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

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)
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

*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
Building the 5G Platform – Standards / Field Trials

Verizon 5G Tech Forum ➔ 3GPP Timeline

- 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
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

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
# 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
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 . . .

4G LTE
Advanced
FTTP
VoLTE

3G Mobile Broadband
Fixed Wireless

Mobility
Autonomous Vehicles Drones

Underserved Home Broadband

Virtual Reality
Augmented Reality
Immersive Video

Massive Connectivity
Smart Cities
Mission Critical IoT

Ultra-fast Video
Low Latency

TODAY
Wi-Fi Phone

Verizon 5G rapidly extending beyond Fixed Wireless
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

**HIGH BANDWIDTH UPLOAD**
- VIDEO UPLOADS | STORE AND FORWARD MULTI MEDIA FILES
- Video Surveillance
- Drone FPV

**ULTRA LOW LATENCY**
- MISSION CRITICAL REAL-TIME MACHINE RESPONSE
- Telematics V2C/V2I
- Utilities Micro grid

**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