Street Light Control and Smart City Application, using HD-PLC

Intelligent Solutions made by iciti
Matthias Lürkens is acting as Chief Technical Officer at LVX Global Deutschland GmbH since May 2021.

In that role he is designing the communication architecture for Smart City and Streetlighting products at LVX. He is taking an active role in creating new standards together with observing and adopting existing standards.

He is having a diploma in electrical engineering from the RWTH Aachen in Germany. Since more than 30 years he is specialists for communicating embedded systems, which got the name IoT.

At LonMark International he is chairman of the Technical Committee. In this role he is participating in evolving the ISO/IEC 14908 control network protocol standard. He is having a world leading know how in 14908 and is coauthor of the 14908-7/8/ standards. As a DIN member he is delegated into CEN TC247WG4 (Open System Data Transmission for Buildings) and in that role liaison manager to ISO/IEC JTC1/SC6 (Telecommunications and information exchanges between systems).
Through technology we use existing infrastructure to enable the benefits of smart cities and buildings to be realized. iciti is efficient tech for smart city solutions, it provides proven and robust NB-PLC and HD-PLC technology as well as RF-MESH and IP communication. For Smart City Infrastructures it reduces risk, saves energy, and leads to reduction of maintenance and associated costs. The standardized interoperable iciti product system solution offers future and investment security because it is independent of specific manufacturers.

FireM is an IoT Technology enabled engineer-led end-to-end solution that identifies and maps the location of events within a building and interfaces to any fire, security or building management system.

Norman Asset Delivery consults to clients in the resources, property and public infrastructure sectors offering services such as, engineering, project management, design management and authority approvals. With extensive experience and outstanding industry relationships Norman Asset Delivery ensures clients successful delivery of assets.

The Smart Cities Council, the world’s largest smart cities network, envisions a world where innovation, technology and data leverages smart, sustainable cities with high-quality living and high-quality jobs. The Smart Cities Council serves as an objective and neutral network for sharing knowledge and accelerating projects.
Long Investment Cycles, 20 years

- Open/Public standards required
- Long implementation
- No vendor or technology lock in
- Growing projects
- Technology independence
- Future safety

Open/Public standards required
Long implementation
No vendor or technology lock in
Growing projects
Technology independence
Future safety
Integrated Multi-functional Humble Lamp Post

- Smart Lighting
- Digital Signage
- Submetering
- Noise Indication & Map
- CCTV
- Environmental Sensors
- Smart Parking
- Vehicle Charging
- Intercom
- Public Announcements
- Waste Management
- Connectivity for Edge Gateways / Public WiFi

WSPLC 2023

DIN SPEC 91347
ISO/IEC 14908 – Control Network Protocol, Applications

Outdoor Luminaire Controller (OLC)

Mandatory Network Variables

Vorgeschriebene Netzwerkvariablen

- nvl
- nvl1
- nvl2
- nvl3
- nvl4
- nvl5
- nvl6

Configuration Properties

Konfigurationswerte

- cpMaxSendTime
- cpMinSendTime
- cpBkpSchedul
- cpLampPower
- cpEnableStatusMsg
- cpDeviceOutSelect
- cpDimLowLevelLight
- cpWarmUpTime
- cpMaxLevelVolt
- cpOLCLimits
- cpPeerUpState

New York Metro

Luggage transport system at Oslo Airport

Acela Highspeed Train

Building automation

Modular equipment for hospital beds

> 30,000 petrol stations in Europe

Emergency lighting on large airports e.g. Dubai

Fire protection systems on ships

Tap control

Building automation

Emergency lighting on large airports e.g. Dubai
## ISO/IEC 14908 – Protocol Structure

<table>
<thead>
<tr>
<th>ISO/OSI Layer</th>
<th>Cloud</th>
<th><strong>MQTT / REST</strong> (IAP = IoT Access Protocol)</th>
<th><strong>ANSI/CTA 709.10</strong> (NWIP for EN 14908-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6,7</td>
<td>Application / Presentation</td>
<td>Network variables / explicit messages / network management</td>
<td>ANSI/CTA 709.5 &amp; 709.6 EN 14908:5 &amp; 14908:6</td>
</tr>
<tr>
<td>5</td>
<td>Session</td>
<td>Request / Response</td>
<td>ISO/IEC 14908-1</td>
</tr>
<tr>
<td>4</td>
<td>Transport / Authentication / Transaction</td>
<td>Acknowledged / Unacknowledged / Repeated</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Network</td>
<td>Addressing / domain / subnet / node / group / broadcast</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>MAC / Link</td>
<td>Framing / CRC / Data / Encoding</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Physical</td>
<td>Wire / Ethernet / Powerline / RF / Optical</td>
<td></td>
</tr>
</tbody>
</table>

- **Open International Standard**
- **License free**
- **LON protocol stack open source**
- **Ongoing Development**
- **Transparent Routable**
- **Hardware Independent**
- **Multiple Vendors** (Products & Core Technology)

