Overview of ITU-T activities on 5G/IMT-2020

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Terms & Definition

- **IMT-2020 [ITU-R M-2083-0]:** systems, system components, and related aspects that support to provide far more enhanced capabilities than those described in Recommendation ITU-R M.1645 (IMT-2000)
- **IMT-2020 Radio:** IMT evolution + new RAT revolution
- **IMT-2020 Network:** flat architecture + white-box-hardware + Virtualization + LINP/ Slices + Softwarization + MEC + DAN (ICN/ CCN) + e-2-e VoLTE enabling + ...
Terms & Definition (cont.)

- **Slice**: Logically isolated set of programmable infrastructure resources (i.e., physical and/or logical resources) to enable functions and services of IMT-2020 network.

- **Network Softwarization**: Automation mechanism for the configuration deploying, managing and maintaining of network equipment and network components.

- **FMC**: Capabilities that provide services and application to the end user regardless of the fixed or mobile access technologies being used and independent of the user's location.
Service Trends

**Everything connected by wireless**
- Monitor/collect information & control devices
  - Multiple personal devices
    - Interaction across multiple devices
  - Transportation (Car/Bus/Train)
    - Entertainment, Navigation, Traffic information
  - Consumer electronics
    - Remote operation using personal terminal
  - Watch/jewelry/cloths
    - Human interface (HI) and healthcare sensors
  - House
    - Remote control of facilities
    - House security
  - Sensors
    - Smart power grid
    - Agriculture and farming
    - Factory automation
    - Weather/Environment
  - Cloud computing
    - All kinds of services supported by the mobile personal cloud
**Extension/enrichment of wireless services**
- Deliver rich content in real-time & ensure safety
  - Video streaming
    - 4K/8K video resolutions
    - Video on newspapers
    - Background video
  - New types of terminal/HI
    - Glasses/Tactile Internet
  - Healthcare
    - Remote health check & counseling
  - Education
    - Distance (remote) learning
    - Any lesson anywhere/anytime
  - Safety and lifeline system
    - Prevention of accidents
    - Robustness to disasters

Source: NTTDocumo
Challenges & Gaps

- **Latency**: 1 ms E2E Latency
- **Throughput**: 10Gbps Per Connection
- **Connections**: 1,000K Connections Per km²
- **Mobility**: 500 km/h High-speed Railway
- **Network Architecture**: LINP Ability Required

**GAP**
- **30~50x**
- **100x**
- **100x**
- **1.5x**
- **NFV/SDN**

**LTE**
- **30~50ms**
- **100Mbps**
- **10K**
- **350Km/h**
- **Inflexible**

Challenges because many of these requirements are conflicting.

Networks are challenged by wide range of requirements

Source: Huawei
IMT-2000, IMT-Advanced & IMT-2020

• All of today’s 3G and 4G mobile broadband systems are based on the ITU’s IMT standards

• IMT provides the global platform on which to build the next generations of mobile broadband connectivity

• ITU established the detailed specifications for IMT-2000 and the first 3G deployments commenced around the year 2000

• In January 2012, ITU defined the next big leap forward with 4G wireless cellular technology – IMT-Advanced – and this is now being progressively deployed worldwide

• The detailed investigation of the key elements of IMT-2020 is well underway, using the partnership ITU has with the mobile broadband industry and the wide range of stakeholders in the 5G community
IMT-2020 vision: 5G usage scenarios

- Enhanced Mobile Broadband
  - Gigabytes in a second
  - 3D video, UHD screens
  - Work and play in the cloud
  - Augmented reality
  - Industry automation
  - Mission critical application, e.g. e-health
  - Self Driving Car

- Smart Home/Building
  - Voice

- Smart City

- Future IMT

- Massive Machine Type Communications

- Ultra-reliable and Low Latency Communications
The values in the figures above are targets for research and investigation for IMT-2020 and may be revised in the light of future studies. Further information is available in the IMT-2020 Vision Recommendation (Recommendation ITU-R M.2083)
IMT2020 Architecture Overview

