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Smart Buildings vs. Intelligent Buildings: Why Intelligent Buildings Are the Better Choice

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Abstract

This article defines the term intelligent building, discusses the driving factors that are influencing intelligent buildings today, and explains how new Ethernet technologies enable transformation of existing buildings into intelligent buildings.

What Is an Intelligent Building?

The term "intelligent building" was first used in the U.S. in the early '80s and a definition given by the Intelligent Building Institution in Washington was:

An intelligent building is one which integrates various systems to effectively manage resources in a coordinated mode to maximize: technical performance; investment and operating cost savings; flexibility.

You've probably heard the phrase "Someone is too smart for their own good" but have you ever heard the phrase "They were too intelligent for their own good"? This is because there is a distinct difference between being smart and intelligent. One of my favorite quotes is "Smart people talk, intelligent people listen." Similarly, the difference between a smart building and an intelligent building is that in a smart building, the user will program systems to act in a manner dictated suitable to the best intentions of the user. However, an intelligent building has the appropriate sensing and processing capabilities to listen for itself and then program itself to do what it sees as optimal. To achieve this, the building must have the relevant sensing capabilities to take as much of the external environment in as necessary, the appropriate communication pathways to transport these data back to the "brain" of the building (which could be located onsite or in the cloud), and machine learning algorithms in its brain to process the information it is getting to dictate the optimal action to take. The action must then be communicated back out to the relevant systems for execution via the same communication pathways.

The Current State of Play with Intelligent Buildings

If you ever find yourself in the unfortunate situation of being lost in the wilderness or stranded on a desert island, it is the rule of three that will keep you alive. This rule states that to survive you have 3 hours to find shelter, 3 days to find water, and 3 weeks to find food before you will perish. Shelter is the top priority to your survival in this scenario, yet while we may not be currently lost in the wilderness, how we fulfill the human need for shelter by shifting to intelligent buildings is paramount for the future of our planet and humanity. Making a new or existing building intelligent is done via digitalization. This is the process of turning the factors that affect the running and maintenance of a building into digital signals that can be measured in real time and communicated back to the brain of the building to be analyzed and then managed. How we digitize new and existing buildings in order to make them more energy efficient and sustainable is the key to securing the future of our carbon footprint as a species. There are four key areas to consider when discussing the future of intelligent buildings:

- Health and safety—Is the space designed with the intent of increasing the state of well-being of its occupants? If the occupants feel safe and their environment is designed to enhance their mood and quality of life, they will be more productive.[1] This is even more paramount in the age of COVID-19 as people return to the office.
- Sustainability—Is the space as efficient as it needs to be to reduce its carbon footprint? This theme not only enhances the lives of the building owners by saving money on energy bills and reducing maintenance costs but also has environmental, economic, and social benefits for the wider population.
- Resilience—Is the space designed with the future in mind to stand the test of time? The buildings of today are built to last 150 years or more. We do not know what innovations or technologies wait to be discovered in the future, but we can plan so that our buildings' information technology (IT) and operating technology (OT) infrastructure can handle the expected data traffic increase of the future as more systems start to come online and become IP addressable.
- Economics—Without the right financial incentives, it is very difficult to implement change. Money is value and there is value to be gained from buildings by making them intelligent. At first, however, capital investments are needed before the savings can be harvested. Innovative financing models will be needed to allow building owners to upgrade their buildings to intelligent buildings.

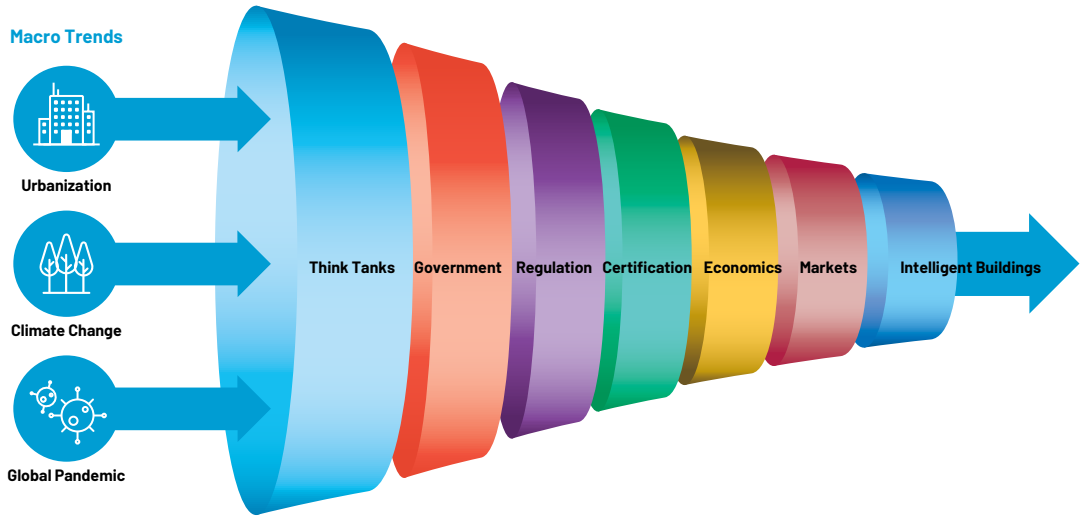

Figure 1. The funnel of influence for intelligent buildings.

