The next generation of wireless broadband.

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5G Planning and Strategy

March 7, 2017
Wireless continues to be the center of innovation.
Annual U.S. wireless data usage.

Megabytes (In Billions)

<table>
<thead>
<tr>
<th>Year</th>
<th>Megabytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>388</td>
</tr>
<tr>
<td>2011</td>
<td>867</td>
</tr>
<tr>
<td>2012</td>
<td>1,468</td>
</tr>
<tr>
<td>2013</td>
<td>3,230</td>
</tr>
<tr>
<td>2014</td>
<td>4,061</td>
</tr>
<tr>
<td>2015</td>
<td>9,650</td>
</tr>
</tbody>
</table>

Source: CTIA

9.6 Trillion Megabytes (MB)
Average Wireless data usage per U.S. subscriber.

Average Monthly Megabytes per Average Data Capable Unit

Source: CTIA
By 2021, the number of mobile-connected devices will exceed the number of people on earth.

7.7 Billion
People on Earth (2021)

11.6 Billion
Connected Devices (2021)

Machine-to-Machine

Source: Cisco
Consumers are using their devices to do more, mobile data is on an ever-upward trajectory.

47% growth 2016-2021 (based on compounded annual growth rate)

1 Gigabyte (GB) = 8 YouTube video hours (VH)
1 Exabyte (EB) = 1 Billion GB or 8 Billion VH

392 Billion Video Hours per month globally

Source: Cisco
The Network is evolving rapidly across several fronts . . .
RAN design evolution.

Low and tight RF
- Macro cells
- Small cells/DAS
- In-building
- Spectrum layers

Dense urban coordination
- Deep fiber
- HetNet

Advanced automation, analytics, scale, control
- C-RAN
- SON
- Virtualization
RAN evolution.

Heterogeneous Network

Multiple Spectrum bands

Low and High Band

Narrow and Wide Spectrum Bandwidths

Various Spectrum Categories

• Licensed
• Unlicensed/LAA – Dynamically shared – 5 GHz
• Shared Access Server – Dynamically shared
Evolution of Wireless Networks.

1G
1980s
Voice

2G
Early 1990s
Texting
Voice

3G
Late 1990s
Internet
Texting
Voice

4G
2010
Video
Internet
Texting
Voice

5G

The Future Possibilities Are Unlimited!

- Autonomous Cars
- Automated Traffic Control and Driving
- Cloud Gaming
- Collaborative Robots
- Augmented and Virtual Reality
- Smart Cities
- Ultra High Definition Video
- Unmanned Aerial Vehicles (Drones)
So what is 5G?

- 10,000x more traffic
- Ultra reliability
- Very low latency
- >10 Gbps peak data rates
- M2M ultra low cost
- Multi-year Battery
- Billions of devices with different needs
- GBs transferred in an instant
- Mission-critical control and automation
5G in the industry.

- **Above 24 GHz (mmWave):** enhanced BB (US/Korea)
- **Mid bands 3 - 6 GHz:** eMBB and mission-critical (Asia)
- **Sub 1 GHz:** MBB and massive IoT (Europe)

- Virtual RAN/Core
- Network Slicing
- Low power (IoT)
- Low latency (IoT/eBB)
- Massive MIMO

**3GPP:** 1Q 2018 (enhanced BB only)
Building blocks for 5G.

1. Large contiguous spectrum bandwidth
2. Massive MIMO (hundreds of integrated antennas)
3. Access to wireline fiber facilities (backhaul)
Early use case: Fixed Wireless.

Evolution of fixed wireless broadband service
Stationary with limited mobility at cell edge
Residential users, commercial office buildings, retail

Pre-commercial Test specifications (www.5gft.org)
Early lessons learned.

- Throughput is the easy part—several Gbps
- No surprises with mmWave propagation
- Precise beam acquisition and maintenance is critical
Pre commercial 5g trials.

Testing with beta customers in 11 markets

Small clusters across various topographies

Fixed and mobility testing during 1H 2017

Prototype equipment from our Partners
BRACE YOURSELF

5G DATA CONNECTION IS COMING.

imgflip.com
Thank you.