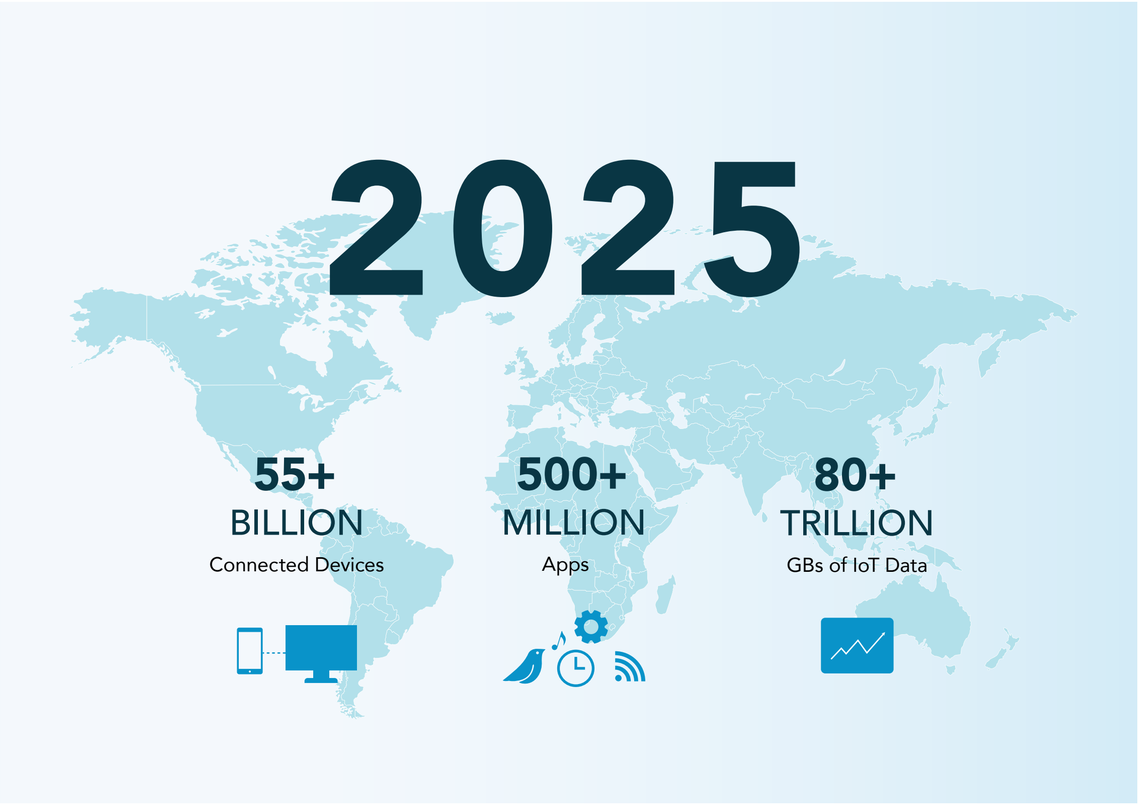
MegaChips

Breaking Through Cost Barriers and Bandwidth Bottlenecks in Smart Buildings

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 23.34% 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[1].



[1] Research and Markets, 2021.

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

1. Integration of control networks eliminates information siloes and enables new levels of automation across buildings
2. Convergence of operational technologies with information technologies brings the power of the cloud and big data but comes with increased security risks
3. Distribution of intelligence across endpoints reduces bottlenecks and allows greater automation
4. 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.

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 installing 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 auto-discovery 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.

This convenience, however, comes at the expense of performance and reliability. Wireless technologies like Zigbee or 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 to some extent, 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 technology, offering higher performance, robustness, and security over wireless solutions.

While wired communication can solve the challenges of RF interference, line-of-sight issues, support for large number of nodes, and the lack of security that plagues wireless installations, it comes with their own set of tradeoffs. Let's take Ethernet as an example. System integrators can maximize bandwidth by installing new Ethernet cable across the facility, but that requires considerable expense to run new Ethernet cable within walls and install the hardware necessary to support large, complex control network infrastructures. Another option is to resort to legacy wireline technologies such as RS485 on twisted pair. This option doesn't solve the bandwidth issue, while the labor cost is similar to installing Ethernet.

Among all communications technologies, BPL (Broadband Powerline) communication holds the greatest promise for meeting the demands of modern smart building applications. By enabling integrators to reuse existing wires to deliver high-speed data, BPL can dramatically reduce cost, complexity, and deployment time.

