



# CONNECTED HOMES AND INTELLIGENT BUILDINGS:

## Solving for Reliability, Convergence, Connectivity

### From Popular Culture to Reality

The concept of an automated home is not a new one: the idea has been floated since the 1930s at World's Fair venues, and in popular culture as TV shows and movies imagine home life of the future – solidifying the public's view of the benefits of home automation.

In the 1980s, modern versions of the automated home began to turn up in the marketplace. The concept of the “connected house” was first introduced by the American Association of Homebuilders, and formed the basis of what we now consider to be “home automation.” The connected house presented a new way to wire, connect, and control all of the devices in the modern home. However, it proved to be too expensive, cumbersome, and difficult to construct, and became limited to the luxury homebuilder market.

Throughout the 1990s, automated home technologies stagnated – for the most part, proprietary (and costly) systems were available only for luxury homes. These proprietary technologies were often system-specific, controlling only the home's lighting or entertainment systems. Marrying these systems into a single, cohesive, easily controlled whole was a challenge tackled only by the most technologically astute systems integrators.

At the same time, a do-it-yourself (“DIY”) market developed around powerline communication systems, and some early market entrants introduced wireless products for home automation. Innovators started to develop self-assembling, ad hoc wireless network protocols from which the now-prevalent ZigBee standard would emerge around the turn of the century.

In the first decade after 2000, technology innovators developed a wide variety of proprietary, open wireless and radio protocols for home automation. ZigBee, ZWave, EnOcean, C-Bus, and KNX are some of protocols that helped bring about the development of home automation applications during this period. These protocols are the “languages” of home automation, and allow devices to speak to each other. As these protocols were developed, the reality of connected equipment became apparent, as well as a demonstrated need for sensors and actuators for closed loop, learning home automation solutions.

### Convergence

With technology costs decreasing, consumers becoming more interested in connected home solutions, and greater reliance on the efficiency of the cloud, solutions for home automation have free reign to become more sophisticated and accessible.

### **The Power of TE:**

*TE is uniquely positioned to help customers succeed in the connected home market. From material components such as relays and connectors, to smart components such as sensors and connectivity components such as antennas, TE offers all of the internal elements that make end products smart and connected.*

The global home automation market now encompasses all controllable elements in the modern home. Connected lighting, appliances, entertainment, and access devices are all commercially available for professional and DIY installation.

Driven by safety and security concerns, energy savings potential, and convenience, the main home automation elements of lighting, safety, security, entertainment, HVAC, and energy management are now controllable using existing technologies. This convergence of market drivers and technologies has resulted in significant market growth potential, with overall market values estimated at \$3.6 billion in 2012, and growing to \$16.4 billion by 2019. This growth is being led by North America, with a total market share of 40.7 percent of global home automation installations<sup>1</sup>.

### **Safety and security**

Established security companies such as ADT<sup>2</sup> are leveraging the connected home trend as the foundation for expanded home automation offerings through SHaaS (Smart Home as a Service). In addition, broadband providers such as AT&T and Comcast, and energy companies such as British Gas, have also created new revenue streams through SHaaS<sup>3</sup>. Broadband, cable, and energy operators are uniquely positioned to succeed in this market, as they have millions of customers who rely on their services for energy management and data access.

Since these service providers seldom design their own components, a wide range of commercially available, interoperable, and easily deployed hardware – such as relays, switches, connectors, sensors, passives – is necessary and critical for growth of the SHaaS market.

## **Drivers of the Connected Home Market**

### **Connected consumers**

The connected consumer is a major driver for the connected home industry. Seventy-eight percent of U.S. consumers own mobile devices, and they realize the value of controlling home functions – such as heating and cooling systems – from anywhere they happen to be. Being able to adjust a home's temperature from the office or check whether a door is locked is a capability not possible even 10 years ago.

The inherent GPS tracking capabilities in mobile devices

create new application options through geo-tracking, such as the ability to unlock a door and turn on the lights as a homeowner enters his or her driveway. Other capabilities are enabled by interfaces to personal wearables, such as fitness and health monitoring devices<sup>4</sup> that can signal a home automation system to dim lights when it senses the user is asleep, or open blinds when the user is waking.

