Panel Session: Standardization

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Two Main Technologies Driving Narrow Band OFDM PLC Standardization (PRIME, G3)

Three Main Technologies Driving Broad Band Standards OFDM PLC Standardization (HPAV, HD-PLC, G.hn)

- PLC Standards completed in 2010
  - IEEE 1901 Broad Band (Megahertz)
  - ITU G.hn Broad Band (Megahertz)
- PLC Standards under development (Examples)
  - IEEE 1901.2 Narrow Band (KHz)
  - ITU G.hnem Narrow Band (KHz)
  - IEC / Open Meter Narrow Band (KHz)
  - SAE J2931 Auto Electric Vehicle PLC Communication
  - ISO 15118 Auto Electric Vehicle PLC Communication
  - ETSI PLC for home automation
IEEE1901.2 NB OFDM PLC Standard Efforts

- Based on two new technologies getting broad global support
  - PRIME
  - G3-PLC

- Extensive testing of base technologies completed, with additional tests underway

- Concentrated areas within IEEE 1901.2
  - EMC, with potential to expand frequency bands in Europe from 95kHz to 500 kHz
  - End User Technical Requirements, further define PLC Smart Grid global requirements
  - Channel Models ad hoc committee – to characterize various PLC grid scenarios
  - IPPAL / IPv6 – development to optimize MAC for upper layer networking (RPL, etc)
  - Coexistence – committee to ensure coexistence mechanisms with SDO backed PLC
  - PHY/MAC 500 – concentrating on base technologies and optional features to support
    - Added modulation
    - Added constellations
    - Added MAC networking considerations
IEEE 1901.2 NB OFDM PLC

Automotive Testing Scenario

• EUTR
  • SAE J293
  • SAE J2847
  • ISO 15118

• EMC
  • CISPR Testing

• Channel Model
  • PWM – 1772 Specification

• IPPAL
  • IPv6, Smart Energy Profile 2.0

• Coexistence
  • Tests with multiple PLC technologies on line

• PHY/MAC 500
  • Optimized parameters for most robust solution
Automotive Companies Involved With Testing
NB PLC IEEE 1901.2 (Motorcycles Coming!)
Example EMC Testing

![EMC Testing Graph]

- **CKC Laboratories, Inc.**
- **Date**: 9/12/2009
- **Time**: 11:35:20 AM
- **WO#:** 90010
- **Maxim Integrated Products**
- **RE310-15-28MHz-Level 2-Limit B-QP**
- **ES-XW7T-1A278-AC**
- **Date Issued**: October 10 2003
- **MAX2991 EV Kit**

![IEEE ISPLC 2011 Logo]
Auto Channel Model Example
100A DC Charging Japan ARIB Band BPSK

Switching frequency harmonics @ 140KHz, 210KHz, 280KHz...
It will be better to use high frequency band between 250KHz-450KHz to get better performance.
ARIB Data rate = 21Kbps in ROBO mode and 85Kbps in Normal Mode
Auto Channel Model Example
250A DC Charging Japan ARIB Band BPSK

69KHz Switching frequency harmonics in the communication band. The harmonics are 20dB stronger than the OFDM signal. 300KHz-450KHz special frequency band to reduce the no. of harmonics in communication band. Data rate = 11Kbps in ROBO mode with 5% retransmission - within ARIB Band BPSK.
SAE 1772 Plug
Auto Channel Model Example

Pilot Line Communications

Scope plot EVSE side CPLT line, CPLT signal off, PLC off:

Spectrum [2MHz] at EVSE side CPLT line, CPLT signal off, PLC off:

Spectrum [50MHz] at EVSE side CPLT line, CPLT signal off, PLC off:

Date: 23.FEB.2011 15:39:11
Auto Channel Model Example

Pilot Line Communications

Scope plot EVSE side CPLT line, CPLT signal on, PLC off:

Spectrum [2MHz] at EVSE side CPLT line, CPLT signal on, PLC off:

Spectrum [50MHz] at EVSE side CPLT line, CPLT signal on, PLC off:
Auto Channel Model Example

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Auto Channel Model Example

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Scope plot EVSE side CPLT line, CPLT signal on, PLC on

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Spectrum [50MHz] at EVSE side CPLT line, CPLT signal on, PLC on
Conclusion

• Narrow Band OFDM PLC is under aggressive, test, study and deployment by main global auto and industrial manufacturers, thanks to pioneering PLC technologies from PRIME and G3-PLC

• IEEE 1901.2 NB PLC standard effort is very successful, well attended by dozens of key industrial stake holders with over 300 documents in Mentor (many of most recent – dedicated to channel models)
Thanks

• IEEE Communication Society
• Dr. Stefano Galli
• Founding Members of IEEE 1901.2
  • Landis & Gyr
  • Aclara
  • Sagem Communications
  • Texas Instruments
  • Maxim Integrated Products