In the table below, we compare RS-485, Ethernet, and BPL. Starting with typical communication speeds and range, RS-485 has speeds of 10Mbps for short range communication, and goes down to less than 100Kbps as the range increases. This reduction in speed is mainly due to cable loss. For Ethernet, although you get the high speeds, you are limited to 100 meters or less. As TCP/IP networking moves from the home and office environment into more industrial applications, the 100-meter range limitation of Ethernet cable becomes a problem. In large facilities, where you have to extend your network across several buildings and to remote sensors, you require much greater range. Here, BPL gives you the best of both worlds. BPL offers the robustness of RS-485 with performance of Ethernet.

	RS-485	IEEE 1901-2020 (BPL)	IEEE 802.3 (Ethernet)
PHY Speed (bps)	10M - 100K	1G	10M/100M/1G
Max Range (m)	10 - 1,000	2,000+	100
No. of Nodes	64	1024	100
IP-Based	✗	✓	✓
High Security	✗	✓	✓
Plug-and-Play	✗	✓	✗
Mesh Networking	✗	✓	✗
Free Topology	✗	✓	✗
Ether and Serial Bridging	✗	✓	✗
Repeater Functionality	✗	✓	✗
Wiring	Twisted pair	Any wire	CAT5

The New Standard for High-Speed Wireline Communications

The latest generation of BPL raises the standard for high-speed wireline communications. Based on IEEE 1901-2020 “Flexible Channel Wavelet OFDM (FCW-OFDM)” and ITU 9905 “Centralized Matric Source Routing (CMSR),” supported by the HD-PLC Alliance, and adopted by ISO/IEC 14908-8 for Control Networks, Gen4-BPL is the right choice for speed, security, cost-efficiency, and ease of installation. It delivers multi-channel, bi-directional, IP-based communication over any wiring (AC/DC power lines, coaxial cable, twisted pair, etc.) where higher speeds, robustness, security, extended reach and capacity are required.

BUILD LARGER, MORE ROBUST NETWORKS WITH MULTIHOP TECHNOLOGY

Gen4-BPL leverages the Centralized Matric-based Source Routing (CMSR) scheme defined in ITU G.9905 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 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 1 illustrates the method used for multihop route construction.

Gen4-BPL supports up to 10 hops, enabling system integrators to expand networks to up to 1024 nodes. In this case, system integrators gain the ability to quickly deploy large systems without time-consuming network planning or costly devices like switches and routers.

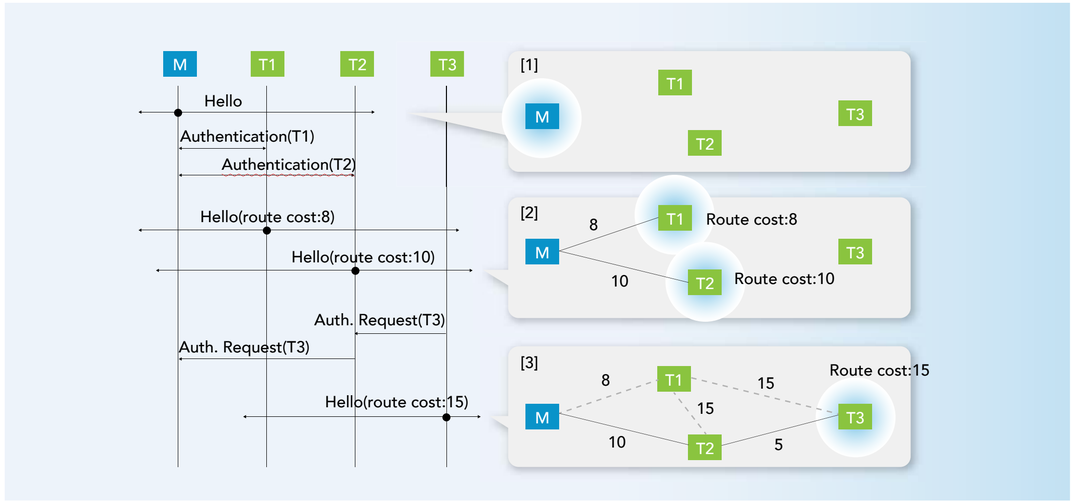


Figure 1: HD-PLC multihop route construction. [1] The Master sends a HELLO packet, and the terminal authenticates it. [2] The terminal sends a HELLO packet with route cost. [3] If there is more than one route, the terminal selects the route with the lowest cost.