These health-monitoring options are also creating new market spaces, such as age-in-place applications that enable real-time monitoring of the elderly and the devices in their homes – a better alternative to moving them to more costly assisted living facilities<sup>5</sup>.

The growth of such markets and the development applications will require the hardware necessary for connectivity.

### **Wireless and radio protocols**

Another technology driver of the connected home market is the coalescence of wireless and radio protocols. The smorgasbord of open and closed protocols and communication standards is typical in a nascent industry. ZigBee, ZWave, KNX, Thread/6LowPAN, Bluetooth LE, and Wi-Fi all are in play in this market, with some manufacturers staking their claims on one protocol, as others hedge their bets and implement two or more in their products.

Each protocol has its strengths, and although they are all different, their combined penetration in the market space is valuable since each illustrates what is possible within a home automation implementation. However, it is likely that only one or two protocols will prevail. Fortunately, the hardware required for connectivity is the same regardless of what communication chip or protocol is implemented.

### **TE'S Role in the Connected Home Marketplace**

TE has strong relationships with the major home automation device OEMs in the connected and home and building markets, including the top 10 home automation suppliers as reported by BCC Research. Connectivity is critical to the efficient manufacturing, assembly, and installation of these devices and TE's products are designed into OEM products that are driving home automation innovation. TE's additional focus on second-tier OEMs and third-tier startups through direct sales relationships and through its distribution partners positions

the company as a major component supplier for this rapidly evolving market.

TE's customer relationships extend across many home automation categories such as hubs, occupancy sensors, appliances, HVAC equipment, and thermostats. TE's interconnect and switching technologies play a critical role in development of home automation systems: For example, TE enables routing power and signals internally and sometimes externally using electrical interconnects, and routing power and signal in these devices via switching components (for example, a power relay is needed in every wireless or wire-controlled Connected AC wall outlet).

TE customers' devices are found in all major sub-systems in the automated home, including:

- Lighting equipment and controls
- Safety equipment and controls
- Security equipment and controls
- Entertainment
- Portable consumer electronics
- HVAC equipment and controls
- Energy management equipment and controls
- White goods
- Portable appliances

Selecting the right connector, switch, relay, or sensor for the device and its application is key to ensuring a long and trouble-free product life. For example, misapplication of products can be a major headache for OEMs, causing product failures that can take years to rectify. TE's global team of product and development engineers, application and sales engineers, account managers, and technology experts helps its customers make these important decisions early in the product development process, where optimization of a design is most important.

## Limitations to Connected Home Adoption

The major elements are in place to drive growth in the connected home market, including:

- Established communication protocols
- Hardware that supports these protocols
- Hardware that interfaces with all main home automation systems (HVAC, Security, Safety, Entertainment, Lighting)
- Cloud-based access for mobile devices
- Cloud-based inter-protocol translation
- Improving and more reasonable price points

However, a number of roadblocks currently limit widespread adoption and are worth mentioning:

### Data security

Data security is an issue for home automation and across all Internet of Things (IoT) connected devices. Whenever a new system or product is released, it becomes a new target for cyberattackers<sup>6</sup>. It is unlikely that an ironclad solution to attacks on connected home systems will be developed in the near future. However, today's connected consumer is accustomed to these risks and accepts them in exchange for the benefits offered by connectivity<sup>7</sup>.

### Standardization

The lack of cohesiveness and standardization across a broad group of competitors may also limit the adoption of home automation technology. Consumers have expressed concerns about committing to a specific system that is not interoperable with other devices – they do not want to commit to a product, only to discover that they cannot integrate it with other systems. These differences in protocol and communication limit economies of scale but are characteristic of any new technology revolution.

Fortunately, hardware remains the same across protocols – so the hardware currently in development by companies such as TE will help drive adoption of home automation, no matter which protocols become standard.

### Consumer awareness

Though many devices for home automation are on store shelves today or available for online purchase, many consumers are confused about the value proposition. For example, a consumer who is in the market for a new refrigerator will need a knowledgeable retail sales associate and comprehensive content on the Internet to explain the benefits and value of a connected home appliance. Without front-line education during the sales cycle, a consumer could opt out, and the connected home capabilities and value would go unrealized.

