Breaking Through Cost Barriers and Bandwidth Bottlenecks in Smart Buildings

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Is your network ready?

The Internet of Things (IoT) has arrived. All around us, a new generation of affordable, intelligent, and interconnected devices is driving improvements to operational efficiency, unlocking new business opportunities, and fundamentally transforming how we interact with the world around us.

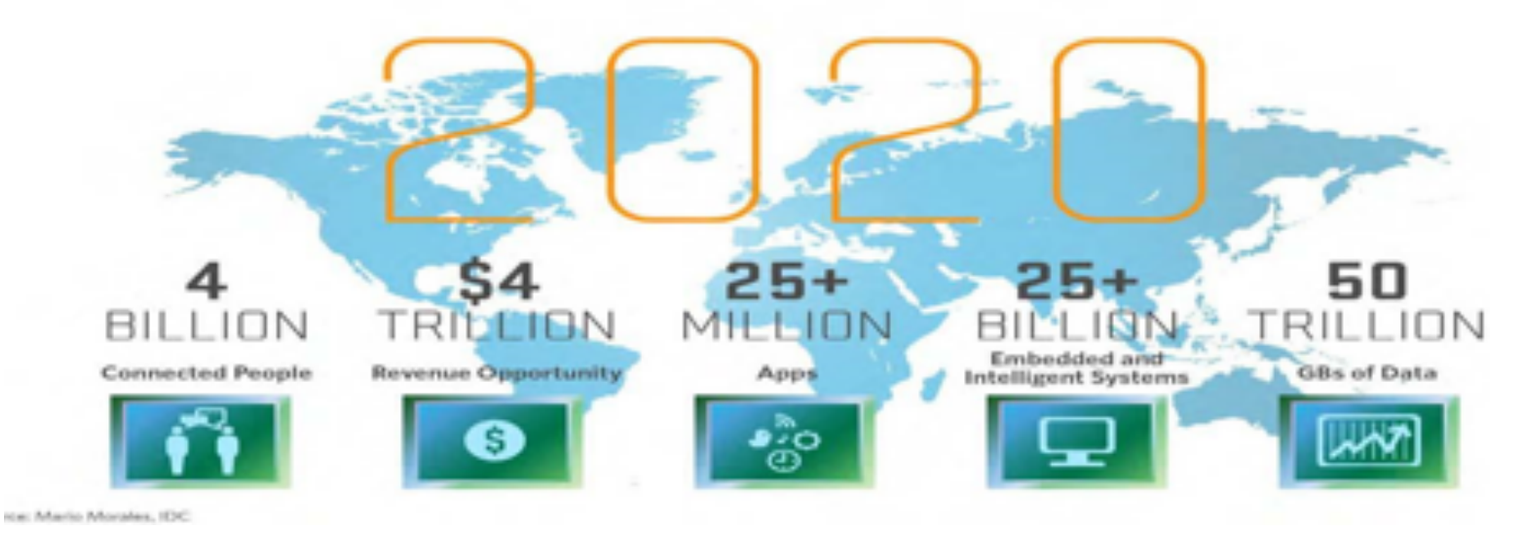
Nowhere are these changes more evident than in the building automation market. After nearly three decades of slow and steady advances, the market for building automation systems (BAS) is poised to take off, fueled by the emergence of new technologies along with a new vision for what's possible in smart buildings. The global smart building market is projected to grow at a rapid 33.7% CAGR over the next five years as building owners and facility managers continue to integrate building automation systems together to achieve cost advantages while improving safety, security, and comfort for occupants.

On the surface, the systems that go into smart buildings look similar to the traditional building automation systems used for access control, building environmental control, energy management, fire detection and safety, lighting control, video surveillance, and more. These systems have become smarter, more capable, and more affordable over the years. However, what truly defines smart buildings today is the integration of these many "islands of automation" into a single control network. We're not quite there yet, but we're quickly approaching that vision as building owners and facility managers seek to make data accessible across the network and achieve new levels of automation and control.

