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There are eight performance attributes to be considered when evaluating whether a 5G network can deliver on its full potential:





## Throughput



#### Verizon has taken its award-winning 4G network to new heights.

- 953 Mbps in a real-world environment, using 4G LTE Licensed Assisted Access (LAA)<sup>1</sup>
- 1.45 Gbps in 4G LTE Advanced in six-channel carrier aggregation<sup>2</sup>



5G has the potential to deliver speeds many times faster than today's 4G networks, powering uses such as:

- Intelligent video
- Remote diagnostics
- Mobile command centers for live video and audio



## 5G networks will one day offer peak data rates of 10 Gbps.

 Verizon 5G Home has demonstrated speeds of 600 to 800 Mbps downlink and 250 Mbps uplink in third-party testing<sup>3</sup>



<sup>1</sup> https://www.prnewswire.com/news-releases/verizon-ericsson-and-qualcomm-reach-superfast-953-mbps-wireless-speed-in-a-dynamic-real-world-environment-deployment-300498759.html

<sup>2</sup> https://www.marketwatch.com/press-release/verizon-nokia-and-gualcomm-use-lte-advanced-technology-of-six-carrier-aggregation-to-reach-145-gbps-2018-09-27

<sup>3</sup> https://www.rcrwireless.com/20181002/test-and-measurement/rcr-exclusive-in-first-independent-testing-verizons-5g-network

### Latency

All kinds of new applications become possible once you reach very low levels of latency, including:

- Immersive extended reality (XR), combining artificial reality (AR), virtual reality (VR) and mixed reality (MR)
- Autonomous driving
- Computer vision
- Haptics-enabled tactile internet
- Robotics

4G LTE networks currently offer end-to-end latency in the realm of 40 to 50 ms. Verizon 5G Ultra Wideband should eventually offer less than 10 ms end-to-end response times.<sup>1, 2</sup>



1 Latency improvements are due to lower latency in the 5G radio access network and the extension of the core network closer to end users. 2 https://www.verizon.com/about/news/verizon-ceo-hans-vestberg-keynotes-2019-consumer-electronics-show



## Mobility

5G technology is designed to enable devices that are travelling up to 500 kph (310 mph) to stay connected to the network.<sup>1</sup> - -. . We've tested 5G network handoff techniques 00 00 to enable passengers . . . . . . in fast-moving vehicles and trains . . . . to stay connected while they . . 0 00 are moving.

#### 1 https://www.itu.int/md/R15-SG05-C-0040/en



### **Connected devices**

The number of connected devices will be more than three times the global population by 2022.<sup>1</sup>

5G will be capable of supporting up to 1 M devices in a square kilometer.<sup>2</sup>

This will allow cities to tap into the power of 5G for things like smart streetlights, remote security monitoring, intelligent rail and smart parking solutions. Verizon 5G Ultra Wideband will eventually handle 10 to 100x more connected devices per square kilometer than 4G.<sup>3</sup>



 1 https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white-paper-c11-741490.html

 2 https://www.samsung.com/global/business/networks/insights/news/5g-is-now-part-1-2018-the-year-of-5g/

 3 https://www.gsma.com/publicpolicy/wp-content/uploads/2017/10/5g\_\_iot\_web\_FINAL.pdf



## **Energy efficiency**

5G will have lower energy requirements for network operations (up to 90% less than 4G when compared per bit). With 5G, complex functions could happen within the network, near the end user.<sup>1</sup> That means the end user's device will not need as much processing capability and will consume less energy.





1 https://www.verizon.com/about/our-company/5g/how-5g-will-pull-cloud-closer

### Service deployment



Network virtualization (i.e., using software to perform network functions) enables service and application deployment without having to install additional hardware.

This will lead to a reduction in typical service deployment time from 6 months to 90 minutes.



Faster deployment times means we can roll out new features and security improvements quickly.



#### Data volume

The 5G standard is designed to support up to 10 TB/s/km<sup>2</sup>.<sup>1</sup> This means that a 5G network can carry a massive amount of data for a large number of simultaneous users.

So users in high-density areas—like airports, stadiums and urban areas will all experience the fast speeds and low latency of 5G service.



