville, and Louisville by 2018, with Los Angeles, San Diego, San Francisco, San Jose, Las Vegas, Nashville, and Orlando following in early 2019.

Presently, AT&T has deployed LTE Advanced, which the company is marketing as a "5G Evolution" network, though LTE-Advanced is not a 5G technology. AT&T has a history of mislabeling network technologies. It previously advertised the transitional HSDPA network as 4G, though this is commonly considered to be an "enhanced 3G" or "3.5G" standard.

Sprint plans to deploy 5G networks in Atlanta, Chicago, Dallas, Houston, Kansas City, Los Angeles, New York City, Phoenix, and Washington, D.C. in the first half of 2019. In August 2018, LG announced what it touts as "the first 5G smartphone in the US" to be released in a partnership with Sprint in the first half of 2019. The company plans to deploy Massive MIMO to LTE networks starting in April 2018, which Sprint markets as having "5G-like capabilities." While this will bring speed improvements to existing compatible devices, this is a transitional technology—it is not a deployment of 5G NR.

T-Mobile USA announced a plan to roll out 5G to 30 cities starting in 2018. Like Sprint, T-Mobile is claiming transitional Massive MIMO deployments as 5G, though T-Mobile's deployment is powered by Ericcson AIR 3246 modems, which support both 4G LTE and 5G NR. When smartphones with 5G NR capable modems are released, the true 5G capabilities of the Ericcson modems can be activated.

As the purchase of Sprint by T-Mobile is awaiting regulatory approval, few concrete details have been publicly disclosed about how this will affect 5G deployment plans. In an interview with ZDNet, T-Mobile CTO Neville Ray indicated the merger will "accelerate" 5G deployment. Unredacted filings (PDF link) to the FCC indicate that the merged companies anticipate significant adoption of 5G smartphones starting in 2021.

UK

EE announced 5G availability for 16 cities in the UK in 2019, starting with London, Cardiff, Edinburgh, Belfast, Birmingham, and Manchester, though this rollout will initially exclude the busiest parts of these cities. According to ZDNet, the "first 1,500 sites that EE is upgrading to 5G amount to around seven percent of its total sites and cover 15 percent of the UK population," though they account for a quarter of all data use on the network.

Together, Vodafone, EE, Hutchison, and Telefonica have paid £1.4 billion ($1.814 billion USD) to regulatory body Ofcom in spectrum licenses needed to deliver 5G service.

Australia

Optus plans to launch 5G fixed-wireless services in Canberra and Brisbane in January 2019, with other capital cities to follow by March 2019.

Telstra has begun 5G network rollouts, starting with the Gold Coast in August 2018, followed by Toowoomba and Brisbane, with 200 towers expected to be live by the end of 2018.

Australia's National Broadband Network (NBN) operator has declared its intent to provide 5G fixed-wireless internet access in a statement to ZDNet.

Chinese vendors Huawei and ZTE have been banned by the Australian government from providing 5G networking equipment to mobile network operators due to national security concerns.

Additional resources

- Sprint targets first mobile 5G nationwide network by early 2019 (CNET)
- Starry, Marvell partner at CES 2018 to accelerate 5G fixed wireless deployments (TechRepublic)
- 5G takes center stage at CES 2018 with actual deployments later (ZDNet)
- How New York City plans to become a 5G leader (TechRepublic)
- Telstra CEO: 2018 will be big for 5G (ZDNet)
- Why the Middle East could be the first region in the world to adopt 5G (TechRepublic)
- South Korea to auction 5G spectrum in June 2018 (ZDNet)
- T-Mobile chief: We're on the fast track to 5G (CNET)
- Ericsson raises $370m for 5G research (ZDNet)
- Samsung tests 5G on Japanese high-speed train (ZDNet)
- The race to 5G: Inside the fight for the future of mobile as we know it (TechRepublic cover story)

HOW DOES A 5G FUTURE AFFECT ENTERPRISES AND MOBILE USERS?

As technology advances, older devices will inevitably reach end-of-life. In the mobile space, this is an outsized concern, as wireless spectrum is a finite resource. Much in the same way that the digital switchover occurred for over-the-air TV broadcasts, older mobile networks are actively being dismantled to free spectrum for transitional LTE and 5G networks.

In the US, AT&T disabled its 2G network on January 1, 2017, rendering countless feature phones—as well as the original iPhone—unusable. Verizon plans to disable its legacy 2G and 3G networks by the end of 2019, which will render most feature phones and older smartphones unusable, as well as IoT devices such as water meters. Verizon stopped activations of 3G-only phones in July 2018. End-of-life plans for the 2G networks of Sprint and T-Mobile have not been publicly disclosed.

And as 5G is used increasingly to deliver wireless broadband, wireline broadband providers will face competition as the two services approach feature parity. With many people using smartphones both as their primary computing device and for tethering a traditional computer to the internet, the extra cost of a traditional wireline connection may become unnecessary for some people and enable those outside the reach of traditional wireline connections to have affordable access to high-speed for the first time.

As 5G specifications are designed around the needs of businesses, the low-power and low-latency attributes are expected to spark a revolution in IoT deployments. According to Verizon Wireless President Ronan Dunne, 5G will enable the deployment of 20 billion IoT devices by 2020, leading to the creation of the "industrial internet," affecting supply chain management, as well as agriculture and manufacturing industries. These same attributes also make 5G well suited to use cases that require continuous response and data analysis, such as self-driving cars and traffic control.

Additional resources

- Video: How 5G will enable 'wireless without limitations' by 2019 (TechRepublic)
- How 5G will drive down the cost of robots (TechRepublic)
- Huawei announces smart city control centre (ZDNet)
- Fiber broadband: Is it a waste with 5G and Elon Musk's satellites on the horizon? (ZDNet)
- Intel and Ericsson 5G connected cars trial attains 1Gbps speeds (ZDNet)
- Deutsche Telekom: 'We are ready for 5G' (ZDNet)
- AT&T Labs' Mazin Gilbert on AI, quantum computing, data collaboration and 5G (ZDNet)

CREDITS

Senior Director, B2B Editorial
Jason Hiner

Editor in Chief, UK
Steve Ranger

Senior Managing Editor
Bill Detwiler

Associate Managing Editor
Mary Weilage

Editor, Australia
Chris Duckett

Senior Features Editor
Jody Gilbert

Senior Writer
Teena Maddox

Chief Reporter
Nick Heath

Staff Writers
Alison DeNisco Rayome
Macy Bayern

Associate Editor
Melanie Wachsman

Multimedia Producer
Derek Poore

Cover image:
iStock/ Guirong Hao

TechRepublic®