Four Key Enablers of Smart Buildings

- Integration of control networks eliminates information siloes and enables new levels of automation across buildings
- Convergence of operational technologies with information technologies brings the power of the cloud and big data but comes with increased security risks
- Distribution of intelligence across endpoints reduces bottlenecks and allows greater automation
- Proliferation of devices and systems places new demands on the smart building communications network

Two big challenges stand in the way of achieving smart buildings. First, system integrators must bridge the gap between the islands of automation created by a multitude of non-interoperable communications protocols. Over the years, applications such as indoor lighting, HVAC, and security systems have evolved their own protocols. System integrators must build a bridge between these islands while protecting their investment in each control network.



ice: Mario Morales, IDC

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Second, device manufacturers and system integrators must reduce the cost and complexity of deployments. In a typical smart building, you'll find tens of thousands of sensors capturing inputs about carbon dioxide, temperature, lighting, occupancy, safety and security, energy use, and more. Control networks are becoming larger and more complex, placing tremendous demands on the underlying communications technology. System designers need solutions that can deliver higher bandwidths, provide ample overhead for security, support more nodes, and reliably communicate over long distances.

There are many communications options available on the market, from building complex wireless networks to installing costly cabling across the facility. However, these approaches greatly increase the cost, complexity, and time of implementation. System integrators need a communications technology that doesn't just meet application requirements but also addresses the cost of implementation.

Building a Smarter Communications Network for Smart Buildings

One of the biggest decisions system integrators face is the choice between wireless and wired communications. Each approach has its advantages and disadvantages. Many implementations will benefit from a hybrid approach that takes advantage of the strengths of both wireless and wired communications to address the specific challenges and objectives of the deployment.

Wireless Solutions

Wireless networks have the advantage of being fast and easy to deploy. Unlike some wired technologies like Ethernet, there's no need to run new cables through walls and floors. System integrators are able to quickly install new devices and then, taking advantage of plug-and-play autodiscovery and mesh networking features, simply turn them on and integrate them into the control network. This capability makes it easy to build and scale wireless networks.

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This convenience, however, comes at the expense of performance and reliability. Wireless technologies like Zigbee, Z-Wave, and WiSUN offer relatively low data rates—250kbps in ideal conditions. But smart buildings are far from ideal environments, and interference from other electronic devices can compromise the quality of the signal and system reliability. Additionally, wireless solutions have range limitations and depend upon line-of-sight transmission. These can be significant drawbacks for smart building applications, where control networks need to stretch across multiple rooms or floors. Adding repeaters and gateways can mitigate these shortcomings, but they also significantly increase the total cost of the deployment.

Wired Solutions

According to IHS, wired connectivity accounts for the largest portion of industrial IoT connectivity today and is forecast to grow at a 23.6% compounded annual rate through 2025. The reason for this growth is easy to understand: Wired networks have the advantage of being a mature

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technology that offers higher performance, robustness, and security over wireless solutions.

The wired connectivity market is divided between a wide range of technologies (twisted pair, Ethernet, coax, and powerline), each of which has their own advantages and disadvantages. Wired communications solve the challenges of interference, line-of-sight issues, and dropped connections that plague wireless installations. They're also generally much faster and support longer transmission distances, making them well-suited for the large, data-intensive networks required by smart buildings.

Wired communication technologies come with their own set of tradeoffs. On the one hand, system integrators can maximize bandwidth and range by installing twisted-pair or coax across the facility. This is not a trivial matter. It requires careful network planning and considerable expense to run new cable within walls and install the hardware necessary to support large, complex control networks. On the other hand, system integrators can avoid this cost and complexity by simply using existing powerlines to communicate and control the nodes that are installed on them. Network deployment over powerline is fast, easy, and extremely cost effective.

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However, powerlines are noisy environments, and traditionally powerline communication (PLC) technologies have sacrificed speed to ensure reliable data transmission. LonWorks, a popular open protocol for building automation systems, is a good example. Whereas LonWorks supports bit rates up to 78kbps over twisted-pair, when it comes to PLC bit rates are reduced to just 5.4kbps. In practice, this means that powerline has become obsolete in all but the simplest control networks. In its place, system integrators have deployed millions of miles of twisted-pair, along with a vast network of costly switches, routers, and repeaters to deliver the throughput demanded by their applications.

The New Standard for High-Speed Wireline Communications

Among all communications technologies, powerline holds the greatest promise for meeting the demands of modern smart building applications. By enabling integrators to use existing wires to deliver data and power, PLC can dramatically reduce cost, complexity, and deployment time. Yet, until recently, the low bandwidth provided by powerline channels limited its usage to all but low-data-rate applications.