### Technical Details

- **Free Topology**: ISO/IEC 14908-2
- **Narrowband Powerline**: ISO/IEC 14908-3
- **IP-Tunneling**: ISO/IEC 14908-4
- **Internet Protocols**: 709.7 & 14908-7
- **CNP/HD-PLC**: 709.8 & 14908-8
- **RF**: 709.9 & 14908-9
Where do we come from: NB-PLC according EN 14908-3 and EN 50065-1

Narrow Band Power Line Communication

- Bandwidth approx. 5 kBit/ sec
- Band B & C (95-125 kHz & 125-140 kHz)
- Repeating technology for robust data transmission
- Typical max. 5 repeaters
- Single source neuron chip (Echelon, now Renesas)
- (ENEL smart meter project Italy)

Frequency range according EN 50065-1
Communication technologies at a glance
### Performance

<table>
<thead>
<tr>
<th>Powerline</th>
<th>Direct IP</th>
<th>sub GHz</th>
<th>2.4 GHz</th>
<th>Cellular</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD-PLC</td>
<td>NB-PLC</td>
<td>fiber optics</td>
<td>LoRa</td>
<td>802.15.4</td>
</tr>
<tr>
<td>distance</td>
<td>&gt;10 km</td>
<td>&gt;10 km (Mesh)</td>
<td>80 km</td>
<td>10km</td>
</tr>
<tr>
<td>throughput</td>
<td>&gt; 40 Mbit/s</td>
<td>5-240 kbps</td>
<td>Gigabit</td>
<td>50 kbit/s</td>
</tr>
<tr>
<td>mesh</td>
<td>yes</td>
<td>possible</td>
<td>no (star/bus)</td>
<td>no</td>
</tr>
<tr>
<td>peer to peer</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>latency</td>
<td>5 ms</td>
<td>&gt; 50 ms</td>
<td>us</td>
<td>high</td>
</tr>
<tr>
<td>packets/sec</td>
<td>high</td>
<td>&lt;20</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>encryption</td>
<td>AES (AES)</td>
<td>IP based</td>
<td>AES</td>
<td>AES</td>
</tr>
<tr>
<td>battery powered</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>device cost</td>
<td>low</td>
<td>low</td>
<td>high</td>
<td>very low</td>
</tr>
<tr>
<td>licensed</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>traffic limit</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>recurring costs</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
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<tr>
<td>Standards</td>
<td>IEEE 1901</td>
<td>ITU-T G.9903</td>
<td>IEEE 802.3xxxx</td>
<td>proprietary</td>
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<tr>
<td>Openness</td>
<td>high</td>
<td>mid</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>Body</td>
<td>IEEE</td>
<td>G3-PLC alliance</td>
<td>IEEE</td>
<td>Semtech</td>
</tr>
<tr>
<td>HD-PLC alliance</td>
<td>proprietary</td>
<td>WISUN</td>
<td>CSA (Matter)</td>
<td>WiFi Alliance</td>
</tr>
<tr>
<td>WiFi Alliance</td>
<td>Bluetooth 5/G</td>
<td>Thread Group</td>
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<tr>
<td>WiFi Alliance</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
CNP/HD-PLC = ANSI/CTA 709.8 & EN 14908-8

- Up to 10 hops
- Long distances
- Media independent
- 1024 Devices
- Low latency
- Running on HD-PLC silicon
- Ethernet

- 2 relays
- Dimmable ballasts
- DALI / 1-10V / PWM
- Energy measurement
Situation
• No light control
• Bad 4G coverage at the coast promenade and the shore
• No mobile internet for tourists
• Low attractiveness

Solution
• HD-PLC based street light control
• Public WiFi access points for public internet
Situation
• No light control
• Bad 4G coverage in the city centre
• No mobile internet for tourists
• Low attractiveness

Solution
• HD-PLC based street light control
• Public WiFi access points for public internet
LED Catwalk, Berlin, Germany

**Situation**
- Testing of future street light function
- High reliability
- Low latency
- High speed

**Solution**
- > 70 HD-PLC light controllers
- Multiple luminaire types connected
- Local control implemented on edge server
- Reference platform and benchmark for future light projects in Europe uses HD-PLC

https://www.led-laufsteg.de/

https://www.youtube.com/watch?v=aLHHPT9csyo
Wiring is a challenge, each clamp is attenuation
Gen4 Benefits

**GENERAL**

- Scalable network performance
  - Faster / Slower
- Successor for NB-PLC
  - X4/5/6/7 much faster than 5 kbit/s with 14908-3
  - Faster than G3-PLC
- Better security due to 802.1X
- Improved interoperability of diagnostics commands

**IOT DEVICE**

- Simpler designs
  - Gen3 BGA->Gen4 QFN
- **MORE I/O ON HDPLC SILICON**
  - **SIMPLER DESIGN OF HD-PLC IOT DEVICES**
- Single Chip design
- Better SW infrastructure
  - Easier integration of automation protocols like LON, BACnet, Modbus/TCP and others
- Less power consumption
- Cheaper
Gen4 Test

- Teststreet with poles with a distance around 30m
- Gen3 didn’t work
- Gen4 covered the whole distance of 163m with a PHY rate between 4 and 7 Mbit/s
- No hops needed
Thank you for your attention

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