IMT Vision towards 2020 and Beyond

IMT-2020 (5G) Promotion Group
February 2014
Outline

- IMT-2020 (5G) Promotion Group
- 5G Challenges and Requirements
- 5G Potential Technologies and Spectrums
- 5G Objectives and Capabilities
In February 2013, three ministries of China (MIIT, NDRC and MOST) jointly established “IMT-2020(5G) Promotion group” based on the original IMT-Advanced promotion group.

Objectives:

- The platform to promote the development of 5G technologies in China
- The platform to facilitate cooperation with foreign companies and organizations
Structure of IMT-2020 (5G) PG

- **Requirement WG**: study 5G vision and requirements towards year 2020 and beyond
- **Wireless Technology WG**: study 5G enabling wireless technologies and 5G system framework
- **Network Technology WG**: study 5G network architecture and key technologies
- **Spectrum WG**: work on spectrum related topics
- **Standards WGs**: interactive with international standard organizations including ITU, 3GPP, IEEE, etc
- **IPR WG**: deal with IPR issues and relevant policy.
Exponential Mobile Traffic Growth Driven by Mobile Internet and IoT

Mobile traffic growth rate

- **Global**
  - 2010-2020: 200
  - 2020-2030: 200

- **China**
  - 2010-2020: 200
  - 2020-2030: 200

- **Shanghai**
  - 2010-2020: 200
  - 2020-2030: 200

- **Hotspot (Xidan, Beijing)**
  - 2010-2020: 200
  - 2020-2030: 1000x

Human
- 1990s: PC
- 2000s: Internet

Machine
- 1990s: Voice
- 2000s: Data

Immersive
- 2010s: Mobile Internet

Cloud
- 2020s: Internet of Things

Connecting everything

Ubiquitous

- >1000x
Mobile Subscriber Growth Trends

Penetration rates

2010 2020 2030

China Global

Mobile subscribers

2010 2020 2030

China Global
M2M Connection Growth Trends

**Global**

- **Human population**
- **M2M connections**

**China**

- **Human population**
- **M2M connections**

<table>
<thead>
<tr>
<th>Year</th>
<th>Human Population</th>
<th>M2M Connections</th>
</tr>
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<tbody>
<tr>
<td>2010</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2020</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2030</td>
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Typical Scenarios and Services

**Typical Scenarios**
- **High traffic**
  - Office
  - Residential Area
- **High density**
  - Subway
  - Stadium
- **High mobility**
  - High-speed Train
  - Freeway

**Mobile Internet services**
- UHD Video Streaming
- Cloud Storage
- Augmented Reality
- Virtual Reality

**IoT services**
- ITS
- Surveillance
- Smart Home
- Smart Grid
User Requirements - Mobile Internet

- Fiber-like access rate
- Higher user experienced data rate
- Comparable to local operations
- Zero latency experience
- Excellent experience under various scenarios
- Consistent experience under diverse scenarios
- Perfect service experience
- Immersive audio-visual experience
- Smooth control experience
- Varieties of personalized services
User Requirements - IoT

Meet the diversified requirements of different industries

Transportation
Medical
Agriculture
Finance
Architecture
Electric power
Industry
Environment

Various types of wireless connections

Currently connect all kinds of mobile terminals

Support massive connections

ITU: 2020: 25 billion connected devices in global
Service Requirements

<table>
<thead>
<tr>
<th>UHD</th>
<th>3D</th>
<th>Virtual Reality</th>
</tr>
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<tbody>
<tr>
<td>Continuous growth of video resolution</td>
<td>Require extremely high data rate (~1Gbps)</td>
<td></td>
</tr>
<tr>
<td>Augmented Reality</td>
<td>Online games</td>
<td>Cloud Desktop</td>
</tr>
<tr>
<td>HUGE amount of data exchange in ms level latency</td>
<td></td>
<td></td>
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</table>
Service Requirements

Cloud Storage

• High data rate
• High traffic volume density

OTT Messaging

• Control signaling overhead

IoT Services

Diverse Requirements
• Massive connected devices
• Low cost
• Low power
• Low latency
• High reliability
• High traffic volume density
• ...
Operation Requirements