That has changed, however, with the advent of the HD-PLC protocol for smart buildings. Originally developed for multimedia networks in residential applications, HD-PLC supports blazing-fast megabit data rates over powerlines. Additionally, it has been enhanced with industrial-grade robustness mechanisms to ensure reliable operation in smart building and smart city systems. Based on the IEEE 1901 and ITU-T G.9905 international standards for high-speed communication, HD-PLC uniquely combines a high-frequency range (2MHz to 28MHz) with wavelet-based OFDM modulation to achieve PHY speeds up to 240Mbps over powerline channels. This gives IoT device makers and system integrators a powerful solution that breaks through both cost barriers and bandwidth bottlenecks.

In 2017, LonMark recognized the inherent performance advantages offered by HD-PLC and adopted it as the new standard for high-speed, multi-node control networks. Industry experts predict that other industrial protocols like KNX and BACnet will soon follow suit to give their users access to the same cost savings, performance upgrade, and deployment simplicity as LonMark customers.

Discover the Advantages of HD-PLC

Achieve Higher Bandwidths Over Longer Distances
Powerlines are hostile environments for communication. The lower 10kHz to 500kHz frequency region is especially susceptible to interference, background noise, impulsive noise, and group delays. Narrowband PLC technologies like LonWorks use different modulation techniques such as FSK to mitigate the impact of this noise, but this effectively reduces the data rate, transmission range, and network size.

HD-PLC solves the problems inherent to PLC by applying advanced, broadband communication techniques such as orthogonal frequency division multiplexing (OFDM) and forward error correction (FEC) to provide robust data communication in the presence of narrowband interferers, group delays, jammer signals, impulsive noise, and frequency-selective attenuations. Moreover, it uses wider bandwidths at higher operating frequencies to achieve a better channel for communication on powerlines. Figure 1 illustrates the relationship between operating frequency and noise for narrowband and broadband PLC.

The table on the following page offers a comparison between HD-PLC and narrowband PLC. The increased bandwidth, support for a large number of nodes, long transmission range, and embedded security make HD-PLC the ideal choice for smart building applications.

Build Larger, More Robust Networks with Multihop Technology
HD-PLC leverages the Centralized Matrix-based Source Routing (CMSR) scheme defined in ITU G.9960 to implement an innovative multihop functionality that dramatically increases network range, robustness, and speed.

Multihop technology takes the guesswork out of network planning and design by enabling any node