The connected home market is still in the early adopter phase, and many startup companies are jockeying for position and for consumer attention. Manufacturers such as TE can help accelerate development of new and attractive home automation products by partnering in product design.

## TE products support home automation product development

Home automation advancements are transforming TE customers' products, and will continue to do so. Consider what thermostats looked like 30 years ago: They were mostly thermo-electro-mechanical devices that used a bimetallic element to switch heat or cooling on and off.

Fast forward to today: The inside of a modern thermostat is starting to look like the inside of a cell phone with new technology including TE's connectivity and sensor products – for example, connected thermostats often incorporate multiple printed circuit boards loaded with electronic components, passive devices, sensors, fine pitch connectors, and micro-sized wire to board connectors for tiny battery back-up packs. Switching and controlling HVAC equipment is critical, so low-profile relays are often incorporated. For user interfacing, mini tactile switches are often used for selector or reset buttons.

Another example: The ubiquitous power receptacle found on every home's walls. This technology, which spent nearly 100 years largely unchanged, is now being replaced with a connected outlet containing power relays, antennas, control circuitry and, of course, a reset button.



Figure 1: Connected thermostat with TE components.

### Micro-sized connectors and switches

Through TE's vast product offering, the company is able to provide micro-sized connectors and switches for the smallest sensor assemblies. Micro-sizing matters: Consumers want their home automation devices to be as small and unobtrusive as possible. This means the internal components of these devices need to be proportionally small, which is further complicated by additional functionality packaged into these devices. For example, occupancy sensors may also contain ambient light level sensors, a microphone, or other sensing/monitoring elements.

### High-current capability

TE also provides high-current connectors, switches, and switching relays into HVAC equipment and appliances,

enabling their connectivity and control in the automated home. Connected, electronic devices are inherently low voltage or low power, and they need to have relays to switch the higher voltage/higher power loads typical in the home. These loads can be anything from a coffee maker or toaster plugged into a connected wall outlet, to a boiler controller wired to a connected thermostat.

### Breadth of choice for product designers

TE's product portfolio is comprehensive – allowing designers to find exactly what they need for their unique ideas and products. At some point in almost every electronic design, connectors and sensors are needed to provide and route power and/or signals into or out of a circuit.

Below is a high-level itemization of some of the TE Connectivity product families that find common use among all the sub-systems listed above.

- Terminal blocks
- Rapid termination connectors
- Point termination contacts (FASTON, PIDG, etc.)
- Small format relays
- Power relays
- Data I/O connectors
- Fine pitch connectors
- Passive printed circuit board components
- Switches
- Spring contacts
- Integration/value-add capabilities
- High-performance labels
- Sensors

### Custom solutions

TE engineers can work with customers to develop a semi-custom or custom design that meets their requirements. The process is initiated by working with one of TE's sales or field application engineers.

TE engineers use the latest metal and polymer materials to develop a perfect-fit product for custom applications. Engineers' ability to pull from a wide range of manufacturing technologies such as high-speed progressive stamping, injection molding, a variety of plating technologies, and automated assembly helps ensure long-term production volumes with a design optimized for manufacturing and the end customer's application.

### Wireless innovations

Remote and wireless communication as well as control and monitoring will be an integral part of connected home ecosystems. These connected capabilities drive value by saving time and money for consumers, and will be key to driving demand and mainstream consumer adoption.

TE is changing the way appliances are wired to enable a more connected appliance that offers the consumer and OEM many benefits. For example, TE's appliances team developed a product called ADNEXHA that eliminates the complex point-to-point wire harness assembly common in modern appliances. It does so by electronically bussing controls and power to all the devices in an appliance.

The result is connectivity that informs. Imagine consumers receiving a text message from their washing machine that the wash cycle is completed, or that the wash detergent

they use is just about gone. The ADNEXHA system makes it possible to communicate detailed information about an appliance back to the main appliance controller – if it is connected to a home's WiFi system, it can deliver status messages back to the homeowner's mobile device.

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### Intelligent Buildings: The TE Opportunity

The commercial building automation space is different from home automation in many aspects. Its growth is tied heavily to commercial building construction trends, which in this decade have been relatively slow, and tempered by the reduction in the commercial building construction pace in China. The resulting building automation space therefore sees Compound Annual Growth Rates (CAGRs) in some regions in the area of 8.5 percent, and in other regions less than 5 percent with global growth averaging around 5.5 percent<sup>8</sup>. The growth expectations for this particular market are far less than what is projected for home automation.

