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October 2, 2018

Ex Parte

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: *Application of T-Mobile US, Inc., and Sprint Corporation for Consent To Transfer Control of Licenses and Authorizations,* WT Docket No. 18-197

Dear Ms. Dortch:

At the request of Commission staff, on September 28, 2018, Bill Stone, David Wheeler, and I of Verizon met with the staff members listed in Attachment 1. During the meeting, we described Verizon's 5G deployment plans, as described in Attachment 2 of this *ex parte*. In particular, we described Verizon's leadership in pushing the 5G ecosystem forward, including through our creation of the 5G Technology Forum, and our aggressive efforts to promote and deploy 5G services. We also described the October 1 launch of Verizon 5G Home – the world's first commercially available 5G service – in parts of Houston, Indianapolis, Los Angeles, and Sacramento.[1] We noted that for 5G to achieve its potential, carriers will need to rely on a mix of spectrum – including a mix of low-, mid-, and high-band spectrum – and we encouraged the Commission to continue its ongoing work in identifying and making additional spectrum available for 5G. Verizon did not take a position on the transaction before the Commission.

Pursuant to Section 1.1206(b) of the Commission's Rules, 47 C.F.R. §1.1206(b), notice is hereby provided of an oral *ex parte* communication in the above-referenced docket.

Sincerely,

Attachments

[1] *See Verizon Turns on World's First Commercial 5G Network*, Verizon News (Oct. 1, 2018) https://www.verizon.com/about/news/verizon-turns-worlds-first-5g-network.

ATTACHMENT 1

Kirk Arner (WTB)
Jim Bird (OGC)
Robert Chen (WTB)
Matthew Collins (WTB)
Monica DeLong (WTB)
William Dever (OGC)
Ben Freeman (WTB)
Garnet Hanly (WTB)
Jonathan Henly
Pramesh Jobanputra (WTB)
David Lawrence
Marcus Maher (OGC)
Charles Mathias (WTB)
Aalok Mehta (WTB)
Murtaza Nasafi (WTB)
Robert Pavlak (OET)
Joel Rabinovitz (OGC)
Ziad Sleem (WTB)
Chris Smeenk
Patrick Sun (WTB)
Thuy Tran (WTB)
Aleks Yankelevich (OSP)

By Telephone

Paul LaFontaine (OSP)
Catherine Matraves (WTB)
Paul Powell (WTB)
Ronald Repasi (OET)
Dana Shaffer (WTB)
Lindsay Tello
Weiren Wang (WTB)
Joseph Wyer (WTB)

ATTACHMENT 2

5G

Bill Stone
VP Network Planning

Key expectations of 5G.

Peak Data Rate* (1-20 Gbps)	**Latency** (1-10 ms)
Connection Density (10k – 1m devices/km²)	**Battery Life#** (10 yrs)

Additional 5G enhancements:
Network density, Area traffic capacity, Network reliability/availability, Position accuracy, Security, Energy efficiency

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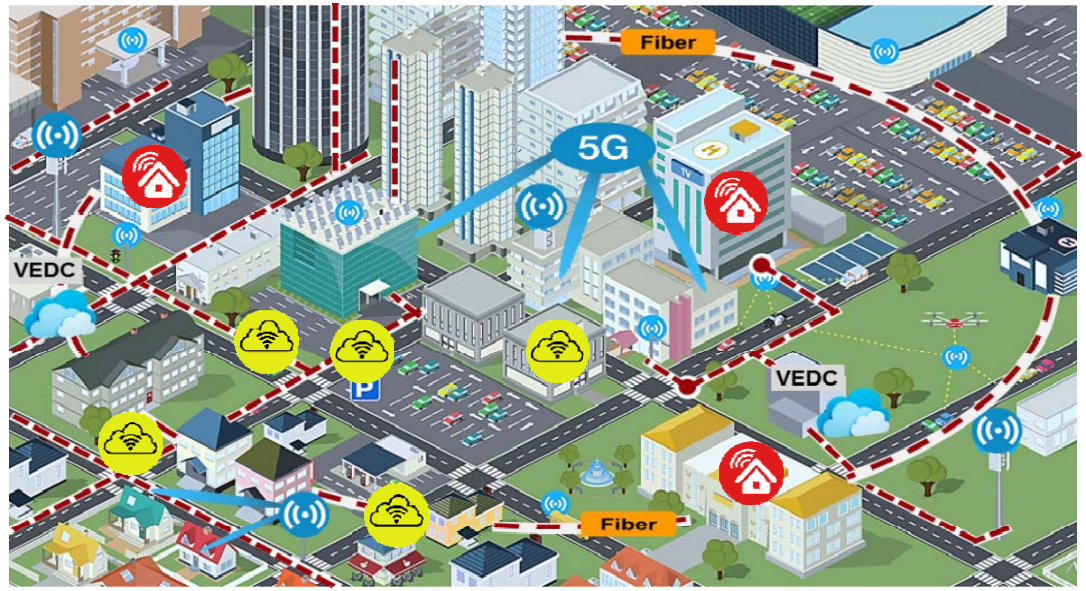
**Peak data rate is spectrum dependent*
#For low power IoT devices in ~ 1 GHz band