Network deployment

• Complexity and cost reduction of dense network deployments
• Flexible and efficient use of fragmented spectrum
• Flexible and scalable network architecture and topology for diverse services

Operation and maintenance

• Improve energy efficiency and cost per bit
• Multi-RAT management, including cellular and non-cellular, TDD and FDD
• Smart optimization based on services and users sensing
• Support a diverse set of services and applications with extremely diverging requirements
Major Challenges of Future IMT Systems

**Challenges in performance**

- **Higher user experienced data rate**
  - 10 – 100 times

- **"Zero" latency**
  - ms level

- **Higher density of connected devices**
  - Millions of connections per km²

- **Higher traffic volume density**
  - Tens of Tbps/km²

- **Higher Mobility**
  - > 500 km/h

**Challenges in efficiency**

- **Higher spectrum efficiency**
  - 5 – 15 times

- **Lower cost per bit**
  - > 100 times reduction

- **High energy efficiency**
  - Performance
  - Energy consumption
  - > 100 times
Possible Roadmap of Future IMT Systems

- Evolution of existing technologies
  - LTE Evolution
  - WLAN Evolution

- "Revolutionary" new technologies

2G  3G  4G  5G

FDMA/TDMA  CDMA  OFDM  ?
Future IMT Technology Framework

- Technology innovations in areas of wireless transmission and wireless networking (including access network and core network)

Key Technologies

- Wireless Transmission Technologies
  - Spectral Efficiency Enhancement
  - Ultra-dense Networks

- Access Network Technologies
  - Heterogeneous Network Convergence

- Core Network Technologies
  - D2D Communications
  - M2M Enhancement
  - High-frequency Communications
  - Other Scenarios / Issues

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Potential Key Technologies

Potential key technologies in wireless transmission

- **Massive MIMO**
- **Full-duplex**
- **NOMA**
- **Enhanced Multi-carrier**
- **Adv. coding and modulation**

Potential key technologies in wireless networking

- **C-RAN**
- **SDN**
- **NFV**
- **Mobile CDN**
Considerations on Future IMT Spectrum

- **Chinese spectrum requirements**

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<th>Current Planned</th>
<th>687 MHz</th>
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<td>Deficit in 2020 and beyond</td>
<td>Up to 1 GHz</td>
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</table>

- **Mid-term**
  - Possible candidates: 450-470MHz, 698-806MHz, and 3400-3600MHz.

- **WRC-15 AI 1.1**
  - Possible candidates: 1427-1518MHz, 3300-3400MHz, 4400-4500MHz, 4800-4990MHz, etc.

- **Above 6GHz**
  - Possible candidates: 1427-1518MHz, 3300-3400MHz, 4400-4500MHz, 4800-4990MHz, etc.

- **Long term**
  - Possible candidates: 1427-1518MHz, 3300-3400MHz, 4400-4500MHz, 4800-4990MHz, etc.
Objectives and Capabilities of Future IMT Systems

**Overall objectives**

- Meet the requirements from more than a thousand times of mobile traffic growth in a sustainable way.
- Provide consistent experience under diverse scenarios with ultra high data rate, ultra low latency and massive connections.

**Consistent experience under diverse scenarios**

- More than 100 times improvement in energy efficiency and cost per bit

**Support of up to 100 billion connections**

**Fiber-like access data rate**

**“Zero” latency user experience**

**Smart optimization based on services and users sensing**
Key Capability and Efficiency Requirements

**User experienced data rate (Gbps)**
0.1 to 1 Gbps

**Connections density (10^4/Km^2)**
Millions of connections/Km^2

**Traffic volume density (Tbps/Km^2)**
Tens of Tbps/Km^2

**Latency (ms)**
Ms level

**Peak data rate (Gbps)**
Tens of Gbps

**Mobility (Km/h)**
>500Km/h

- **Future IMT**
- **IMT Advanced**

Spectrum efficiency

Cost efficiency

Energy efficiency
Capability Cube of Future IMT Systems
Thanks for your attention