Cost Effective IP-Based High-Speed Wireline Communication Technology

Breaking Though Cost Barriers

- Renewable Energy
- Smart Cities Streetlighting
- Commercial & Residential Buildings
- Internet of Things
Shout Out

David Kniepkamp - Presenter
President
Smart Controls LLC

Michael Navid - Contributor
CEO & Founder
Ecolinqx

MegaChips – Technical Contributions
Jump On It!

- Urbanization Increasing
- Energy Demands
- Healthy Workspace
- Safe Workspace
Onwards & Upwards!

North America Smart Building Market Size, 2018-2029 (USD Billion)

www.fortunebusinessinsights.com
Opportunity Knocks!

50 Billion by 2025
Connected Devices*

$4+ Trillion
Revenue Opportunity

25+ Million
Applications

5+ Billion
Connected People

50+ Trillion
GBs of Data

*Statista 2021
Get Your Game On!

- Higher bandwidths
- Support more nodes
- Longer range
- IP-Based
- Security at every node

- Fast response times
- Standards based
- Multi-source
- Interoperable
- Low deployment cost
Hybrid Control

- Wireless
- Serial
- Narrow-Band Power Line
- Ethernet
Wireless Solutions

- Zigbee
- Z-Wave
- EnOcean

Convenience
- Quickly Install
- Plug-and Play Autodiscover
- Mesh Networking

Performance
- Data Rates – 250kbps (ideal)
- Line-of-Site
- Range Limitations
- Interference
Wired Solutions

- BACNET
- MODBUS
- LONWORKS

Convenience
- Serial – Long Distance
- Ethernet – Fast Data Rates
- NB Power Line – Easy Install

Performance
- Serial – Slower Data Rates
- Ethernet - Costly
- NB Power Line – Sized Limited
Challenges

▪ Islands of Automation Created by Multitude of Communication Protocols and Media

▪ Reduce the Cost and Complexity of Deployment
Tasks to Overcome

- Integration of Control Networks
- Convergence of OT with IT
- Distribution of Intelligence Across Endpoints
- Standardized and Interoperable Communication Network
Advantage of HD-PLC

- Megabit Data Rates
- Ranges Up to Several km
- Up to 1024 Nodes
- Crypto-Strong Encryption
- IP-Based Mesh Networking
- Over ANY Wire
This chart shows how HD-PLC stacks up against other wireline technologies. With multi-hop technology, HD-PLC is able to deliver broadband speeds over the long distances one normally expects to find in only low speed approaches like RS-485.
Avoiding Noise

The diagram illustrates the level of noise in Narrowband PLC, Broadband PLC, and HD-PLC band frequencies. The noise level decreases significantly from Narrowband PLC to Broadband PLC, and the decrease continues further in HD-PLC, indicating effective noise reduction strategies in higher frequency bands.
What is HD-PLC?

Advanced Wireline Communication Technology Delivering Long-Range, Secure, Bi-directional, IP-based, High-Speed Communication over ANY WIRE.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>IEEE1901-2020, &amp; ISO/IEC14908-8</td>
</tr>
<tr>
<td>Frequency Band</td>
<td>2 – 125MHz</td>
</tr>
<tr>
<td>Modulation</td>
<td>Flexible Channel Wavelet OFDM</td>
</tr>
<tr>
<td>Transmission PHYRate</td>
<td>1Gbps</td>
</tr>
<tr>
<td>Access Method</td>
<td>CSMA/CA, Dynamic Virtual Token Passing</td>
</tr>
<tr>
<td>Security</td>
<td>AES 128-bit Encryption</td>
</tr>
<tr>
<td>Error Correction</td>
<td>Reed-Solomon/LDPC-CC</td>
</tr>
<tr>
<td>Coexistence</td>
<td>ISP (Inter-System Protocol)</td>
</tr>
<tr>
<td>Routing</td>
<td>CMSR (ITU-T G.9905)</td>
</tr>
<tr>
<td>IP Support</td>
<td>IPv6 (IETF)</td>
</tr>
</tbody>
</table>
IEEE1901-2020: Flexible Channel Wavelet OFDM

Single Standard – World of Applications

- Longer Range
  - 4 Channels at 62.5Mbps
  - 4 Channels at 125Mbps
  - 4 Channels at 250Mbps
- High Speed
  - 2 Channels at 500Mbps
  - 1 Channel at 1Gbps

15 User Selectable Frequency Channels
ITU-T G.9905 Centralized Metric-Based Source Routing Extends Range, Robustness & Scalability

**MULTI-HOP CAPABILITY**
Extends range up to 10x; supports distances up to several km; scalable up to 1024 nodes

**MESH NETWORKING**
Selects best route based on link quality; improves coverage and system robustness

**INDUSTRIAL-GRADE PERFORMANCE**
Ideal for time-varying transmissions; low control overhead; routing load independent of number of nodes
HD-PLC Multihop Route Construction
<table>
<thead>
<tr>
<th>Feature</th>
<th>HD-PLC</th>
<th>RS-485</th>
<th>ETHERNET</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY Speed (bps)</td>
<td>500M</td>
<td>100k</td>
<td>10M/100M/1G</td>
</tr>
<tr>
<td>Max Range (m)</td>
<td>2,000+</td>
<td>1000+</td>
<td>100</td>
</tr>
<tr>
<td>No. of Nodes</td>
<td>1024</td>
<td>64</td>
<td>100</td>
</tr>
<tr>
<td>Free Topology</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>IP-Based</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>High Security</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Ether and Serial Bridging</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Repeating</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Wire Type</td>
<td>Any wire</td>
<td>Twisted pair</td>
<td>CAT5</td>
</tr>
</tbody>
</table>
Integrating Islands of Automation
Simple Bridging Enables System Convergence

- Ethernet Extender
- Ethernet ↔ RS-485
- RS-485 ↔ RS-485
- Power-over- COAX (PoC)
- Power-over Ethernet (PoE)
- Wireless Bridge
Key Takeaways

- HD-PLC is the most advanced high-speed wireline communication standard for Smart Cities
- Based on IEEE1901-2020 PHY/MAC, and ITU G.9905 routing standards
- Adopted by ISO/IEC 14908-8 Standard for High-Speed Wireline Communications and Control Networks
- Provides higher data rates, more security, and wider coverage than RS-485
- Provides longer range, IETF IPv6, higher # of nodes, and lower cost than Ethernet
- Works on any wires (power lines, twisted-pair, CAT5, RG58, COAX…)
- Protocol independent: can support LON, BACnet, KNX, MODBUS…
- Free topology provides flexibility and freedom in your network designs
- Interoperability and certification provided by HD-PLC Alliance and Lonmark International
- Multi-source solution (chip/module/box) to ensure availability and support
Thank You!

Michael Navid  
CEO & Founder  
Ecolinqx  
Michael.navid@ecolinqx.com  
www.ecolinqx  
+1 408 666 7466

David Kniepkamp  
President  
Smart Controls LLC  
david.Kniepkamp@smartcontrols.com  
www.smartcontrols.com  
+1 618 394 0300

and  
MegaChips  
www.megachips.com