Building automation for commercial buildings started with early pneumatic controls, and has developed into a mature market. Developers of these systems have moved beyond the formerly heavily segregated, separate systems controlling HVAC, security/access, lighting control, building safety, and physical plant control. Today, through integrated system controllers, these separate systems can now talk to one another using a common language made possible by modern serial bus communications such as BACNET and KNX.

### Standardization drives progress in commercial market

Cloud capabilities have brought this market a level of management and control not seen in the past, and have made possible complex heuristics that make the modern building much more intelligent than its predecessors. In today's commercial building systems, many of the bugs and issues now manifesting themselves in home automation have long since been ironed out through the standardization present in BACNET and KNX protocols. The cloud simplifies multi-building management, and serves as a data aggregator for building managers responsible for multiple buildings without the need for a large IT staff to manage a dedicated system.

While both these systems initially emerged as hard-wired, they have been extended into wireless realms to provide connectivity in less accessible conditions. A vast majority of the commercial building systems remain wired though due to the simplicity of installing, maintaining, and troubleshooting such systems.

Another factor in the steady reliability of commercial systems is that they are all professionally installed and designed in close communication among the building architect, general contractor, electrical contractor, and low voltage controls contractor. In some instances, even the building owner is involved in the decision process, since a building owner with multiple plants under its control almost always selects the same system. In this way, facility maintenance personnel have a common system to maintain, control, and troubleshoot if needed, creating a strong brand alliance in the commercial controls space.

#### **High demand for sensors**

The need for sensors is even more important in the commercial building space. Building managers need to know what is going on their buildings, including who is accessing the buildings and at what time, how much energy is being used, where the energy is used, what areas of the buildings are occupied, the temperature and how uniform environmental conditions are, and how efficiently the physical plant is being run (e.g., is a bearing going bad or a filter plugged).

In addition to the sensors, there are far more actuators in a commercial building. A centralized control system may take readings from multiple airflow sensors in a building, and dynamically adjust airflow dampers to ensure equalized airflow and comfort throughout the building. From a safety standpoint, if a smoke or flame detector indicates a fire in one part of a building, the system may completely close the air dampers on the area where the fire is detected to starve the fire of oxygen, while at the same time activating the building fire suppression system through remote actuated valves.

#### **TE's Role in the Connected Building Market**

The connected buildings industry is made up of global players such as Johnson Controls, Honeywell, Siemens, Schneider, and United Technologies. Since systems tend to be heavily wired, TE claims a market advantage because of its wide range of connector products - particularly in the terminal block arena, since this is the I/O termination method used throughout the world.

Wireless devices offer opportunities for TE products as well. All such devices have at least one switch used to reset and configure the devices, with many using multiple DIP style switches to hard-program various characteristics into the different devices.

TE's heavy focus on the physical plant and equipment manufacturing means the company offers multiple connectors and sensors within the boilers, air handlers, and AC systems in commercial buildings. TE's connectors, relays, switches, and sensors are found in the main control units, satellite controllers, various sensor devices, and the actuators offered by commercial building device OEMs.

The future will see buildings more heavily instrumented than ever before, with an increasing focus on environmental quality (including air, comfort, light) to maximize the efficiency and comfort of building inhabitants. Energy efficiency will continue to be a major market driver, as will the trend toward Zero Net Energy (ZNE) buildings. ZNE requires that a building be designed from the ground up to minimize energy use and maximize the use of renewable energy from sun, wind and other geo-sources. The features vary based on the climate zone in which the building is located, but could include placing adjustable awnings on the south side of the building to shade windows to minimize cooling loads during the summer; or more skylights and light tubes to use more natural light sources and minimize electrical use for lighting.

Similar to what is seen in home automation devices, there will be significant miniaturization and intelligence in commercial building devices. TE's years of experience and product breadth interconnecting small, consumer devices positions the company well to address this trend.

**LEARN MORE ABOUT  
TE'S SOLUTIONS FOR  
THE CONNECTED HOME.**

[www.te.com/connectedhome](http://www.te.com/connectedhome)

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