Radio access networks energy efficiency: standards and measurements
Standardization Initiatives for Energy Efficiency in Radio Access Networks

Mauro BOLDI
Telecom Italia Engineering & TILab
Wireless Access Innovation
Agenda of today’s talk

Introduction to Energy Efficiency in Telecom Italia
The Role of Telecom Italia and Engineering&Tilab with respect to EE
An overview of Telecom Italia and Engineering&Tilab department
Some insight on EE in Telecom Italia

ETSI Standards for EE
The Standards working on EE in ETSI EE Working Groups
Insight on ETSI EE-EEPS Specifications (ES 203 228)

Other initiatives in Standards, Conclusions
Some details on 3GPP, ITU-T and GSMA
Conclusions
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Some insight on EE in Telecom Italia
Telecom Italia is the leading Italian Telecommunications and ICT group and one of the most important player on the Brazilian market.

Italy’s ICT leader with business operations in: fixed and mobile telecommunications, internet, digital content, office and systems solutions, research and development.

**Employees**

<table>
<thead>
<tr>
<th>Employees</th>
<th>65,872</th>
</tr>
</thead>
</table>

**Customers**

<table>
<thead>
<tr>
<th>Customers</th>
<th>117,878,000</th>
</tr>
</thead>
</table>

**2013 Revenues (€)**

<table>
<thead>
<tr>
<th>2013 Revenues (€)</th>
<th>23,407,000,000</th>
</tr>
</thead>
</table>

**2013 Investments (€)**

<table>
<thead>
<tr>
<th>2013 Investments (€)</th>
<th>4,400,000</th>
</tr>
</thead>
</table>

Unless otherwise specified, all figures are as at September 30, 2014.
Focus on TILab: The History

- 1964
  - Based on Turin CSELT, Centro Studi e Laboratori Telecomunicazioni, carries out Research for Telecom Italia Group

- 2001
  - TILAB, a merger of CSELT and the BU Venture Capital & Innovation, has the goal to increase the Innovation Rate within Telecom Italia Group, consistently with the objectives of the other Business Units. These goals have been reinforced by the integration of TILAB and Telecom Italia Network Engineering Area
Telecom Italia Lab

Competence center for Telecom Italia Group’s research and development activities, taking over Telecom Italia Lab’s resources and know-how:

- Pilots technological innovation, new technology scouting, surveys, feasibility assessments and research into prototypes

- Areas of operation: fixed-line and mobile access network design and development, transmission network upgrades, service and platform development, next-generation terminal design and testing
## Wireless Innovation: main activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scouting, Benchmarking &amp; Trial access innovation</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td><em>including dissemination of results</em></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>Antennas, Electromagnetic fields, laboratories</td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>LTE/LTE Advanced radio interface evolution towards 5G</td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>Wireless access physical layer and receivers</td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td>International projects and energy efficiency</td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>Cooperation with University, Vendors</strong></td>
<td><img src="image7.png" alt="Image" /></td>
</tr>
<tr>
<td><strong>Standardization activities (3GPP, ETSI, ITU, …)</strong></td>
<td><img src="image8.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Telecom Italia confidential
Energy Efficiency in Telecom Italia – Motivation (from 2014 Sustainability Report)

- Telecom Italia is actively committed to achieve the objectives of “Digital Agenda”, developed by Italian Government to implement European directives in the framework of European Digital Agenda.

- Three strategic areas are identified by Telecom Italia to pursue the objective of Digital Agenda:
  - Digitalization, connectivity and social innovation
  - Digital culture
  - Environmental safeguard/sustainable development

- Main initiatives to promote sustainable development
  - Protect the environment
  - Improve energy efficiency
  - Reduce greenhouse effect and other polluting emissions

By means of an optimization of energy sources, continue research to improve energy performance, adoption of environmentally friendly purchase policies, spreading of a correct attitude towards environmental issues.

Agenda of today’s talk

ETSII Standards for EE
The Standards working on EE in ETSI EE Working Groups
Insight on ETSI EE-EEPS Specifications (ES 203 228)
Energy Efficiency for mobile radio access (ES 202 706 and ES 203 228)
In liaison with ITU-T and 3GPP

- The document deals with both a homogeneous and heterogeneous networks (GSM, UMTS, LTE-LTE/A) considering networks whose size and scale could be defined by
  - **topologic** (a possible example a control node, its supported access nodes as well as the related network elements)
  - **geographic** (city-wide, national or continental networks)
  - **demographic** (urban or rural networks)
### Metrics for energy efficiency assessment (ES 203 228)

#### EE\textsubscript{MN,D}

<table>
<thead>
<tr>
<th>Consumption</th>
<th>Energy EC\textsubscript{MN}</th>
<th>Wh or J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>Data volume DV\textsubscript{MN}</td>
<td>bit</td>
</tr>
</tbody>
</table>

**3GPP ref.**
- TS 36.314 § 4.1.8.1&2
- TS 32.425 § 4.4/4.5/4.10

**Time period**
- week/month/year (week granularity)

**Comment**
- EC Based on metering information
- DV Based on O&M counters at node level
- Availability/reliability as quality indicator

\[ EE_{MN,D} = \frac{DV_{MN}}{EC_{MN}} \]

