5G for Smart Sustainable Cities

Dr Paolo Gemma
Working Party 2/5 Chairman of ITU-T Study Group 5 and U4SSC Vice-chairman
**5G** will usher in a new era of driverless cars, smart buildings and much more. 5G cellular and wireless networks will be more densely connected. They will be catalyst for Internet of Things (IoT) innovation and technologies.
Setting Environmental Requirements for 5G

International Standards
Supplements
Technical Reports

ITU-T SG5

Electromagnetic compatibility (EMC)
ITU-T K.Suppl.10

Electromagnetic fields (EMF)
ITU-T K.Suppl.9
ITU-T K.Suppl.14
ITU-T K.Suppl.16

Energy feeding & efficiency
ITU-T L. 1220
Draft ITU-T L.1221
ITU-T L.1222
ITU-T L. Suppl.36

Resistibility
ITU-T K.Suppl.8

5G
5G technology and human exposure to RF EMF

Contains an analysis of the impact of the implementation of 5G mobile systems with respect to exposure level of EMF around radiocommunication infrastructure

- **Higher frequencies and higher throughput**
- **Smart antennas**: will minimize RF-EMF exposure level by improving antennas’ efficiency.
- **Small cells**: can improve network coverage and capacity. Since small cells transmit data at a lower power level, they can also improve the performance of mobile handsets by lowering their power output.
- **Internet of things (IoT)**: EMF exposure will usually be much lower than from other devices and systems.
The impact of RF-EMF exposure limits stricter than the ICNIRP or IEEE guidelines on 4G and 5G mobile network deployment

- Provides an overview of the challenges faced by countries, regions and cities when deploying 4G or 5G infrastructures.
- Includes a case study on Poland
- Based on inputs and contributions from, inter alia, Poland, India, Ericsson, Nokia, China Telecom, Huawei, Uganda, Cisco, GSMA and Vodafone, Telstra, Korea, Belgium, etc.
There isn’t 4G Power Standard. Why do we Need 5G Power Standard?

1. Power consumption is different: 2-3-4-5G, quantitative change to qualitative change
2. Business different: Function slicing

<table>
<thead>
<tr>
<th>Max power consumption of wireless (unit: W)</th>
<th>Average AC and DC powering capacity of legacy site</th>
</tr>
</thead>
<tbody>
<tr>
<td>8,507</td>
<td>GU</td>
</tr>
<tr>
<td>11,171</td>
<td>LTE phase 1</td>
</tr>
<tr>
<td>12,461</td>
<td>LTE phase 2</td>
</tr>
<tr>
<td>16,231</td>
<td>Massive MIMO 1</td>
</tr>
<tr>
<td>20,636</td>
<td>MIMO 2</td>
</tr>
<tr>
<td>24,406</td>
<td>5G</td>
</tr>
</tbody>
</table>

+ Baseband radio backhaul
+ Radio 26 Baseband (LTE)
+ Radio 1800 and 700
+ MIMO other base band and more backhaul

New power architecture expected
How to optimize Energy Consumption in 5G Networks

Key topics

AC capacity limit
How to limit power peak requirement from grid with limited AC capacity

Remote powering
How to feed the large power equipment on the tower from up to 100m away

Different important business
How to keep business from being interrupted

PAV classification
How to determine if a site is suitable for critical business such as IoV, telemedicine etc.

Sustainable power feeding solutions for 5G network
New Architecture will be Considered in 5G Power Standards

AC mains power requirement can be limited, Li-ion battery will become more prominent.

Power system communicates with the main equipment, enabling different business to have a different backup time.

- From backup to cycling
- Power staggering usage

Limited AC capacity

Discharge@peak

Lead acid can’t used in this kind scenarios

Higher output voltage is required

PAV is a visible KPI for site management. The PAV requirements for key businesses have to be determined and standardized.

• Max 42m, 48V architecture @6mm²
• AAU can input 57V even up to 72V

This area, PAV is not high enough for IoV, telemedicine, etc.

Voice  Data  IoV  Critical business

Critical business

Max 48m
AC Capacity Requirement Limit & Li-ion Battery Application

AC mains power capacity is not enough in half of GUL site

- On average, 30% of the existing grid access cables need to be transformed or expanded for 5G deployment. (with over 30,000 sites surveyed in Germany, England, Holand, Spain, China, Indonesia, Philippines, etc.)
- The AC capacity of 158 (49%) sites is not enough in 320 sites in G carrier of P country in Massive MIMO project. It will up to 229 (72%) sites if 5G deployed if the solution is in traditional way, 53 transformer in the sites need to be upgraded.

