G3-PLC 500 kHz for Smart Metering

Dr. Michael Koch
Vice President Strategic Positioning
From the startup to the worldwide market leader in powerline solutions

devolo AG, Germany – subsidiaries
- devolo Asia Consulting Ltd.
- devolo Austria GmbH
- devolo Benelux bvba
- devolo France SARL
- devolo Schweiz GmbH
- devolo Spain SL
- devolo UK Ltd.

Further focused sales areas
- Italy, Portugal, Poland, Greece and Scandinavia (SE, NO, FI, DK, IS)
- Others currently under development
Three business units for the future

2013

2014

2015

Home Networking
B2C / B2B

Home Control
B2C / B2B

Smart Grid
B2B
Smart Metering Szenario

Typical application of the Access PLC for the Smart Grid Scenarios
Comparison of PLC Technologies

+ already available as PLC EMC standard: EN 50065
+ separate frequency band for energy supply company and private use

- low data rates
  - small frequency spectrum for PLC transmission
  - poor transmission channels as general EMC filtering is only above 150 kHz
- interaction with other devices, such as e.g. inverters and capacitive switches
Comparison of PLC Technologies

+ high data rates
- range ideal for in-house transmission, insufficient in the access area
- the need for repeaters harms business plans

→ devolo's concept for in-house PLC

<table>
<thead>
<tr>
<th>Distance</th>
<th>CENELEC-Band</th>
<th>150-500 kHz-Band</th>
<th>PLC above medium wave radio broadcast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency in kHz</td>
<td>3</td>
<td>150</td>
<td>500</td>
</tr>
</tbody>
</table>
Comparison of PLC Technologies

+ high coverage and long range: longest transmission distance 1.7 km (measured in field tests; limited by infrastructure)
+ significantly higher data rate compared to CENELEC band, but lower than in the band above medium wave radio broadcast

→ devolo's concept for IP-based communication in PLC Access Networks/Smart Grid applications
G3-PLC road to an international standard

- May 2008: International contest for the design of G3-PLC (Launched by ERDF)
- Oct 2009: G3-PLC first field tests on 5 nodes – Presentation of the results at Metering Barcelona

- Sep 2011: Creation of the G3-PLC Alliance with 12 founding members
- Dec 2011: G3-PLC ITU standard – G9955 and G9956
- Successful interoperability tests

- G3-PLC ITU T standard – New version G 9903 (Cenelec A, FCC, ARIB)
- Clarifications and enhancement brought by IOT
- Development of the certification processes

- Feb 2014: First interim certificates, Arib band
- Apr 2014: G3-PLC ITU Standard (Cenelec A, FCC, ARIB)
- Aug 2014: Official certification

Source: G3-PLC Alliance
IP-Access Powerline for Smart Grids

Field trials by Vattenfall and devolo in Hamburg and Berlin

- IP-based PLC in real time
- High-speed with long distances by usage 150-500 kHz
- Fast, reliable performance
Field Trial in Hamburg Bramfeld

**Goals of Test**

- Determination of round trip delay time
- Determination of bandwidth in the physical layer
- Calculation of bandwidth in the application layer
- Accessibility of the nodes
- Channel measurement
- Analysis of the lead time for parametrizing and firmware upload to the meters

**Description of Environment**

- Typical environment of urban grid
- High concentrated grid
- Distance between the nodes: min. 200 m
- Installation of one access point in a substation
- Installation of 22 nodes at customers’ premises
- Test only with synthetic data
Performance Test Results

**PLEASE NOTE:**
Achieved data rates are on application layer - physical layer data rates are nominally much higher.
G3-PLC based Fieldtrials with Vattenfall

Berlin Trials

- **Aim**
  Evaluation of data rates, distances and channel characterization of G3-PLC 500k in areas where CENELEC-PLC failed due to difficult power grid conditions.

- **Locations**
  - Berlin, Märkisches Viertel: Extensive domestic complex.
  - Berlin, Hohenschönhausen: Multi dwelling unit
  - Berlin, Kaulsdorf: Low voltage overhead wire.