Network architecture for the future.



Intelligent Edge

Low Latency Services

Dense Wireless

Deep Fiber

3.5GHz

LAA

Integrated Fiber-Wireless
Small Cell Densification

Cloudification
SDN

Intelligent Caching
Connected Infrastructure

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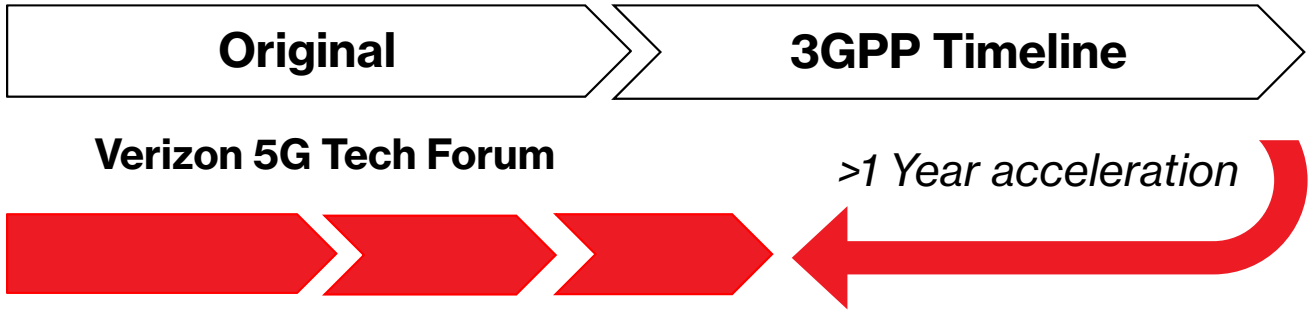
Building the 5G Platform – Standards / Field Trials



- ✓ **5GTF → 3GPP Release 15 acceleration**
- ✓ **11 cities customer fixed wireless trial completed successfully**
- ✓ **Commercial equipment FCC certification mostly complete**
- ✓ **First 3GPP compliant 5G over the air testing on mmwave for mobility in the U.S.**

Launched 4 cities to date in 2018

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Building the 5G Platform

Technologies

Digital signal processing to leverage new spectrum bands

Benefits of High Bands

- Small size antenna arrays
- Non-interfering signal forming & tracking
- Wide bandwidth

Benefits of Mid Bands

- Massive MIMO

Passive Infrastructure

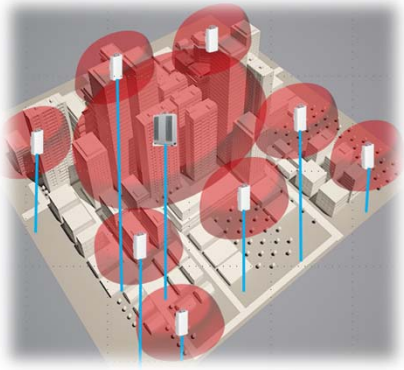
Deep fiber & cell densification deployment collaboration with municipalities

Fiber Availability

- Deep backhaul

Small Cell Density

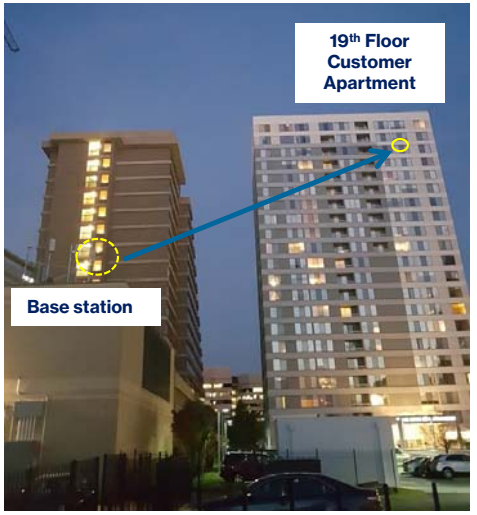
- Collocation



5G Pre-Commercial Trial Results

- Focused on fixed wireless - trial participants were located as far as 2000+ feet from radio and as high as 19th floor
- Success with non-line of site use cases
- Able to achieve data rates over 1 Gbps with wide bandwidths
- Small form factor indoor units
- Option for outdoor antenna
- Real world deployment experience