#### EE\textsubscript{MN,C}

<table>
<thead>
<tr>
<th>Consumption</th>
<th>Energy EC\textsubscript{MN}</th>
<th>Wh or J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>Coverage Area</td>
<td>m\textsuperscript{2}</td>
</tr>
</tbody>
</table>

**3GPP ref.**
- TS 36.314 § 4.1.8.1&2
- TS 32.425 § 4.4/4.5/4.10

**Time period**
- week/month/year (week granularity)

**Comment**
- EC Based on metering information
- Coverage based on counters, for each RAT
- Metric to be used in rural or deep rural areas

\[ EE_{MN,C} = \frac{coverage\ area}{EC_{MN}} \]
Example of extrapolation (Italy’s demographical example)

<table>
<thead>
<tr>
<th>Demography Classification</th>
<th>Percentage of presence in the global area</th>
<th>$EE_{MN}$</th>
<th>$EE_{MN,DV}$</th>
<th>$EE_{MN,C}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense Urban (DU)</td>
<td>0.1%</td>
<td>200 b/J</td>
<td>2.7 m²/MJ</td>
<td></td>
</tr>
<tr>
<td>Urban (U)</td>
<td>5%</td>
<td>40 b/J</td>
<td>19 m²/MJ</td>
<td></td>
</tr>
<tr>
<td>Sub-urban (SU)</td>
<td>20%</td>
<td>8 b/J</td>
<td>38 m²/MJ</td>
<td></td>
</tr>
<tr>
<td>Rural (RU)</td>
<td>64.9%</td>
<td>2 b/J</td>
<td>115 m²/MJ</td>
<td></td>
</tr>
<tr>
<td>Unpopulated</td>
<td>10%</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Global EE</td>
<td></td>
<td>5.7 b/J</td>
<td>92.4 m²/MJ</td>
<td></td>
</tr>
</tbody>
</table>

- Example **without any reference to actual networks**
- Hypothesis of 2 weeks measurement in a network with a hypothetical demography distribution as in column 2; weighted measurement of the “available” sub-networks
Attention has to be paid to the selection of the sub-networks where to make the measurements, to ensure that the results are technically sound and, even if this is not the primary goal, comparable.

Of course results measured in very different environments (different in terms of demography or climatology or topography, but also different due to the goal and function of the network) are hardly comparable.

But the important issue is to introduce a method to make tests that can represent a common reference whenever a test of mobile network energy efficiency is performed over a radio access network.

An essential part of this common base method is represented by the reporting tables in clause 8.

Even if the measurements are done in very different scenarios the details of the scenarios are reported in the tables and only considering not only the final Energy Efficiency results but also how they have been obtained the test will be considered standard compliant.
Agenda of today’s talk

Other initiatives in Standards, Conclusions
Some details on ITU-T and GSMA
Conclusions
### Work areas of interest:

<table>
<thead>
<tr>
<th>Q13/5</th>
<th>Environmental impact reduction including e-waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q17/5</td>
<td>Energy efficiency for the ICT sector and harmonization of environmental standards</td>
</tr>
</tbody>
</table>

- Definition of measurement methods, metrics/KPI and reference values for different technologies
- Sharing of best practices for ICT’s energy efficiency enhancements
- Analysis of the most energy efficient architectures and solutions in support of smart grids
- Complement and harmonize ICT and environmental standards developed by other ITU Study Groups and Standardization Bodies

### Work in progress

- **L.assDC** - Assessment of energy efficiency on infrastructure in data center and telecom center
- **L.M&M_Networks** - Energy efficiency measurement and metrics for telecommunication network
- **L.NET_Infra_assessment** - Total network infrastructure Energy efficiency metrics
- **L.RBS_assesment** - Energy efficiency metrics of mobile station cell site and best practice for energy saving
GSMA and Energy Efficiency

- GSMA is actively committed in a Mobile Energy Efficiency benchmarking to measure and monitor energy efficiency in MNO networks.

- Moreover it develops also initiatives regarding MEE optimization in selected MNO networks conducting site surveys to analyze costs and benefits of EE for MNOs.

- GSMA collaborated in ETSI group for the publication of ES 203 228, jointly with ITU-T Q17/5 and in liaison with 3GPP SA5 and RAN3 groups.
Concluding remarks

- Due to the mobile ultra broadband development and the traffic explosion in recent and future years the energy efficiency for mobile networks is gaining momentum in Mobile Network Operators perspectives.

- Telecom Italia is actively committed to improve Energy Efficiency, with particular regards for Mobile Networks equipment and operations, and department Engineering & TILab is committed in those activities and in the standardization related topics.

- ETSI is developing in the TC EE standards for Energy Efficiency in Mobile Networks.

- Of particular relevance in ETSI is the ES 203 228, under joint development between ETSI EE-EEPS and ITU/T WG3 Q17/5, in liaison with 3GPP SA5 and RAN3 and in cooperation with GSMA.

Questions? Comments?
Thank you all!