These four themes can be addressed through building automation. Today, building automation is largely based on closed and siloed systems working in isolation to perform their function without influence or actuation into other systems. In a building, these systems are the HVAC, lighting, access control, fire alarm, elevators, and occupancy detection to mention a few. Siloed systems are largely inefficient, contributing to a larger carbon footprint.

In the next sections, we will discuss the big macro trends driving the shift to intelligent buildings and the key benefits that can be derived from investing in intelligent building technology.

Why Do We Need Intelligent Buildings?

In Figure 1, we have what is called the funnel of influence. It is a rough outline of the ecosystem for how the need for intelligent buildings is driven in the modern world. First, we start with the macro trends of the world, which are urbanization and climate change.

Urbanization is the migration of the world's population from rural areas to urban areas such as cities. People move to cities for a better way of life. Cities offer employment prospects as well as better access to goods, services, healthcare, and education. Population growth also contributes to urbanization and it's estimated that >65% of the world's population will live in an urban environment by 2050. It is predicted that the global building floor space will double by 2060, equivalent to adding an extra New York to the world every month for 40 years.[2]

Climate change is the change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onward that's been attributed largely to the increased levels of atmospheric carbon dioxide produced by using fossil fuels. The IEA estimates 40% of the world's carbon dioxide emissions can be attributed to buildings, with 28% of the emissions being contributed by the running and maintenance of the buildings alone.[3] The alarming estimate is that 50% of the energy currently used by buildings is wasted.[4] The energy consumption and, in turn, CO_2 emissions in buildings have barely flattened off in recent years, showing that with more buildings due to come online, the impact of buildings on the environment will only get worse unless energy efficient is improved.

Many influential think tanks such as the United Nations Environment Programme and the World Bank are now focusing on policies for improving energy efficiency in buildings, providing incentives to invest in sustainable and intelligent buildings, and retrofitting old buildings to meet current EU sustainability standards.

The world's governments bound by their obligations to tackle climate change are starting to implement these suggested policies. The EU as part of their Green Deal policy is now providing funding for a large retrofit program. There are approximately 220 million buildings in the EU, 85% of which were built before 2001 and 90% of existing buildings will still be standing in 2050, providing a large base for retrofitting. The EU aims to retrofit 30 million buildings by 2030. Equally, there's hope in the U.S. that the Infrastructure Bill and Smart Buildings Acceleration Act and the China 5-year plan will drive similar initiatives in these markets.[5]

Government policies and building regulations drive energy improvements with the upcoming updates to the Energy Performance of Buildings Directive in the EU. Equally, the ASHRAE standards in the U.S. are driving regulatory compliance, with other country specific regulations also coming online.

It is also becoming more and more common for buildings to have green and intelligent building certification. In some cases, this is a requirement for specific financial investments, but mostly it is understood that these certificates add a significant premium to the building's earning potential. LEED, BREEAM, and EDGE are all well-known green certificates, but local certification in China is now building pace. Intelligent building certification is newer but with TIA and UL coming together to form SPIRE, this too will become more popular.

Looking at the economics of these potential improvements to buildings creates a premium for healthier, greener, and more intelligent buildings. In London, research has shown that certified buildings command a 4% premium for rental and sales relative to noncertified buildings in the same area.[6]

From world events to world economics, the shape of buildings is changing, and the top building automation companies are taking note. We notice that in line with quarterly revenue reporting, the megatons of CO_2 saved for their customers are being reported along with emphasis on greener and healthier buildings. How