Line of Sight



MDU Installs

Low-E Glass

Home unit

Optional Outdoor Antenna

Successful trials in 11 markets with mmWave home broadband

4G LTE / 5G NR Standardization

- 4G LTE is evolving in Parallel with 5G
- 5G will provide potential for revolutionary applications and support a much wider ecosystem
- 5G enables favorable economics with new deployment scenarios
- 5G New Radio (NR) has Two Phases for the Standards Work
  - **Release 15 completes in June 2018, enabling initial 5G launch in 2018**
  - Mobility / Non Stand Alone option 3 radio completed in December 2017

- Release 16 completes by December 2019, containing a complete 5G system description enabling end to end architecture for 5G in 2020.

Standards based Commercial products follow Release completion based on Vendor implementation

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Key Release Points

Release 14 / 5G Study

- Cat M IOT: Higher data rates, VoLTE
- Narrowband - IOT: Positioning support, Power consumption
- Enhanced LAA (Uplink - unlicensed)
- V2X services (Telematics, Drones)
- **Latency Reduction (semi persistent scheduling)**
- TDD in CBRS (3.5 GHz)
- **Enhanced MIMO (up to 32 antennas)**
- Indoor Positioning Enhancements
- **Improved Carrier Aggregation - higher Data rate**

Release 15

5G NR

- **mmWave – bandwidth to 400MHz**
- Unified, Flexible, self-contained structure for both FDD and TDD
- **Massive MIMO, Beam management**
- Advanced coding / modulation and reference signal system
- **Ultra-Reliable & Low Latency Communications**
- **Tight Interworking with LTE**
- **Advanced design for Gbps data**
- **C-RAN / Cloud RAN architecture**
- Enhanced Support for Drones

Release 16

5G NR

- Improved Positioning
- **NR-NR Carrier Aggregation enhancements**
- **Enhanced mobility support**
- **Integrated access and backhaul**
- **NR wideband & Industrial IoT (joint LTE/NR)**
- Shared networks / neutral host / local networks
- NR-U
- **Additional Ultra Reliable / Low Latency Use Cases (uRLCC)**
- Massive Machine Type Comm. (MMTC)

5G New Radio (NR) mmWave Deployment

Deployment for mobility

- Integrated radios provide deployment flexibility
- mmWave allows for higher antenna elements
- Decrease in size / weight over sub-6 products
- Can be deployed on various structures