- **NaaS (LINEP, Slice)**
- **Virtualized Telco Functions**
  - Network Functions (Radio, EPC, IMS,..)
  - Other Functions
- **Resource Virtualization**
- **HW Resources**
  - Computing
  - Storage
  - Networking
- **Distributed Functions**
  - Edge Cloud
  - SDN enhanced Transport NW
  - Internet
- **Centralized Functions**
  - Centralized Cloud
Ultra Low Latency Broadband Communication in IMT2020 Networks

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ICN Information Centric Networking (new Y. 3071 – 03/2017)

- Recognition of user requests and their corresponding responses by networks due to its name based routing.
- Overlay/ native transport
- See also ITU-T Y.3032 “Configurations of node identifiers and their mapping with locators in future networks”
Example: 5G concept of end to end slice

If $\mathcal{U}$ is the set of all resource sets \{Antennas, Fronthaul, ..\} then

Slice $\mathcal{S}_i$ is a set of resource subsets taken from resource sets \{Antennas, Fronthaul ..\}
Key areas of study: (1) Network softwarization

- **Softwarization**: Designing, implementing, deploying, managing and maintaining networks using software
- Exploits characteristics such as flexibility and rapidity of design
- Softwarization creates conditions that enable the re-design of network and service architectures
- Optimization of costs and processes, self-management
Key areas of study: (2) Network slicing

- **Slice**: Unit of programmable resources, e.g., network, computation, storage
- Allows logically isolated network partitions
- Envisaged to cover a wide range of use cases with one network, e.g., one slice for voice communications, a separate slice for automated driving
**Key areas of study: (3) Architecture enabling convergence**

- Fixed access networks to interwork with radio access networks
- Goals for IMT-2020: A converged access-agnostic core - identity, mobility, security, etc., are decoupled from the access technology
- Network architecture to support fixed / mobile convergence, with seamless user experience

*Architecture discussion at a Focus Group meeting, Palo Alto, September 2016*
5G, open source and IPR

There is a collaboration of ITU-T SGs with open source initiatives to develop proofs of concept addressing technical issues identified

- **ITU-NGMN workshop** on "Open Source and Standards in 5G" (25 May 2016)
- **Conclusions:**
  - Open source needed in the context of 5G
  - Open source components will complement the development of standards in 5G
  - Open source and standards are converging and both can benefit in 5G from each other, e.g., interoperability, virtualization of network functionalities or software defined networking
  - Open source and standards are not two different worlds, they do not live in silos, and close cooperation creates opportunities for both
FG **IMT-2020 Workshop and Demo Day**: Wireline Technology Enablers for 5G
(Geneva, December 2016)
Deliverables of FG IMT-2020
(FG IMT-2020 achieved nine deliverables, December 2016, see here)

- Draft Terms and definitions for IMT-2020 (IMT-O-040)
- Draft Recommendation: Requirements of IMT-2020 from network perspective (IMT-O-042)
- Draft Recommendation: Framework of IMT-2020 network architecture (IMT-O-043)
- Draft Recommendation: Requirements of IMT-2020 Fixed and Mobile Convergence (IMT-O-044)
- Draft Recommendation: IMT-2020 Network Management Requirements (IMT-O-046)
<table>
<thead>
<tr>
<th>Work item</th>
<th>Q</th>
<th>Timing</th>
<th>Liaison relationship</th>
<th>Subject / Title</th>
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</thead>
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<tr>
<td>Y.IMT2020-terms</td>
<td>Q20/13</td>
<td>2017-11</td>
<td>-</td>
<td>Terms and definitions for IMT-2020</td>
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<tr>
<td>Y.IMT2020-reqts</td>
<td>Q20/13</td>
<td>2017-11</td>
<td>-</td>
<td>Requirements of IMT-2020 network</td>
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<tr>
<td>Y.IMT2020-frame</td>
<td>Q20/13</td>
<td>2017-11</td>
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<td>Y.IMT2020-arch</td>
<td>Q20/13</td>
<td>Q2 2018</td>
<td>-</td>
<td>Architecture of IMT-2020 network</td>
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<td>Y.IMT2020-CE-Req</td>
<td>Q20/13</td>
<td>2017-11</td>
<td>-</td>
<td>Requirements of capability exposure in IMT-2020 networks</td>
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<td>Y.IMT2020-CEF</td>
<td>Q20/13</td>
<td>Q2 2018</td>
<td>-</td>
<td>Capability exposure function in IMT-2020 networks</td>
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<tr>
<td>Suppl. To Y.IMT2020 serirs</td>
<td>Q21/13</td>
<td>2017-07</td>
<td>-</td>
<td>Standardization and open source activities related to network softwarization of IMT-2020</td>
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<tr>
<td>Y.IMT2020-MultiSL</td>
<td>Q21/13</td>
<td>Mid 2018</td>
<td>-</td>
<td>Framework for the support of Multiple Network Slicing</td>
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<td>Y.IMT2020-mgmt-frame</td>
<td>Q21/13</td>
<td>2017-07</td>
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<td>IMT-2020 Network Management Framework</td>
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<td>Y.IMT2020-mgmt-req</td>
<td>Q21/13</td>
<td>2017-07</td>
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<td>IMT-2020 Network Management Requirements</td>
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<td>Y.IMT2020-NetSoft</td>
<td>Q21/13</td>
<td>2017-11</td>
<td>-</td>
<td>High level technical characteristic of network softwarization for IMT-2020</td>
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</table>
## Current work items of SG11 related to IMT-2020 technologies (as of June 2017)

