Communication Technologies for Smart Grid

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Communication Technologies

• Wireless
  – RFID ( LF/HF/UHF )
  – Low Power RF ( Zigbee, 6LowPAN, W-MBUS )
  – GSM/GPRS
  – Bluetooth / Bluetooth Low Energy
  – WiFi

• Wired Communication
  – RS485
  – Power Line Communication
    • SFSK, OFDM, DPSK, Proprietary
Regulations  Unlicensed ISM/SRD bands

USA/Canada:
- 260 – 470 MHz (FCC Part 15.231; 15.205)
- 902 – 928 MHz (FCC Part 15.247; 15.249)
- 2400 – 2483.5 MHz (FCC Part 15.247; 15.249)

Europe:
- 433.050 – 434.790 MHz (ETSI EN 300 220)
- 863.0 – 870.0 MHz (ETSI EN 300 220)
- 2400 – 2483.5 MHz (ETSI EN 300 440 or ETSI EN 300 328)

Japan:
- 315 MHz (Ultra low power applications)
- 426-430, 449, 469 MHz (ARIB STD-T67)
- 2400 – 2483.5 MHz (ARIB STD-T66)
- 2471 – 2497 MHz (ARIB RCR STD-33)

India:
- 2400 – 2483.5 MHz (FCC Part 15.247; 15.249) ?
- 865 – 867 Mhz ?

**ISM** = Industrial, Scientific and Medical

**SRD** = Short Range Devices
Challenges / Recommendations

• Scope of projects to be clearly defined

• Standardization across Utilities for AMR / AMI

• Infrastructure – Variation in Use Cases ( Rural / Urban )

• **Open to Hybrid technologies** – Successful Pilots
  – HAN ( 2.4G ), NAN ( Sub 1G / PLC ), WAN ( GSM/GPRS )

• Accountability / Ownership of Network Maintenance
  – Collaboration amongst Meter OEM, Utility, IT
The industry’s broadest wireless connectivity portfolio:

<table>
<thead>
<tr>
<th>Supported standards</th>
<th>13.4KHz / 13.56MHz</th>
<th>Sub 1GHz</th>
<th>2.4GHz to 5GHz</th>
<th>Satellite</th>
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</thead>
<tbody>
<tr>
<td>RFID, NFC, ISO14443A/B, ISO15693</td>
<td>SimpliciTI 6LoWPAN W-MBus</td>
<td>Proprietary 2.4GHz PurePath Wireless</td>
<td>ZigBee® 6LoWPAN RF4CE</td>
<td>Bluetooth® technology Bluetooth® low energy</td>
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<td>GPS</td>
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**Example applications**

**Product line up**

| TMS37157 TRF796x TRF7970 | CC1110 CC430 CC1190 CC11xL CC1120 CC1180 | CC2500 CC2543 / 44 / 45 CC2590 / 91 CC8520 / 21 CC8530 / 31 | CC2530 CC2530ZNP CC2531 CC2533 CC2520 | CC2560 / 7 CC2540 / 1 CC2570 / 1 | WL1271 / 3 CC3000 | CC4000 |

Red = SimpleLink family of self-contained, wireless connectivity solutions
Power Line Communication
A rapidly emerging technology enabling the Smart Grid

• Power Line Communications Refers to a Method of Narrow Band Communications that uses the *Existing* Power Lines as the Communication Medium

• Based on S-FSK or OFDM

• Reduces System Cost

• Increases System Reliability
PLC Frequency Bands, Stds and Regulations

• PLC frequency bands in Europe
  – Defined by the CENELEC:
    • CENELEC-A (3 kHz – 95 kHz) are exclusively for energy providers
    • CENELEC-B, C, D bands are open for end-user applications
  – Bands A, B and D protocol layer is defined by standards or proprietarily defined
  – Band C is regulated – CSMA access

• PLC frequency bands in USA
  – Single wide band – from 150 to 450 kHz
  – FCC band 10 kHz – 490 kHz
  – Access protocol defined by standard
  – HomePlug broadband: 2–30 MHz

• PLC frequency bands in Japan
  – ARIB band 10 kHz – 450 kHz

• PLC frequency bands in China
  – 3–90 kHz preferred by EPRI
  – 3–500 kHz single-band not regulated

Standards
✓ Prime
✓ G3
✓ IEC 61334

Regulations
✓ CENELEC
✓ FCC
✓ ARIB
PLC for Smart Grid AMI Worldwide

• Countries with PLC deployment for Smart Grid
  – **Spain** (PRIME on CENELAC band)
  – **France** (G3 on CENELAC band)
  – **Taiwan** (G3 on FCC band)
  – **Korea** (IEEE P1901.2 on broadband)

• Countries with PLC pilots deployment for Smart Grid
  – **China** (SFSK on EPRI band)
  – **Mexico** (PRIME on CENELAC band)
  – **Japan** (ITU-T G.9955 on ARIB band)
  – **Turkey** (G3 on CENELAC band)
  – **Poland** (PRIME on CENELAC band)
  – **USA** (Propreitry for Home Plug)
Power Line Communication Challenges

• Frequency dependent attenuation
  – Line Attenuation due to conductor material properties and branching
  – Echos and interference due to Multipath propagation.

• Noise due to Loads
  – Colored background noise due to Computers, Dimmers, Hair Dryers
  – Narrowband Interference
  – Synchronous periodic impulsive noise from Thyristor based DC power supplies
  – Asynchronous periodic impulsive noise due to switching transients
  – Asynchronous impulsive noise in Industrial environments due to Arc welding etc.

The latest PLC technology based on OFDM is looking to be well immune to all the above factors.
PLC for AMI in India - Readiness

• The conclusion from initial level field tests done by TI in India is that “Latest PLC technology should work well in Indian conditions.”

• In some cases like High Rise Buildings, PLC is the only viable solution for Meter to In-Home Display (HAN) communications.

• Suppliers and utilities need to come together to carry forward more varied field tests in different scenarios to finalize on the following:
  – Which PLC standard works best in Indian Conditions?
  – Which Frequency Band works in Indian Conditions?

• Deployment and Commissioning of PLC Networks for AMI will be easy as it requires only the replacing the existing E-Meters with PLC enabled meters.

• For Neighborhood area networks (NAN), the data concentrators can be installed at Distribution transformers which may connect to the substation using GSM/GPRS.
TI Offering for PLC

**Power Line Modem Developer’s Kit (TMDSPLCKIT-V3)**
Enables easy development of Software Based PLC Modems. Kit includes 2 PLC Modems, software supporting OFDM (PRIME/G3 & FlexOFDM) and SFSK communication.

**PLC - System On Module (SoM)**

**Smart Grid Infrastructure Evaluation Module**
*TMDSSGI-EVML138 – Grid Infrastructure*
Development tool for next generation Data Concentrators And Power Analytics devices. The OMAPL138 processor is Featured for Control, Communication and Signal Processing. Support for several communications including Ethernet, PLC, RF, RD232, USB and CAN.
THANKS