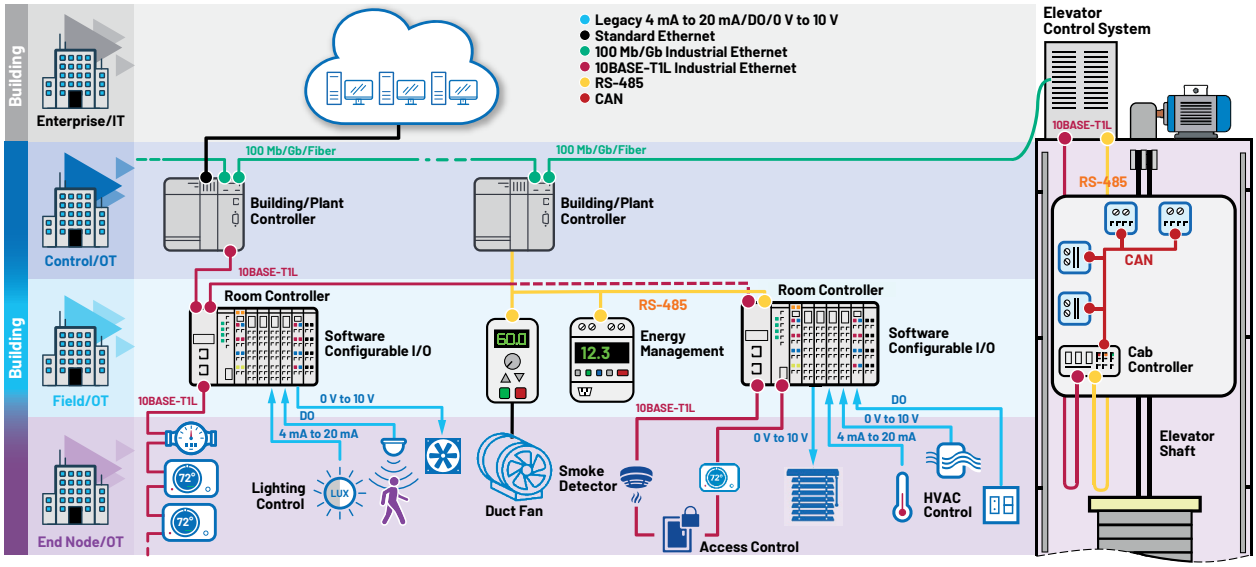

Figure 2. Intelligent building infrastructure.

these building automation companies will achieve this savings is through vast building digitization and digitalization, allowing intelligence all the way to the edge node, gathering more intelligent data, and generating more actionable insights across multiple building systems, allowing the opportunities to fine tune and optimize each buildings' performance to ensure maximum energy efficiency and maximum sustainability.

How to Achieve an Intelligent Building

Most buildings today have a building management system or BMS. These comprise of disconnected subsystems specific to the function they perform as stated in the introduction; that is, lighting, HVAC, access control, etc. To make these buildings intelligent, it is not just a case of gutting them and putting whole new infrastructure in; this would be too costly. It is up to the semiconductor industry to enable the retrofit market with technologies that can digitize the current infrastructure and connect separate building systems to each other. Figure 2 is a good example of how multiple technologies and communications protocols could transform a legacy BMS system into an intelligent building.

Ethernet is a common protocol that enables our day-to-day life and businesses with high data rates, but it is limited in terms of the distance it can reach and the topologies it can support. What if we could run Ethernet and IP over simple cables, such as single twisted pair over a 1 km in distance? This would provide seamless connectivity all the way from the cloud to the edge node, converging the IT and OT worlds to break down the silos of existing systems where data may be gathered but are not actionable nor do they generate valuable insights.

10BASE-T1L is a key technology to enable edge connectivity—this protocol allows the seamless connectivity from the cloud all the way to the edge node, allowing IP addressable edge nodes that in turn allow real-time actionable control from anywhere. Having such seamless control will result in lower cost of ownership as the networking is simplified, the data can be easily aggregated and interpreted, and installation and maintenance are also simplified. We can now add intelligence where there may have been simple analog sensing in the past. By digitizing the edge and generating more intelligent data, we can digitalize the entire building.

10BASE-T1L was ratified by the IEEE in 2019 as 802.3cg. Analog Devices is a member of this committee and was influential in driving this standard. The key elements of this standard are providing power and data over a single cable with a data rate of 10 Mbps—the cable in this case being a single twisted pair with the reach being 1 km. It's important to note that for retrofitting within a building, the existing twisted pair cabling can be used.

When this is compared to some of the existing infrastructure such as RS-485, we can see some valid improvements. The data rate is constant over 1 km, and it is not dependent on the distance as per RS-485. Moreover, the number of nodes is unlimited with 10BASE-T1L for data, whereas it's limited to 256 for RS-485. One key advantage is the provision of power over the same single twisted pair up to 52 W—in a similar way to POE, whereas it's limited to what we called engineered power with RS-485.

However, it is well understood that RS-485 still has a valid position in building automation for particular use cases. We also understand that buildings will not perform the full digital transformation overnight, so 10BASE-T1L needs to work alongside existing systems for the foreseeable future. Here we can see 10BASE-T1L giving seamless IP all the way to the edge working side by side with RS-485 and software configurable IOs for legacy architectures.

While the standard provides guidelines to ensure meeting the 1 km distance, there are no restrictions on using other cables with the understanding that the full distance may not be reached. Shielded and nonshielded cables are allowed, which means retrofitting is possible in most cases. It would be advantageous to identify exactly where there was an issue in 1 km of cabling. Any BMS system operator fully understands the effort involved in installing, commissioning, and maintaining a system with km of cables. Luckily, this is possible with 10BASE-T1L as it enables compliance and link quality testing as well as the ability to perform tests for the installation and maintenance of the cabling.

Conclusion

The need to turn buildings intelligent is important to cut down on excess carbon emissions as global warming has already led to the extinction of multiple species on our planet. If we are not careful, we could be next.[7] Intelligent BMS provide the data needed to make decisions around: sustainability and efficiency, communication, building control and automation, worker health and safety, and security. This in turn improves the levels of health and safety, sustainability, resilience, and economics of the buildings market.

For more information on the topic of intelligent buildings, please visit analog.com and get in touch with our Intelligent Buildings and Infrastructure Team.

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