<table>
<thead>
<tr>
<th>Work item</th>
<th>Q</th>
<th>Timing</th>
<th>Liaison relationship</th>
<th>Subject / Title</th>
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<tbody>
<tr>
<td>Q.rrp</td>
<td>Q8/11</td>
<td>2017-11</td>
<td>ITU-T SG13</td>
<td>Request routing protocol for content delivery</td>
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<td>Q. NEA-REQ</td>
<td>Q7/11</td>
<td>2018-12</td>
<td>SG13, ETSI</td>
<td>Signalling Requirements of NFV Entity Management for Network Attachment</td>
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<td>Q.SAN-MIM</td>
<td>Q7/11</td>
<td>2017-11</td>
<td>SG13, JCA-SDN, IEEE 802.21</td>
<td>Signalling requirements of SDN-based access networks with media independent management capabilities</td>
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<tr>
<td>Q.BNG-CFS</td>
<td>Q5/11</td>
<td>2019-07</td>
<td></td>
<td>Signalling requirements for control and forwarding plane separation in vBNG</td>
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<tr>
<td>Q.BNG-DBoD</td>
<td>Q5/11</td>
<td>2017-11</td>
<td>SG13, JCA-SDN</td>
<td>Signalling requirements for dynamic bandwidth adjustment on broadband network gateway implemented by SDN technologies</td>
</tr>
<tr>
<td>Q.BNG-IAP</td>
<td>Q5/11</td>
<td>2018-12</td>
<td></td>
<td>Signalling requirements of IP address pool based on broadband network gateway by SDN technologies</td>
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<tr>
<td>Q.SCO</td>
<td>Q4/11</td>
<td>2017-07</td>
<td>SG13, JCA-SDN</td>
<td>Scenarios and signalling requirements for SDN based Central Office</td>
</tr>
<tr>
<td>Q.SD-WAN</td>
<td>Q4/11</td>
<td>2019-03</td>
<td>ONUG, SG13</td>
<td>Signalling Requirement for SD-WAN service</td>
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<tr>
<td>Q.SMO</td>
<td>Q4/11</td>
<td>2018</td>
<td>SG13, JCA-SDN</td>
<td>Signalling requirements of Software-defined Metro Orchestration</td>
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<tr>
<td>Q.SVDC</td>
<td>Q4/11</td>
<td>2018-12</td>
<td>SG13, JCA-SDN</td>
<td>Signalling requirements of the Sew interface for Virtual Data Center</td>
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## Existing ITU-T Standards related to IMT2020

