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The Standards
Road to 5G

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5G – A National (and Global) Priority

enabling a seamlessly connected society ....

... that brings together people along with things, data, applications, transport systems and cities in a smart networked communications environment

North America will continue to lead the world in mobile wireless today and in the future with 5G
The Coming “Augmented Age” and the “Age of Things”

Industrial Age

Space Age

Digital Age

Information Age

Industrial Revolution 2.0

Augmented Age / Age of Things
“Robotification”
“Information of Everything”
Artificial Intelligence

Time
A Look to the Future – 2020 and Beyond, the rise of “Things”

2020: Estimated 25 Billion Total Connected Devices … Of which 10.5 billion will connect using mobile technology

- source: GSM Association

1.2 billion total M2M connections in the automotive sector global by 2025

Enhanced IoT Solutions

• 3GPP LTE-NB IoT standards set this summer

• Cat-M1 trials starting in November
  ➢ Broad range of use cases
  ➢ Expected Cat-M1 benefits:
    ➢ Access to low-cost module technology
    ➢ Extended battery life of 10 years or more for enabled IoT devices
    ➢ Enhanced LTE coverage for underground and in-building areas that challenge existing coverage

• Cat-NB1 progressing
  ➢ Lower throughput and lower power use cases

• 5G “Massive IoT”

IoT is allowing “things” that were not connected before to now work seamlessly together, making our work and our lives more efficient in ways that we never dreamed possible
Characteristics of 5G technology that deliver city benefits include:

- Broadband virtually everywhere
- Reliable speed
- Adaptive
- Energy efficient
- Responsive, near real time
- Combining wireless networks
- Quality of experience

Evolution to 5G will enable rapidly growing, diverse services for both human and machine communications.
An Example Transformation - The Connected Car

Features and possibilities of the connected car:

- Advanced diagnostics
- Telematics
- Remote services
- Global services
- Rear seat infotainment
- Family tracker
- Voice recognition
- Automotive app store
- Vehicle updates
- Connected media

Usage-Based Insurance

- Collect detailed driver data, with permission, to propel innovation in your business, while also helping your most reliable customers save money by driving more safely

*Enables automobile manufacturers to invent new ways for customers to experience car ownership and transform their in-vehicle experience*
5G Use Cases - Enabling Industrial Revolution 2.0

New capabilities of 5G will allow for new business modeling for vertical industries by offering mobility, flexibility, security, reliability and interoperability.

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Enhanced Mobile Broadband & UHRLLC Use Cases

• Enhanced Mobile Broadband (eMBB)
  • Expected throughput of 5 Gbps +
  • UHD video (4k, 8k), 3D video (including broadcast services)
  • Virtual Reality
  • Augmented Reality
  • Tactile Internet
  • Cloud gaming
  • Broadband kiosks
  • Vehicular (cars, buses, trains, aerial stations, etc.)

• High reliability / low latency
  • Industrial control
  • Remote manipulation
  • Mission-critical applications e.g. ehealth, hazardous environments, rescue missions, etc.
  • Self-driving vehicles

Source: ITU-R
Connected “Everything” → Ever Changing Cyber Risk Landscape

**DDoS attack shows dangers of IoT 'running rampant'**
Experts, U.S. senator call for greater Internet of Things security


An IoT botnet is partly behind Friday’s massive DDoS attack
DVRs and other devices compromised with the Mirai malware are being used in the attack.

Source: PCWorld.com, Oct 21, 2016

AT&T has recorded a 3,198% increase in IoT vulnerability scans over the past three years.


To adequately protect from security breaches, a multi-layered approach is recommended.

**Endpoint**
**Network**
**Data & Applications**

- **Endpoint Layer:** Helps secure the actual device or endpoint that is connected to the internet. Ex: robot, car, oil rig, etc.
- **Network Layer:** Helps secure data in transit to and from a device that is connected. AT&T is a leader in providing the highly secure transmission of information to help secure data in transit over a wireless and wireline connection.
- **Data/Application Layer:** Provides intrusion detection and prevention, specific security policies and controls to help protect stored data, as well as information-affiliated applications used by the device user.

**Threat Management**
**Threat Analysis Layer:** Involves the collection and examination of data across all the layers (endpoint, network and data/application), to help identify, isolate, and manage threats.

