Challenges of M2M in 5G

Mischa Dohler
Professor, King’s College London, UK
Fellow & Distinguished Lecturer, IEEE
Board of Directors, Worldsensing
Editor-in-Chief, ETT

KTH, Stockholm, Sweden
09/05/2014
1

M2M Usage Today
Industrial M2M Applications
M2M in Smart City Rollouts

Smart Parking

Traffic Flow

Travel Time

Smart City Control Platform

Smart Bins

Critical Infrastr.

Historic Sites

Proven Technologies With Solid Deployment Track-Record Today!
Data Access Technologies
M2M Prime Business Criteria

Availability = coverage, roaming, mobility, critical mass in rollout, etc.
Reliability = resilience to interference, throughput guarantees, low outages, etc.
(Total Cost of Ownership = CAPEX, OPEX.)
## Standardized M2M Protocol Stacks

<table>
<thead>
<tr>
<th>Application</th>
<th>Transport</th>
<th>Networking</th>
<th>MAC</th>
<th>PHY</th>
<th>Cellular M2M</th>
</tr>
</thead>
<tbody>
<tr>
<td>IETF CORE</td>
<td>Lightweight TCP, UDP</td>
<td>IETF ROLL</td>
<td>802.15.4</td>
<td>802.15.4-2006</td>
<td>LTE/LTE-A MTC</td>
</tr>
<tr>
<td>HTTP, etc.</td>
<td>TCP, UDP</td>
<td>IPv4, IPv6</td>
<td>/e Industrial Apps.</td>
<td>/f RFID</td>
<td>LTE/LTE-A Networking Layer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>802.15.4</td>
<td></td>
<td>LTE/LTE-A Link Layer</td>
</tr>
</tbody>
</table>

© 2014 Mischa Dohler
Problems of ZigBee-like Solutions

Interference in ISM
- 868 MHz
- 2.4 GHz
- 5 GHz
- 433 MHz

No Global Infrastructure

Lack of Interoperability

Higher Total Cost
Industries start to understand!

**Zigbee and Z-wave are out. Broadcom’s new chips bet on Bluetooth and Wi-Fi for IoT**

*by Stacey Higginbotham  May 29, 2013 - 1:36 PM PDT*

22 Comments  

**SUMMARY:** The wide array of wireless radio technologies used to get devices online may soon shrink as major players in the chip world start choosing the standards they will support for the internet of things.

*photo: Shutterstock / Jiri Hera*
Advantages of Low-Power WiFi

Ubiquitous Infrastructure

Number of Wi-Fi Public Hotspots in the World (in million), 2009-2015

Interference Management

NAV Medium Reservation

Vibrant Standard

300 members

Sound Security

WPA2/PSK/TLS/SSL

© 2014 Mischa Dohler
LP-Wifi vs ZigBee Capillary M2M

6LoWPAN vs. Low-power Wi-Fi at 54Mbps

<table>
<thead>
<tr>
<th></th>
<th>6LoWPAN</th>
<th>Low-power Wi-Fi</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Packet size</strong></td>
<td>8 Bytes 1024 Bytes</td>
<td>8 Bytes 1024 Bytes</td>
</tr>
<tr>
<td><strong>Time (ms)</strong></td>
<td>6 23.61</td>
<td>11.3 16.58</td>
</tr>
<tr>
<td><strong>Energy (mJ)</strong></td>
<td>2.5 9.17</td>
<td>0.55 1.28</td>
</tr>
</tbody>
</table>

“Low-power Wi-Fi provides a significant improvement over typical Wi-Fi on both latency and energy consumption counts.”

“LP-Wifi consumes approx the same as 6LoWPAN for small packets but is much better for large packets.”

© IEEE, from “Feasibility of Wi-Fi Enabled Sensors for Internet of Things,” by Serbulent Tozlu (2011)
Advantages of LPWA M2M Networks

Large Coverage

Low Cost

Available Today

Operator Model
Current Eco-System

**Sigfox** (market leader in Q1 2014):
- **technical**: sub-GHz, UNB, very long range, one-way
- **business approach**: operator, yearly license fee; €20+ million VC

**On-Ramp:**
- **technical**: 2.4GHz ISM band; “Random Phase Multiple Access”; 170dB link budget
- **business approach**: equipment provider mainly; Managed Service SLA possible

**Cycleo (now Semtech):**
- **technical**: sub-GHz, CDMA-based, long range
- **business approach**: equipment provider

**Neul:**
- **technical**: initially TVWS only; now shift into other bands too (notably licensed!)
- **business approach**: originally only equipment; now SLA possible
Performance Comparison

© Orange, excerpt from PhD Thesis of Dr Quentin Lampin:

15 years lifetime

LPWA Network

Mesh Network
3

M2M (MTC) in 5G Cellular Systems
Advantages of Cellular M2M

Ubiquitous Coverage

Mobility & Roaming

Interference Control

Service Platforms

© 2014 Mischa Dohler
Creation of oneM2M Partnership project
5G HetNets M2M Architecture
5G M2M: Dealing with Scalability

![Graph showing data success probability vs. number of clustered MTC devices.](image-url)
5G M2M: Dealing with Lifetime

![Graph showing lifetime vs number of clustered MTC devices](image)

- From 656 down to 625 days: \( \approx 492 \) days
- \( \approx 17 \) days
- \( \approx 3 \) days

- **Only eNB**
- **eNB+HeNB**
5G M2M: Dealing with Delay

© Massimo Condoluci, Mischa Dohler, Antonella Molinaro, Giuseppe Araniti

© 2014 Mischa Dohler
Concluding Remarks
Closing the Data Cycle

BIG DATA Analytics

Knowledge
Information
Raw Data

Data Collection → Data Processing → Data Actuation

Machine-to-Machine
Sensor Streams

Human-to-Machine
Crowdsourcing

Information-to-Machine
Internet

Improve Efficiency
Offer New Services
Power Applications

Data Feedback
M2M in 5G

Mischa Dohler
Professor, King’s College London, UK
Fellow & Distinguished Lecturer, IEEE
Board of Directors, Worldsensing
Editor-in-Chief, ETT