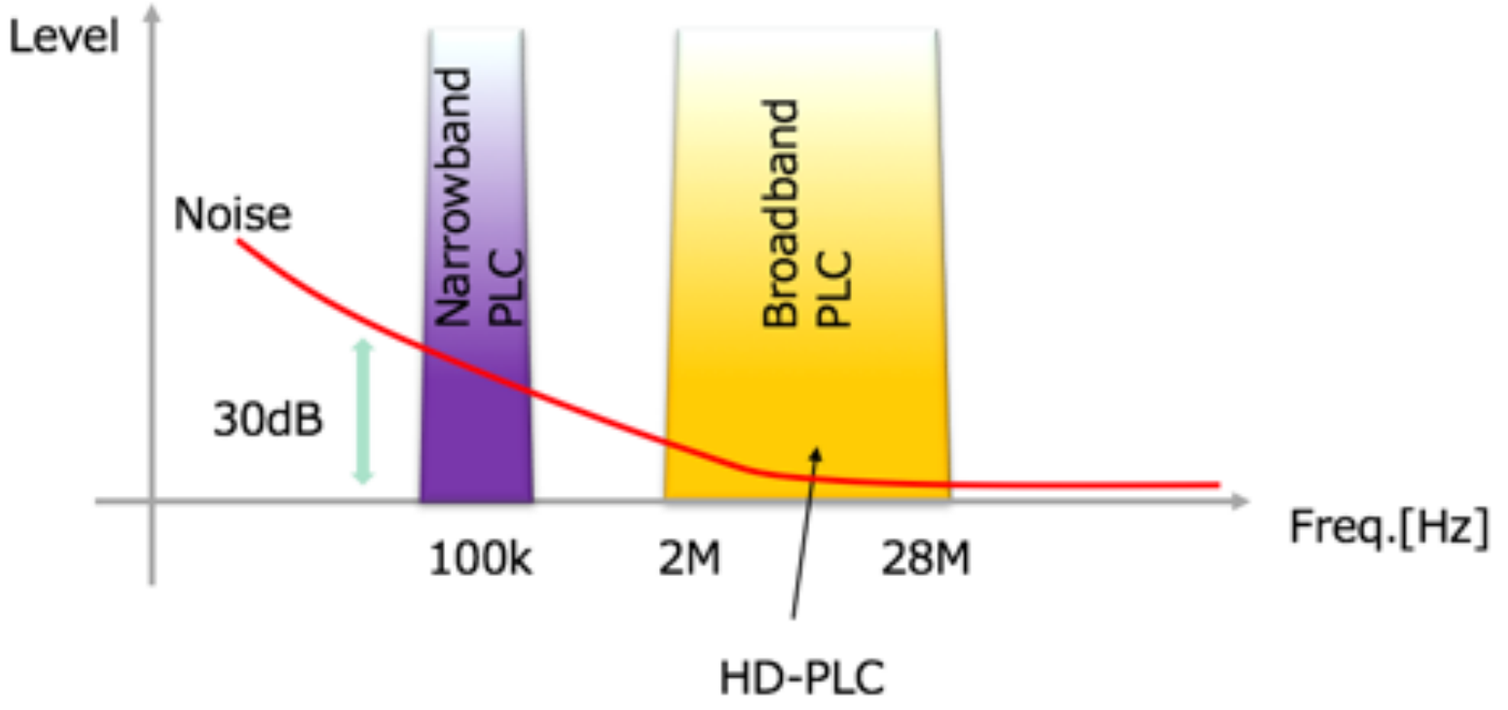

Figure 1: The higher operating frequency range of broadband PLC enables it to achieve high bandwidths while avoiding the noise problems associated with narrowband technologies.

	Narrowband PLC	Broadband PLC
Certification	LonMark, others	HD-PLC
Application	Command & Control	Industrial Networks
PHY Rate	< 100kbps	>100Mbps
Modulation	FSK, SFSK,SS	OFDM
Standard	IEC61334/CEA-709.1	IEEE1901, ITU G.9960
Frequency Range	10KHz to 150KHz	2MHz to 28MHz
# of nodes	64	1024
Range	Long	Long
IP Stack	N/A	IPv4/IPv6
Security	Low	AES-128
Power	Low	Low/Medium

to act as a repeater. With this technology, the nodes in the network dynamically calculate route cost and select the best route based on link quality. This eliminates bottlenecks and improves robustness, since the network will automatically reroute traffic if any given node fails. Figure 2 illustrates the method used for multihop route construction.

HD-PLC supports up to 10 hops, enabling system integrators to expand networks to up to 1024 nodes. In this case, throughput is reduced (10Mbps, min), but system integrators gain the ability to quickly deploy large systems without time-consuming network planning or costly devices like switches and routers.

Plug-and-Play Mesh Networking

HD-PLC's multihop technology brings the benefits of mesh networking to wired networks. System integrators no longer need to spend days planning and configuring their smart building control networks. With HD-PLC, they can simply plug in their devices and let the network take care of the rest, automatically calculating route cost and dynamically optimizing traffic. Deployments are now faster and easier than ever.

Cryptostrong Cybersecurity

Cybersecurity is a growing concern in the IoT. Yet, narrowband technologies lack the overhead to effectively implement adequate countermeasures. HD-PLC changes all that by providing the bandwidth and countermeasures needed to address growing cybersecurity concerns. Crypto-strong AES-128 encryption, together with black- and whitelisting of devices, reduces the risk of behind-the-firewall attacks. Additionally, the use of IPv4 and IPv6 addressing enables the addition of state-of-the-art security features through simple firmware updates.

A Bridge Between Islands of Automation

One of the biggest advantages of HD-PLC is its ability to communicate over any wire, not just powerlines. This is a powerful benefit for system integrators seeking to bridge islands of automation. Because the HD-PLC protocol implements an Ethernet-like transmission, HD-PLC devices can act as an Ethernet or serial bridge, enabling double use as gateways for IP cameras, Wi-Fi hotspots, or other wired control networks. This flexibility reduces both the cost and complexity of system integration, making HD-PLC ideal for the converged networks that typify today's smart cities and buildings.

