5G: The network of the future

Today's mobile users want faster data speeds and more reliable service. The next generation of wireless networks—called 5G—promises to deliver that, and much more. Engineers say these networks will boost the development of other new technologies, such as autonomous vehicles, virtual reality, and the Internet of Things.

Wireless engineers are designing a number of brand-new technologies so 5G networks can handle far more traffic at much higher speeds than the base stations that make up today's networks. Together, these technologies will bring peak download speeds of 20 gigabits per second (compared to 1 Gb/s on today's 4G networks) to users and deliver data with less than a millisecond of delay (compared to about 70 ms on 4G). With 5G, users should be able to download a high-definition film in under a second (a task that could take 10 minutes on 4G LTE).

Today's wireless networks have run into a problem: More people and devices are consuming more data than ever before, but it remains crammed on the same bands of the radio-frequency spectrum that mobile providers have always used. That means less bandwidth for everyone, causing slower service and more dropped connections.

One way to solve that problem is to transmit signals on a new range of the spectrum, one that's never been used for mobile service before. That's why providers are experimenting with broadcasting on millimeter waves, which use higher frequencies than the radio waves usually used for mobile phones. Millimeter waves are broadcast at frequencies between 30 and 300 gigahertz, compared to the bands below 6 GHz that were used for mobile devices in the past. There is one major drawback to millimeter waves, though—they can't easily travel through obstacles like buildings or even rain.

In addition to broadcasting over millimeter waves, 5G base stations will also have many more antennas. Today's 4G base stations have a dozen ports for antennas that handle all cellular traffic: eight for transmitters and four for receivers. But 5G base stations can support about a hundred ports, which means many more antennas can fit on a single array. That capability means a base station could send and receive signals from many more users at once, increasing the capacity of mobile networks. This technology is called massive MIMO (multiple-input multiple-output). So far, massive MIMO has only been tested in laboratories, but in early experiments it has set new records for efficiency.

Although massive MIMO looks very promising for the future of 5G, installing so many antennas to handle traffic also causes more interference if those signals cross. To reduce this effect, beamforming can be used to identify the most efficient data-delivery route to a user. At massive MIMO base stations, signal-processing algorithms plot the best transmission route through the air to each user. Then they can send individual data packets, bouncing them off buildings and other objects in a precise pattern. By coordinating the packets' movements and arrival time, beamforming allows many users and antennas on a massive MIMO array to exchange much more information at once. Additionally, since millimeter waves are easily blocked by objects, beamforming can help by focusing a signal in a concentrated beam that points only in the direction of a user, rather than broadcasting in many directions at once.

With these and other 5G technologies, engineers hope to build the wireless network that future smartphone users, VR gamers, and autonomous cars will rely on every day. Already, researchers and companies have set high expectations for 5G by promising ultralow latency and record-breaking data speeds for consumers. If the remaining challenges can be solved and researchers discover how to make all these systems work together, ultrafast 5G service could reach consumers in the early 2020s.

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Task: *Answer the questions below* ***in English****.*

1. Briefly explain what "5G" is. Identify at least three expected benefits.

The next generation of wireless networks—called 5G—promises to deliver that, and much more

5G networks can handle far more traffic at much higher speeds than the base stations that make up today's networks.

These technologies will bring peak download speeds of 20 gigabits per second (compared to 1 Gb/s on today's 4G networks) to users and deliver data with less than a millisecond of delay (compared to about 70 ms on 4G).

5G can transmit signals on a new range of the spectrum, one that's never been used for mobile service before.

With 5G, users should be able to download a high-definition film in under a second (a task that could take 10 minutes on 4G LTE).

2. Why does a mobile user effectively have less bandwidth today?

   More people and devices are consuming more data than ever before, but it remains crammed on the same bands of the radio-frequency spectrum that mobile providers have always used

3. How are millimeter waves different from the radio waves used today? Name one advantage and one disadvantage of using millimeter waves.

   Millimeter waves operate on a new range of the spectrum, one that's never been used for mobile service before. That's why providers are experimenting with broadcasting on millimeter waves, which use higher frequencies than the radio waves usually used for mobile phones. Millimeter waves are broadcast at frequencies between 30 and 300 gigahertz, compared to the bands below 6 GHz that were used for mobile devices in the past

   However, one disadvantage is that they can't easily travel through obstacles like buildings or even rain.

4. Describe the concept of "massive MIMO" in your own words. In what way does this technology affect mobile network capacity?

   5G base stations can support about a hundred ports, which means many more antennas can fit on a single array. That capability means a base station could send and receive signals from many more users at once, increasing the capacity of mobile networks

5. What technology is being developed to reduce interference? Describe how this technology works.

   To reduce this effect, beamforming can be used to identify the most efficient data-delivery route to a user. At massive MIMO base stations, signal-processing algorithms plot the best transmission route through the air to each user. Then they can send individual data packets, bouncing them off buildings and other objects in a precise pattern. By coordinating the packets' movements and arrival time, beamforming allows many users and antennas on a massive MIMO array to exchange much more information at once

6. Explain how beamforming can help reduce a negative aspect of millimeter waves.

   Since millimeter waves are easily blocked by objects, beamforming can help by focusing a signal in a concentrated beam that points only in the direction of a user, rather than broadcasting in many directions at once.

7. What is the current status and outlook of 5G technology? In your opinion, what is the most significant way 5G technology may change mobile applications? Why?