The New ANSI/CTA 709.8 Advanced High-speed Power Line Communication Technology (HD-PLC) for Smart Cities and Buildings
 Speaker Bio

- More than 30 years experience in the high-tech sector
- Actively involved in the growth and advancement of various communication and networking technologies in the automation space for the past 15 years
- Founder and Board Member of the G3-PLC Alliance from 2011-2014
- Board Member of HomeGrid Alliance (G.hn) from 2008-2011

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MegaChips
Agenda

- HD-PLC Overview
  - Installation FAQ
- Fieldbus Core
- LON on HD-PLC
- BACnet on HD-PLC
- RS485 on HD-PLC and others
- Building automation aspects
...Is your network ready?
WHAT CUSTOMERS ARE ASKING?

- Higher bandwidths (>1Mbps)
- Support large number of nodes (1000+ nodes)
- Long range (1km+)
- IP based
- Security at every node
- Standards based
- Multi-source
- Interoperable
- Low cost
EXISTING TECHNOLOGIES REQUIRE DIFFICULT TRADEOFFS

**SERIAL**
Long range, but slow and limited nodes

**POWERLINE (Narrowband)**
Lowest deployment cost, but slow and unreliable

**WIRELESS**
Easy to deploy, but range is an issue

**ETHERNET**
Very fast, but cost can be prohibitive
ANSI/CTA 709.8 HD-PLC LEAPS PAST OTHER WIRELINE TECHNOLOGIES

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.
Narrowband vs. Broadband PLC

Signal and Noise Level

Level (dB) vs. Freq.[Hz]

- NB PLC
- BPL
- HD-PLC

30dB noise level at different frequencies.

<500K Hz for NB PLC
2M Hz for BPL
28M Hz for HD-PLC
# Wireline Options

<table>
<thead>
<tr>
<th>RS485</th>
<th>LONWorks</th>
<th>HD-PLC</th>
<th>Ethernet</th>
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<tr>
<td><strong>Topology</strong></td>
<td>Daisy Chain</td>
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<td><strong>Range</strong></td>
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<tr>
<td><strong>PHY Rate</strong></td>
<td>9.6Kbps</td>
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<td><strong>Modulation</strong></td>
<td>NRZ, etc</td>
<td>FSK, etc</td>
<td>OFDM</td>
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<td><strong># of nodes</strong></td>
<td>32/256</td>
<td>127/32K*</td>
<td>1,024</td>
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*LONWorks allows up to 32,385 in a single network, spread on various trunks. A trunk usually is limited to maximum 127 devices.*
ADVANTAGES OF ANSI/CTA708.9

- Megabit Data Rates
- Ranges Up to Several km
- Up to 1024 Nodes
- Crypto-Strong Encryption
- IP-Based Mesh Networking
- Over ANY Wire
## ANSI/CTA708.9 KEY SPECIFICATIONS

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<tr>
<th>Base Standards</th>
<th>IEEE1901-HDPLC/ITU G.9905</th>
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<tr>
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<td>Data rate (Phy/MAC)</td>
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<td>Message throughput</td>
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<td>Latency</td>
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<td>IP Support</td>
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For more information see: [www.megachips.com/products/plc-communications/](http://www.megachips.com/products/plc-communications/)
THE FASTEST WAY TO BUILD ROBUST, LONG-RANGE, HIGH-SPEED NETWORKS

QuickMesh with Multi-hop
- Every node can act as a repeater
- Plug-and-play mesh networking
- Fast authentication times

Dynamic Optimization
- Periodically exchanges Hello message to calculate and maintain best route
- Self-optimizing and self-healing

Free Topology
- Master handles all transactions between terminals
- Dramatically reduces traffic, enabling larger networks

Automatic Routing
- Calculates link cost of each path to determine best path
- Automatically calculates lowest route cost for each node

ITU G.9905 CMSR
SIMPLE BRIDGING ENABLES SYSTEM CONVERGENCE
A SMARTER COMMUNICATIONS PROTOCOL
ANSI/CTA 708.9 Silicon and Products

- Chips and Development Kits
  - Panasonic
  - MegaChips

- Products

- Gesytec
- xingtera
- MITSUMI
- Panasonic
- VS Lighting Solutions
- Nuri Telecom
- GigaFast
- PMS

, and more…
LON HD-PLC Diagnostics Tools

- Each device is an analyzer
  - Performance data
  - Signal spectrum
  - Topology
  - Configuration settings
  - Software update

List of network node is available.

CINR of each node can be confirmed.

Network configuration by topology and communication quality of each node can be confirmed.
POPULAR APPLICATIONS

- HVAC
- POS Systems
- Video entry
- Lighting Automation
- Solar Inverters
- Security Systems
Speaker Bio

- 30 years experience in communication systems
- LON specialist since 1995
- LonMark International Vice Chair since 2016
- Chair of German Marketing Task Group
- CEN/TC247 WG4 member

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- RS485 on HD-PLC and others
- Building automation aspects
Installation FAQ
Installation

- Basics
  - Wiring
  - Master/terminal function
- HD-PLC Extended
  - Pairwise key for authentication
  - Whitelist for devices

- DIP switch
- Master/terminal
- Power line

- RS485
- Ethernet
Installation

- Basics
  - Wiring
  - Master/terminal function
- HD-PLC Extended
  - Pairwise key for authentication
  - Whitelist for devices
- Functions
  - Baud rate for RS485
  - IP-address
  - CNP-HD-PLC master
  - lonip/CNP-HD-PLC router
  - And more
Blockers