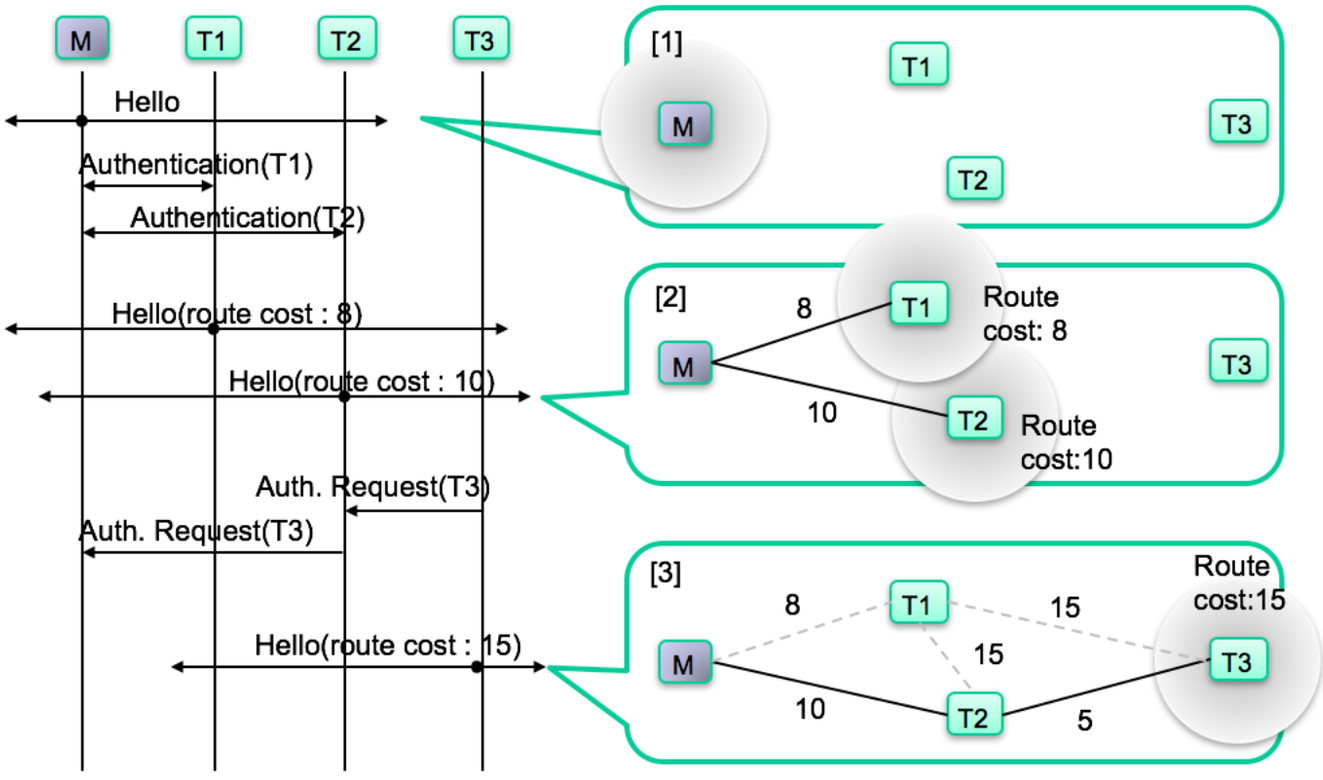

Figure 2: HD-PLC multihop route construction. [1] Master sends a HELLO packet, and terminal authenticates it. [2] Terminal sends a HELLO packet with route cost. [3] If there is more than one route, terminal selects the route with the lowest cost.