1 https://5g-ppp.eu/wp-content/uploads/2015/02/5G-Vision-Brochure-v1.pdf



## Reliability



Verizon offers the most reliable 4G LTE network in the nation.

We are bringing that same expertise and focus as we architect and build our 5G network.



#1 in overall network
 performance in the U.S. — 11x in a row.<sup>1</sup>

1 Rankings based on the RootMetrics® U.S. National RootScore® Report: 2H 2018. Tested with best commercially available smartphones on four national mobile networks across all available network types. Your experiences may vary. The RootMetrics award is not an endorsement of Verizon. Visit <u>www.rootmetrics.com</u> for more details.



# How we're deploying the Verizon 5G **Ultra Wideband** network



## The 8 attributes can only be fully realized on a 5G network built the right way.



#### Fiber

- Significant fiber in major cities to drive densification
- Verizon has committed to invest \$1.05 billion on new fiber-optic cable from Corning from 2018 to 2020<sup>1</sup>

#### Small-cell deployment

- Verizon has spent years densifying our 4G LTE network. Many 4G locations will be used for 5G
- We have built relationships with municipalities of all sizes so we can accelerate network deployment

### Millimeter-wave spectrum

1 1 1

- · Critical spectrum holdings
- Nationwide deep millimeter-wave spectrum

#### $\Box$

#### Edge computing

- We have network locations nationwide that are ideally suited to house edge computing resources
- Edge computing will enable low-latency applications

1 verizon.com/about/news/verizon-agrees-105-billion-three-year-minimum-purchase-agreement-corning-next-generation



#### **Integrated Smart Communities**



Improving sustainability and efficiency | Reducing crime and increasing security | Enhancing citizen experience



## 5G for public safety

5G will potentially support many solutions for public safety and first responders, including:

- Real-time intelligence
- Critical training
   preparedness
- Next-generation
   communications
- Remote asset operations
- Augmented reality (AR) on-the-job support





#### Understanding the public safety spectrum: What are Bands 13 and 14?

#### What is Band 14?

Congress allocated Band 14 – a 20 MHz slice of radio spectrum in the 700 MHz Band – to public safety, and authorized the First Responder Network Authority (FirstNet) to use it to support deployment of a nationwide public safety broadband network.

FirstNet leased Band 14 to AT&T, which will use it to serve both its commercial and public safety customers. AT&T's use of Band 14 is predicated on a contractual agreement to provide public safety with priority use of its LTE network, but it does not have to serve them on Band 14.

#### What is Band 13?

The Verizon 4G LTE network uses Band 13, which:

- Is adjacent to Band 14 in the 700 MHz Band
- Has the same technical characteristics
- Also provides priority for public safety communications

#### verizon

### **Delivering on the public safety promise**



Verizon Responder Private Core



Preemption



Mobile Broadband Priority

(('†'))

Wireless Priority Service



LTE deployable network



Mission-critical PTT features



Applications



Situational awareness



#### Mobile Connectivity Trailer

Verizon Mobile Connectivity Trailers are towable, rapidly deployable communication trailers.

- A Mobile Connectivity Trailer creates a 4G LTE cellular coverage area where there is no wireless coverage
- It empowers emergency response and law enforcement communications during and after disasters and other events
- You can purchase or lease your own Mobile Connectivity Trailer to enable your team to communicate when and where they need to





#### Skyward simplifies your drone program.



\* Skyward offers direct integrations with select industry-leading OEMs and software providers.



#### **Verizon Response Team**

The Verizon Response Team (VRT) is ready to support first responders, government agencies, nonprofit organizations and communities to help them stay connected during emergencies.

VRT support includes:

- Nationwide hotline: 800.981.9558
- Loaner phones and data devices
- Mobility solutions: Cells on Wheels (COWs), Cells on Light Trucks (COLTs) and Mobile Cell Towers (MCTs)
- Verizon Wireless Emergency Communication Centers
- We have deployed assets for wildfires, civil unrest, winter storms, hurricanes, the 2017 solar eclipse and major sporting events
- In one year, we supported over 90 agencies across the nation with 5,900 devices



#### Do you have any questions? Let's talk.

Feel free to tell us more about your organization and the challenges you face. Go ahead and reach out. We're listening.

Contact your Verizon Wireless specialist to get the answers you need. Find your rep at verizonenterprise.com/support/wireless/