3.5GHz

28/39GHz

5G Opportunities

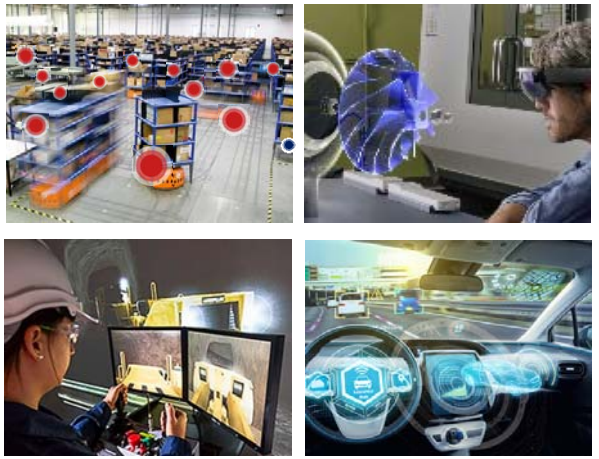
Fixed Wireless

"Quad Play" Opportunity

Mobile Broadband

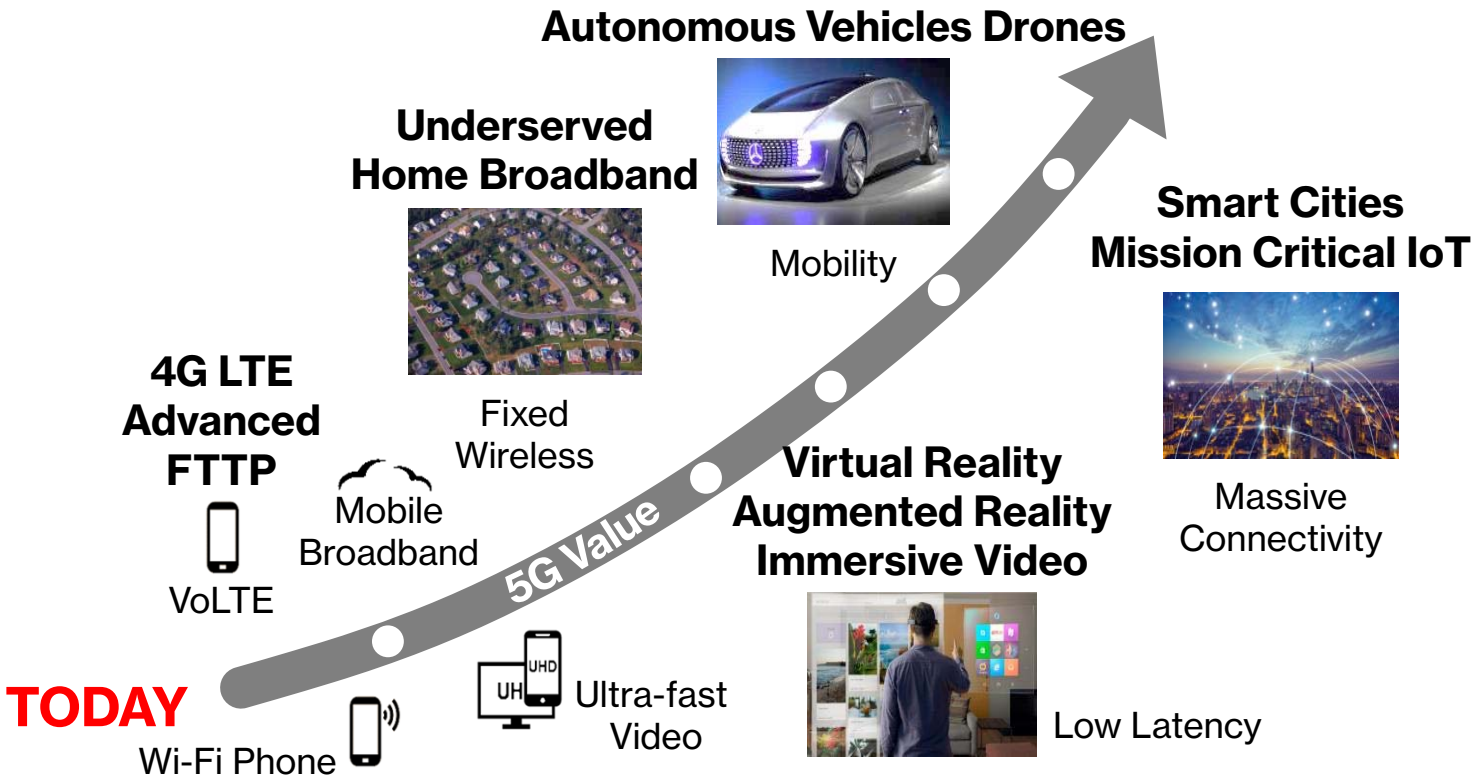
New Consumer Apps AR/VR

5G-Enabled Cloud



Intelligent Edge/MEC Industrial Automation

5G enables new opportunities & markets . . .



Verizon 5G rapidly extending beyond Fixed Wireless

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Emerging IoT use cases can be clustered into 5 major categories

HIGH BANDWIDTH DOWNLOAD

HD VIDEO STREAMING | HUMAN COMMAND AND CONTROL

Virtual Reality

Telematics Infotainment

ULTRA LOW LATENCY

MISSION CRITICAL REAL-TIME MACHINE RESPONSE

Telematics V2C|V2I

Utilities Micro grid

HIGH BANDWIDTH UPLOAD

VIDEO UPLOADS|STORE AND FORWARD MULTI MEDIA FILES

Video Surveillance

Drone FPV

HIGH DENSITY | LOW COST

LOW MB USAGE | DELAY TOLERANT | LOW COST | LOW POWER

Connected Home

Industrial Internet

PROXIMITY

DEVICE-TO-DEVICE DISCOVERY| ANTISIPATORY BEHAVIOR

Smart Home Assistant | Services Discovery

Thank You