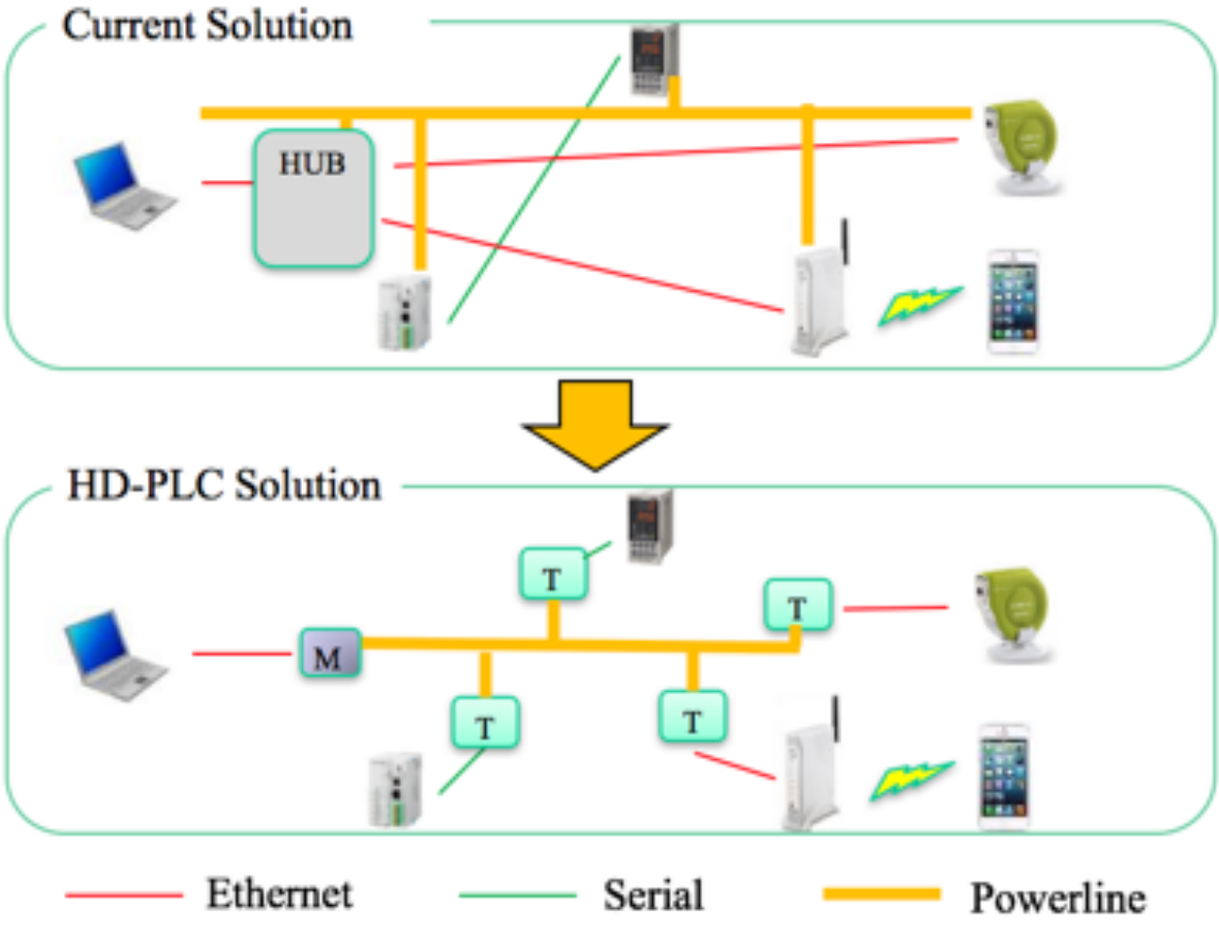

Figure 3: HD-PLC can communicate over any wire, making it an ideal bridge between powerline, Ethernet, and serial networks.

Getting Started with HD-PLC

Now you can easily upgrade to megabit data rates; build larger, more robust IIoT networks; and meet new cybersecurity demands. MegaChips' BlueChip HD-PLC solution integrates everything you need to reliably deliver high-speed, bidirectional, IP-based communications over AC and DC powerlines, coax, and twisted-pair.

The world's first fully compliant IEEE1901 HD-PLC solution with multihop, BlueChip combines MegaChips' state-of-the-art analog front-end (AFE) with baseband, physical (PHY), and media access control (MAC) layers into a single compact package capable of delivering data rates above 10Mbps over up to 10km of cabling (using multi-hop). Two options are available. The MLKHN1501 integrates up to 256Mb RAM for space-constrained designs, while the KL5BPLC250WMP is provided without memory.

Our line of BlueChip Evaluation Kits make it easy to get started with HD-PLC. Get the hardware, software, and documentation you need to easily set-up and evaluate system performance, and give your software developers a jumpstart with sample firmware and sample external command programs. The BlueChip SDK makes evaluation easy with tools for power control, channel monitoring, net test, and more.

Smart Features Enable Smarter Devices

- Data rate up to 240Mbps (PHY) enables smarter applications
- Multihop capability supports up to 1024 nodes and 10km range
- Free topology simplifies network design and deployment
- AES-128 encryption secures each node in the network
- Ethernet and serial bridging simplifies integration of devices and networks
- Low power consumption reduces total energy footprint

Order Your BlueChip Evaluation Kit Today

Discover how HD-PLC can help you break through cost barriers and bandwidth bottlenecks in your next smart building design.

ORDER NOW >>

Core Features of HD-PLC

PHY speed	240 Mbps
Max. number of nodes	1,024
Max. number of hops	10
Throughput in max. extend	10 Mbps
Latency	20 mms
Message throughput	200 p/s
Encryption	AES128
Security	Black- and whitelisting of devices

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