Li-ion battery + smart power can help reducing 90% of AC mains modernization

- Form backup to cycling
- Power staggering usage

53 sites → 5 sites

Site Transformers to be upgraded

Based on P carrier Massive MIMO + 5G project analysis

* Lead acid can’t used in this kind scenarios
**DC Cable Limit and System Voltage**

Traditional 48V system can’t support 5G in average powering distance

Higher output voltage is required

- The power consumption of 5G AAU is higher than 1000W
- Work voltage of AAU: 36V to 57V
- Powered by 8.2mm2 cable, cable loss exceed 20% (60m, when battery is discharge in the last phase)
- Thick cable (> 10mm2) can’t connected to the terminals of AAU directly, and thick cable is much costly

- AAU can input 57Vdc even up to 72Vdc, powering distance will be prolonged to 200m. 57Vdc or 72Vdc will be considered in 5G power standard
- Up to 400 Vdc architecture can support powering from N km away. Standards are available: ITU-T L.1200. Local regulation is not available in most countries. Not safe voltage used in telecom installation

AC

Min 43V

~100m

Min 36V

Max 56m, 48V architecture @8mm²

>200m, 57Vdc constant voltage@8mm²
Business Oriented Backup Solution is Expected

Traditional power systems have a 2 steps shutdown, sliced critical business of 5G lacks the same protection.

Business oriented smart power system is expected

@AC mains failure

Unimportant equipment

Important equipment

Definable backup time base on business

IoV: Internet of vehicle

T-M: Telemedicine
Visible PAV and Benchmark Should be Defined

Network outage is unacceptable in a smart world

- 2G: date missed
- 3/4G: deal delay
- 5G: life lost

PAV should be visible and benchmarked for critical business

Business availability = PAV × slice availability

PAV: Power Availability
Recommendation ITU-T L.1220
Innovative energy storage technology for stationary use - Part 1: Overview of energy storage
This Recommendation provides an overview of energy storage technologies for stationary telecom/ICT equipment (e.g. battery systems, super-capacitor systems etc) used in telecom networks, data centres and customer premises equipment (CPE).

Draft Recommendation ITU-T L.1221
Innovative energy storage technology for stationary use - Part 2: Battery
This Recommendation introduces technologies and methods for evaluating, selecting and testing battery systems for defined applications.

Recommendation ITU-T L.1222
Innovative energy storage technology for stationary use - Part 3: Supercapacitor technology
This Recommendation contains the selection criteria for telecommunication application based on main performance parameters and the methods for proper use.
Current work items on setting the environmental requirements for 5G

- Draft Recommendation ITU-T L.5G_powering on “Sustainable power feeding solutions for 5G network”.
- Draft Recommendation ITU-T L.EE_5G_base_station on “Energy efficiency Metrics and measurement methodology for 5G base stations”.
- Draft Recommendation ITU-T L.methodology_arch on “Methodology to assess the environmental impact of the different proposed architectures”.
- Draft Recommendation ITU-T L.ENV-KPI-5G-ARCH on “Environmental KPIs/metrics for 5G architectures”.
- Draft Recommendation ITU-T L.EE_sclicing on “Energy efficiency and slicing of IMT2020/5G”.
- Draft Recommendation ITU-T L.ARCH_EOL_CE on “Environmental Impact of architecture solutions with regards to End of Life and Circular Economy (CE)”.
Internet of things (IoT) and its applications

Smart cities and communities, including e-services and smart services

Internet of things identification
U4SSC responds to SDG 11: "Make cities and human settlements inclusive, safe, resilient and sustainable. U4SSC advocates for public policy to encourage the use of ICTs to facilitate and ease the transition to smart sustainable cities.

Supported by:

U4SSC is currently working on:
- Guidelines on tools and mechanisms to finance SSC projects
- Guidelines on strategies for circular cities
- City science application framework
- Blockchain 4 cities
- Guiding principles for artificial intelligence in cities
- The Impact of Frontier Technologies on Cities:
  - Artificial Intelligence and cognitive computing
  - Data processing and computation
  - Sensing technologies and IoT

United for Smart Sustainable Cities initiative
The U4SSC Initiative developed a set of international KPIs for SSC to establish the criteria to evaluate ICT´s contributions in making cities smarter and more sustainable, and to provide cities with the means for self-assessments.

Over 50 cities worldwide are already implementing these KPIs

The Case of Dubai

The Case of Singapore

Coming soon: The Case of Moscow

Coming soon: ITU Global Smart Sustainable Cities Index
Upcoming meetings

- ITU-T Study Group 5 Regional Group for Latin America (SG5RG-LATAM)
  24 October 2018, Bogotá, Colombia
- World Smart City Forum
  29 November 2018, Santa Fe, Argentina
- ITU-T Study Group 5 Regional Group for Asia and the Pacific (SG5RG-AP) meeting
  3 December 2018, Wuxi, China
- Forum on Artificial Intelligence, Internet of Things and Smart Cities
  3 December 2018, Wuxi, China
- ITU-T Study Group 20 “Internet of things and smart cities & communities” meeting
  3-13 December 2018, Wuxi, China
Bring digital to every person, home and organization to build a fully connected, intelligent 5G City.
Thank you!

For more information please contact: tsbsg5@itu.int