- **Results**
  - Stable communication connections
  - Data rates of up to 70 kBit/s payload UDP
  - The achieved distances were by far longer than expected.

Next step: >1000 industrialized products will be tested in the biggest two cities of Germany (Berlin, Hamburg)!
G3-PLC based Fieldtrials with Vattenfall – Berlin Results

Flat buildings with 20 floors

<table>
<thead>
<tr>
<th>Throughput [kBit/s]</th>
<th>Meter 1</th>
<th>Meter 2</th>
<th>Meter 3</th>
<th>Meter 4</th>
<th>Meter 5</th>
<th>Meter 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>max:</td>
<td>84</td>
<td>83</td>
<td>82</td>
<td>79</td>
<td>81</td>
<td>82</td>
</tr>
<tr>
<td>avg:</td>
<td>79</td>
<td>81</td>
<td>76</td>
<td>73</td>
<td>53</td>
<td>77</td>
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<tr>
<td>min:</td>
<td>60</td>
<td>74</td>
<td>56</td>
<td>45</td>
<td>22</td>
<td>59</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Round Trip Delay [ms]</th>
<th>Meter 1</th>
<th>Meter 2</th>
<th>Meter 3</th>
<th>Meter 4</th>
<th>Meter 5</th>
<th>Meter 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>max:</td>
<td>513</td>
<td>469</td>
<td>474</td>
<td>503</td>
<td>1267</td>
<td>574</td>
</tr>
<tr>
<td>avg:</td>
<td>433</td>
<td>426</td>
<td>437</td>
<td>448</td>
<td>650</td>
<td>441</td>
</tr>
<tr>
<td>min:</td>
<td>418</td>
<td>417</td>
<td>427</td>
<td>426</td>
<td>490</td>
<td>419</td>
</tr>
</tbody>
</table>
System requirements of the Commission
Recommendation of 9.3.2012, C(2012) 1342 on preparations for the roll out of smart metering systems

- (10) *Data protection and information security features should be built into smart metering systems before they are rolled out and used extensively.* Such features can effectively improve consumers’ control over the processing of personal data.

- (11) … to stimulate and support introduction of the ‘*security and data protection by design*’ principle at an early stage in the development of smart grids, particularly for the roll-out of smart metering systems.

- (15) *An assessment of the data protection impact carried out by the operator* and stakeholders prior to the roll-out of smart metering systems will provide the information necessary in order to take appropriate protective measures. Such measures should be *monitored and reviewed throughout the lifetime of the smart meter.*

→ German concept: Introduction of a Smart Meter Gateway (SMGW)
Overview of Smart Metering System in Germany

Security and Privacy are ensured by the Smart Meter Gateway
- Protection of confidentiality, authentication, integrity of data
- End-to-End Security
- Information flow control

→ Requirement for higher data rates than without security/protection
devolo’s access technology approach based on G3-PLC 150-500 kHz has a very high potential as communication infrastructure for smart metering systems and other Smart Grid applications

- Support of IP-traffic
- Data rates observed during the field trials are typically higher than 50 kBit/s (payload TCP)
- This is above present estimations for data rates requirements for metering systems and Smart Grid application.
- With it’s coverage and the observed distances, repeaters are generally not necessary.
- Data transmission is robust against interferences on the power grid.
- No interferences have been observed against other systems.

- System requirements on security and data protections increase data rates requirements.
  - CENELEC PLC systems cannot meet these requirements.

Next step: >1000 industrialized products will be tested in the biggest two cities of Germany (Berlin, Hamburg)!
devolo G3-PLC Modem 500k

Reliable data transmission in Smart Grids

G3-Powerline technology for efficient communication on smart grids.

G3-PLC uses your existing power grid to transmit data from smart meters, infeed renewable energy sources and grid status measurement.

Powerline is the essential technology to build up a smart grid in your municipality.

„We have extensively tested devolo’s G3-PLC Modem 500k prototype. Our expectations have been greatly surpassed. That’s why we run a large field test with devolo’s serial product.“

Jan-Philipp Blenk
Project Manager Vattenfall Europe Metering GmbH
Thank you very much for your attention.