Source: AT&T
# 5G Ecosystem & Technology Enablers

<table>
<thead>
<tr>
<th><strong>LTE-Advanced Evolution</strong></th>
<th><strong>mmWave</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrowband LTE</td>
<td>New Waveforms</td>
</tr>
<tr>
<td>New Radio (NR)</td>
<td>Massive MIMO &amp; Beamforming</td>
</tr>
<tr>
<td>NexGen Core</td>
<td>Advanced Inter-Node Coordination</td>
</tr>
<tr>
<td>Multi-RAT Integration &amp; Management</td>
<td>Densification</td>
</tr>
<tr>
<td></td>
<td>D2D Communications</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>“Softwarization”</strong></th>
<th><strong>Tactile Internet</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Source</td>
<td>Mobile Edge Computing</td>
</tr>
<tr>
<td>Network Function Virtualization (NFV)</td>
<td>Virtual &amp; Augmented Reality</td>
</tr>
<tr>
<td>Software Defined Network (SDN)</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>Network Slicing</td>
<td>Cloud</td>
</tr>
<tr>
<td>Management &amp; Orchestration</td>
<td>Big Data Analytics</td>
</tr>
</tbody>
</table>
Projected Industry 5G Standards Timelines

- **3GPP Release 14**
- **3GPP Release 15 (5G Phase 1)**
- **3GPP Release 16 (5G Phase 2)**
- **IMT-2020 Technical Performance Requirements**
- **IMT-2020 Proposals**
- **IMT-2020 Specifications**

- **NR NSA Initial specs for silicon design**
- **NR & NexGen SA and NSA Initial full specs for eMBB and UHRLLC**
- **Full 5G Standard**

**You Are Here**

- **WRC 19**
- **Standards-compliant commercial deployments of mobile services via 5G anticipated 2020-2021**
The Progress of 5G - Global Initiatives*

**Standards & Associations**
- 5G Americas
- 3GPP
- ITU-R, ITU-T
- ATIS
- ETSI
- IEEE
- ARIB
- TIA
- GSM Association
- CTIA
- NGMN

**Global Initiatives**

**Europe**
- EU Framework Project 8 Horizon 2020
- 5G Infrastructure Public Private Partnership (5G-PPP)

**Japan**
- Fifth Generation Mobile Communications Promotion Forum (5GMF)

**China**
- IMT-2020 Promotion Group
- China National Key Project on 5G

**Korea**
- 5G Forum

**Academia**
- NYU Wireless
- Berkeley SWARM Lab & Wireless Research Center
- Georgia Tech Broadband Wireless Networking Lab
- University of Notre Dame Wireless Institute
- CWSA at Purdue University
- Clean Slate Project at Stanford
- UCSD Center for Wireless Communications
- Wireless@MIT Center
- Wireless @ Virginia Tech
- UT Austin WNCG
- University of Surrey 5GIC
- TU Dresden

* Not Comprehensive

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Non-3GPP Access and 5G

LTE → two main ways 3GPP interworks with non-3GPP access (e.g., IEEE 802.11 / Wi-Fi); expected to be carried forward to 5G:

- Wi-Fi Offload via core network interworking
- Wi-Fi Aggregation in RAN

Non-3GPP Accesses Under Consideration for Support by 5G System:

- Wi-Fi
- Fixed Wireline
- Satellite

WLAN (802.11) in unlicensed spectrum provides a practical complimentary means of meeting some 5G use cases

- Enhanced Mobile Broadband (high data rate hotspots use case for areas with high user density where very high traffic capacity is needed)
Preparing for the Future of Artificial Intelligence

Software-defined networking and machine learning/artificial intelligence
• powerful tool for making networks more reliable and secure

AI and machine learning potential to improve lives by helping to solve some of the world’s greatest challenges and inefficiencies
• There is a lot of intelligence in the network and as we get to 5G, there will be more and more technologies coming up in the network that help alleviate and improve the experience

Basic and applied R&D on AI have already begun reaping major benefits to the public in:
• health care
• transportation
• the environment
• criminal justice, and
• economic inclusion

National Artificial Intelligence R&D Strategic Plan
• establishes a set of objectives for Federally-funded AI research
• Ultimate goal of this research is to produce new AI knowledge and technologies that provide a range of positive benefits to society

"imagine the Nation and the world in 50 years and beyond, and to explore America’s potential to advance towards the frontiers that will make the world healthier, more prosperous, more equitable, and more secure"

Source: https://www.whitehouse.gov/blog/2016/10/12/administrations-report-future-artificial-intelligence
What’s Next?

- Continued Transformation of Mobile Networks
- LTE-Advanced to LTE-Advanced Pro
- Software Defined Networks & Network Function Virtualization
- Enhanced IoT Solutions
- Faster Data Speeds
- Spectrum
- 5G
  - Key Architecture Components & Considerations
  - Trials
  - Standards

The evolution to 5G will spur innovation, making cities more livable, secure, efficient, and responsive to citizens’ needs.
The Challenge ...

“Working together, we can write the next chapter in the mobile revolution that has already transformed our lives and society. Working together, we can unleash new waves of innovation and discovery that we are yet to imagine.”

- Prepared Remarks of FCC Chairman Tom Wheeler
  National Press Club, June 20 2016
Thank You