PLUG-AND-PLAY MESH NETWORKING

BPL'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 BPL, 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. Gen4-BPL 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 Gen4-BPL 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 BPL protocol implements an Ethernet-like transmission, BPL 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 Gen4-BPL ideal for the converged networks that typify today's smart cities and buildings. Figure 2 illustrates the simplicity that Gen4-BPL brings to control network design.

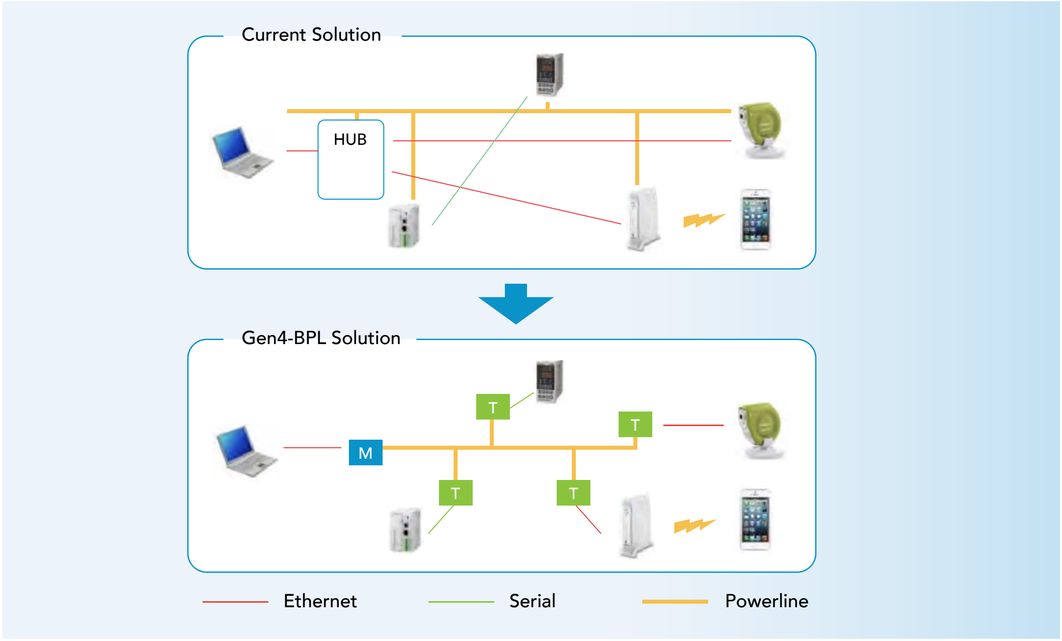


Figure 2: Gen4-BPL can communicate over any wire, making it an ideal bridge between powerline, Ethernet, and serial networks.

Getting started with Gen4-BPL

Now you can easily upgrade to megabit data rates; build larger, more robust IIoT networks; and meet new cybersecurity demands.

The Gen4-BPL Broadband Powerline Communication

MegaChips' Gen4-BPL High-Speed Power Line Communication Solution is a state-of-the-art, highly integrated system-on-chip (SoC) that delivers broadband speeds over existing wiring infrastructure.

Gen4-BPL combines Physical (PHY) and Media-Access-Control (MAC) layers, a fully integrated Analog-Front-End (AFE) with high-precision A/D and D/A data converters, programmable gain amplifier (PGA), bandpass filter, and line driver in a single compact package to deliver speeds of up to 500Mbps at the PHY layer. Gen4-BPL is designed for your most cost-sensitive smart building applications while delivering the highest flexibility, performance, speed, robustness, response times, and power efficiency in the market today.

Smart Features Enable Smarter Devices

1. Data rate up to 500Mbps (PHY) enables smarter applications
2. Multihop capability supports up to 1024 nodes and 10km range
3. Free topology simplifies network design and deployment
4. AES-128 encryption secures each node in the network
5. Integrated Ethernet and serial bridging simplifies integration of devices and networks
6. Low power consumption reduces total energy footprint

Offering higher-performance at a fraction of the size, cost, and power consumption of the previous generations, Gen4-BPL comes in two versions – "Streamer" for high-speed applications and "Multihop" for long-range.

MegaChips'Gen4-BPL Evaluation Kits make it easy to get started with BPL. Get the hardware, software, and documentation you need to easily set up and evaluate system performance. The Gen4-BPL SDK makes design-ins easy. It includes reference designs, software development tools, sample firmware codes and more to give your engineers a jump start in their designs.

Order your Gen4-BPL Evaluation Kit today—and discover how HD-PLC can help you break through cost barriers and bandwidth bottlenecks in your next smart building design.

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