▪ wanted
▪ Filter 2-40 MHz
  - e.g. EMC filter
  - 80 db attenuation blocks completely
▪ unwanted
▪ Different phases
▪ Transformers
▪ Circuit breakers
▪ Residual current breakers
Jump over the ditch

- Phase coupler
  - E.g. Homeplug AV
- Capacitive
- Inductive/capacitive
  - Residual current breaker
  - Meter
- HD-PLC repeater
  - Bridges pairwise

PLC-A ➔ Ethernet ➔ PLC-B
Redundant master

- Automatic Master Transition
Dual Master

Master 1 <-> ETH <-> Master 2 <-> Terminal C <-> Terminal D <-> Terminal Z

Master 1 (inactive) <-> ETH <-> Master 2 <-> Terminal C <-> Terminal D <-> Terminal Z
Analysis

- Each device is an analyzer
  - With Ethernet port

- Device list
- Topology
- Performance
- CNR
- Iperf/jperf
Topology/PHY rate
Iperf/jperf
Testing
Fieldbus on HD-PLC
Fieldbus Core

User Application

Fieldbus Client API

I/O driver

UART

Fieldbus Stack

(Fieldbus, BACnet, ...)

Fieldbus Server API

UDP/TCP

IP

UART

HD-PLC

http
ssl
tls

I/O

Application CPU

serial

HD-PLC CPU

Fieldbus API

UART

Fieldbus Client API

User Application

HD-PLC CPU

I/O

Application CPU

serial
Development Kit

- 12 digital I/O
  - Input
  - Output
  - I2C/SPI/UART
- 2 analog in
- 2 analog out
- Debug
- Protocol independent
CTA-709.8

- Project State: Approved
- 85% complete
- Estimated Complete: 2020-01-31

- Europe: EN 14908-8
  - Final vote
  - April 2020 CEN meeting
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<td>Control Network Power Line (PL) Channel Specification</td>
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**Software Protocol Stack**

- 709-6
- 709-1 / 709-5

**Hardware**

- Transceiver
- FPGA / RF-chip
- Media converter
CTA-709.8 details

- **Master device**
  - Spreads messages to the nodes
  - Identical with the HD-PLC master
    - HD-PLC devices know the master
    - Simplifies installation
    - Needs to have own IP address

- **Aggregation**
  - IP is not perfect for ping pong with small messages
  - CTA-852 already implements aggregation
  - Remember tcp_nodelay
CTA-709.8 Master

Diagram showing the connections between Master A and Terminals B, C, D, and E.
CTA-709.8 aggregation
CTA-709.8 devices

- Vossloh Schwabe outdoor luminaire controller
- Gesytec development kit
- Gesytec HD-PLC bridge
  - 709.8 master
  - Bridging Ethernet and RS485
  - Connects Adesto Smart Server to HD-PLC
  - Connects Easylon Router to HD-PLC
- Demo with SmartServer and VS outdoor luminaire controller
BACnet/HD-PLC

- Introduce free topology with high speed
- Simplify IP based BACnet
  - No switches
  - Longer distance
- Substitute MSTP
  - Enhance reliability
  - Reuse wiring
  - Performance upgrade
BACnet

BACNet Application Layer (APDU)

BACnet Network Layer (NPDU)

ISO 8802-02
LON
PTP
MSTP
IP
UDP
RS 232
RS 485
IP Link
LON FT 709.7

SC

Application (7)
Presentation (6)
Session (5)

Transport (3)

Data-Link (2)

Physical (1)
BACnet

BACNet Application Layer (APDU)

Transport

BACnet Network Layer (NPDU)

IP

UDP

IP Link

IP on HD-PLC

Generic HD-PLC
## BACnet/HD-PLC

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**Device Object**
### e.g. Binary Input Object

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Works already

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<tr>
<td>Device</td>
<td>22</td>
<td>eShark Test App</td>
<td>Device</td>
<td>Gesytec GmbH</td>
<td>704</td>
<td>eShark, HDPLC-BACnet</td>
<td>FW 1.3</td>
<td>SW 2.56</td>
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<td>14</td>
<td>9 Element(s) in use</td>
<td>6 Element(s) in use</td>
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System Status: [0, Operational]
Database Revision: 2
Device Addr. Binding: 0 Element(s)
Active CCV Subscript: [0] NULL
Active VT Sessions
Last Restart Reason
Time Of Day. Restart
BACnet/HD-PLC Router

- Media converter for BACnet/IP on HD-PLC
- BACnet Router for native BACnet/HD-PC
Roadmap

- BACnet plug fest May 2020 in Germany
  - eShark development kit with BACnet/IP on HD-PLC
  - Gesyline HD-PLC DIN rail bridge
RS485 on HD-PLC

- Free topology for RS485
- Large distances
- Enhances reliability
  - Grounding issues
  - Distance issues
- Different baud rates for trunks
- Restrictions
  - No low latency protocols like BACnet/MSTP or profibus
BACnet on RS485
Other field bus systems

- IP based protocols
  - KNX/IP, Modbus/TCP, proprietary

- Protocols using UARTs
  - KNX, DALI, proprietary

- Aspects
  - Serial: latency / handshake / baudrate
  - IP: multicast / message size
Building automation aspects
Building Automation Aspects

- Performance boost on existing wiring
  - Save cost
  - Fire load does not change
- Runs in parallel with legacy devices on same wire
  - Easy migration
- Runs on power cables
  - No new wiring
  - Puts communication where it is needed
Thank You

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