<table>
<thead>
<tr>
<th>Awareness</th>
<th>Approved Recommendations</th>
</tr>
</thead>
</table>
| **Service** | Y.3011: Framework of network virtualization for future networks  
Y.3012: Requirements of network virtualization for future networks  
Y.3300: Framework of software-defined networking  
Y.3320: Requirements for applying formal methods to software-defined networking  
Y.3321: Requirements and capability framework for NICE implementation making use of software-defined networking technologies |
| **Data** | Y.3031: Identification framework for future networks  
Y.3032: Configuration of node IDs and their mapping with locators in future networks  
Y.3033: Framework of data aware networking  
Y.3034: Architecture for interworking of heterogeneous component networks in FNs |
| **Environment** | Y.3021: Framework of energy saving for future networks  
Y.3022: Measuring energy in networks |
| **Socio-Economic** | Y.3013: Socio-economic assessment of future networks by tussle analysis  
Y.3035: Service universalization in future networks |
| **Smart Ubiquitous Net.** | Y.3041, Y.3042, Y.3043, Y.3044, Y.3045 |
| **Control plane** | Q.3051: Signalling architecture for the control plane of distributed service networking  
Supplement 67 “Framework of signalling for software-defined networking”  
Q.3315: Signalling requirements for flexible network service combination on broadband network gateway  
Q.3711: Signalling requirements for software-defined broadband access network  
Q.3712: Scenarios and signalling requirements of unified intelligent programmable interface for IPv6  
Q.3713: Signalling requirements for Broadband Network Gateway (BNG) pool (under AAP, LC is 28.03.2017)  
Q.4040: The framework and overview of cloud computing interoperability testing |
Resolution 93 of WTSA-16
“Interconnection of 4G, IMT-2020 networks and beyond”

*Instructs the study groups*
... to identify as soon as possible future ITU T Recommendations that need to be developed associated with the interconnection of 4G, 5G/IMT-2020 networks and beyond...

*Instructs the study group 11*
... to develop ITU-T Recommendations which specify the framework and signalling architectures to be used for establishing interconnection of 4G, IMT-2020 networks and beyond to achieve interoperability worldwide...

*Instructs the study group 2*
... to develop ITU-T Recommendations which specify the ENUM architecture to be used for networks and beyond...interconnection of 4G, IMT-2020

*Resolves*
... that ITU-T Recommendations to address network architectures, roaming principles, numbering issues, charging and security mechanisms as well as interoperability and conformance testing for interconnection of 4G, IMT-2020 networks and beyond shall be progressed as quickly as possible...
**IMT-2020/5G Workshop and Demo Day**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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</table>
| 09:00 - 09:20 | Opening and Welcome  
- Opening Remarks  
- Welcome Remarks |
| 09:20 - 10:20 | IMT-2020/5G related activities in ITU-T SGs                           |
| 10:20 - 10:40 | Coffee Break                                                           |
| 10:40 - 12:00 | 5G Wireline Network and Aspects: a view by operators and vendors       |
| 12:00 - 13:30 | Lunch                                                                   |
| 13:30 - 14:30 | IMT2020/5G Demos and Proof of Concept                                   |
| 14:30 - 15:50 | IMT-2020/5G Technical and Standard Progress in other groups            |
| 15:50 - 16:10 | Coffee Break                                                           |
| 16:10 - 16:50 | (continuation) IMT-2020/5G Technical and Standard Progress in other groups |
| 16:50 - 17:30 | Demonstrations                                                          |
| 17:30 - 17:50 | Summary on workshop results by Study Group 13 Chairman                 |

Geneva, Switzerland, 11 July 2017

Contact: tsbworkshops@itu.int

Web page: [https://www.itu.int/en/ITU-T/Workshops-and-Seminars/201707/Pages/default.aspx](https://www.itu.int/en/ITU-T/Workshops-and-Seminars/201707/Pages/default.aspx)
Conclusions

• The scope of IMT-2020 is broader than previous generations of mobile broadband communication systems

• Use cases foreseen include enhancement of the traditional mobile broadband scenarios as well as ultra-reliable and low latency communications and massive machine-type communications

• ITU’s work in developing the specifications for IMT-2020, in close collaboration with the whole gamut of 5G stakeholders, is well underway, along with the associated spectrum management and spectrum identification aspects

• IMT-2020 will be a cornerstone for all of the activities related to attaining the goals in the 2030 Agenda for Sustainable Development

• Academia has the unique opportunity to participate in ITU’s standardization activities and to contribute to the development of future 5G systems
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