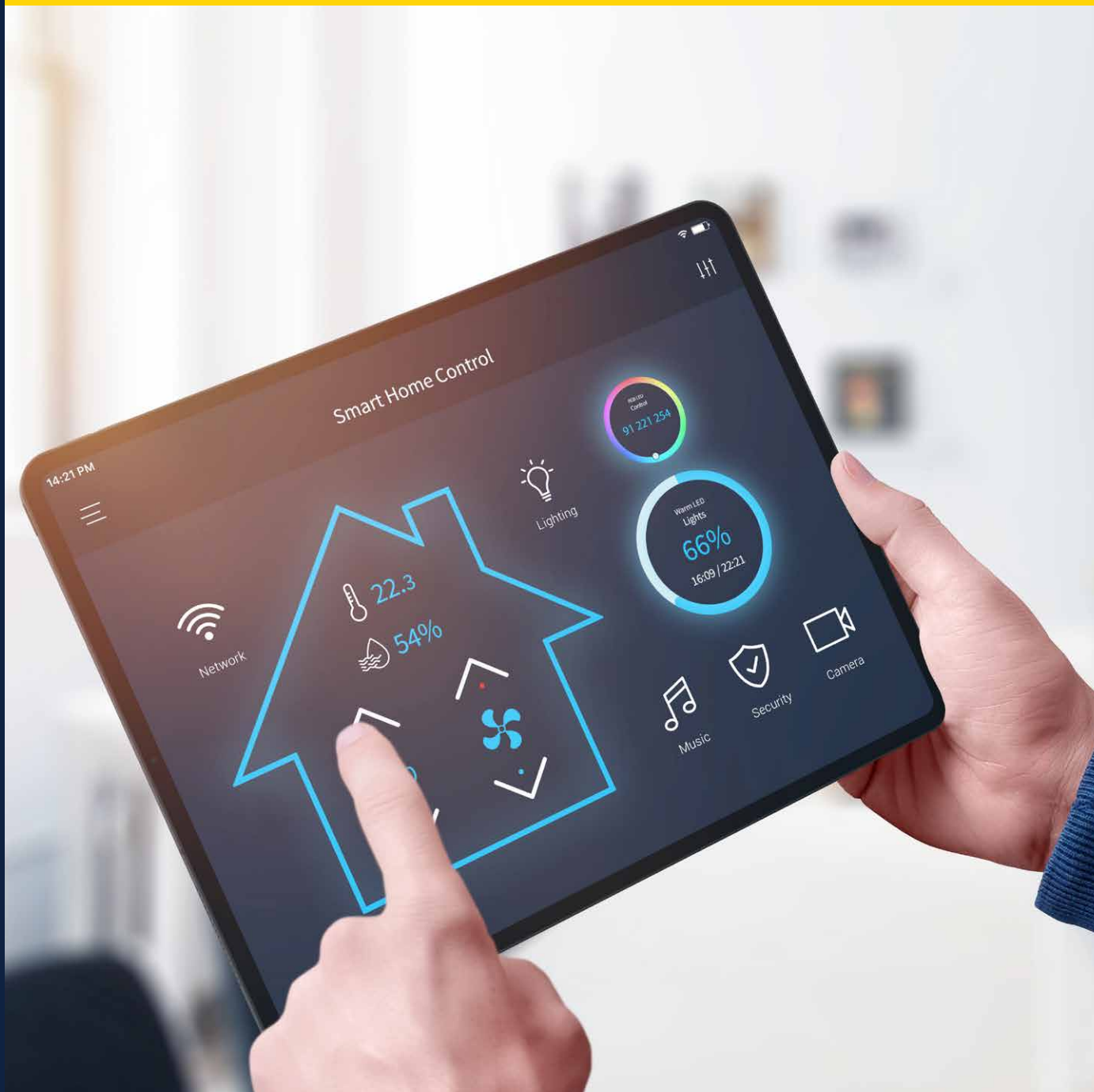
Seamless smart home connectivity with Matter



Introduction

Since any device in the home - ranging from doorbells, sprinklers, and garage openers to stoves, washers, and fireplaces - can be connected and controlled via the internet, the problem facing elegant smart home solutions became one of compatibility.

How can each of these devices, often from different manufacturers with different communication and connectivity protocols, work together or be managed by a central home assistant device?

This is the question that Matter, the new smart home connectivity standard, strives to answer.

WATCHING THE SMART HOME GROW

Looking at the history of the smart home provides an opportunity to understand the key technology that creates a foundation for the development of Matter.

Making the Home Smart

Almost immediately after the advent of electricity in the home, the notion of automating household tasks and connecting the associated appliances to each other began to permeate the engineering community. As early as 1950, the first appearance of a smart home made its way onto the cover of Popular Mechanics. "Push Button Manor", as it was called, featured a bevy of interconnected switches, lights, appliances, and the like, permanently wired within the walls, ceiling, and floors of the house.

Soon after, in 1969, computational modules from Westinghouse were added to create the first computerized version of a smart home. Offering many of the same controls and features seen in modern home assistants like Amazon's Echo, this original design called the "Echo IV" debuted in Pittsburgh, Pennsylvania almost half a century earlier.

In both Push Button Manor and the Echo IV smart home, the vision of how intelligently connected electronic devices could make life around the house easier, more efficient, and arguably more enjoyable was already well defined. Unfortunately, the available technologies were still several decades behind where they needed to be.

In 1975, Pico Electronics introduced what became the first widely adopted home automation protocol, a new communication standard they called "X10." Using powerline modulation, the X10 protocol effectively created a network of devices plugged into a home's AC power wiring. Controllers, timers, and even wall-mounted light switches could be configured to control light bulbs, appliances, thermostats, and other devices to enable the most common home automation tasks. Though simple and limited in functionality, the X10 system gained mass popularity and is, in fact, still actively operating today.

The final piece to the smart home puzzle, the widespread adoption of internet connectivity, came on the scene in the late 1980's. Local area networks and high-speed data connections opened up a whole new world of opportunity for home automation - a world which continued to expand and mature with the advent of wireless standards, cellular connectivity, and cloud computing. By 2010, nearly every electronic device in the home was somehow connected to the internet directly or indirectly via a smartphone, ushering in the era of the Internet of Things (IoT).

matter

Matter ensures seamless interaction between connected smart homes and smart building devices across different IP technologies. The standard ensures that multiple brands can interact smoothly and securely ensuring data privacy.

The Matter application layer allows wide adoption by addressing many applications in an open-source delivery and certification infrastructure.

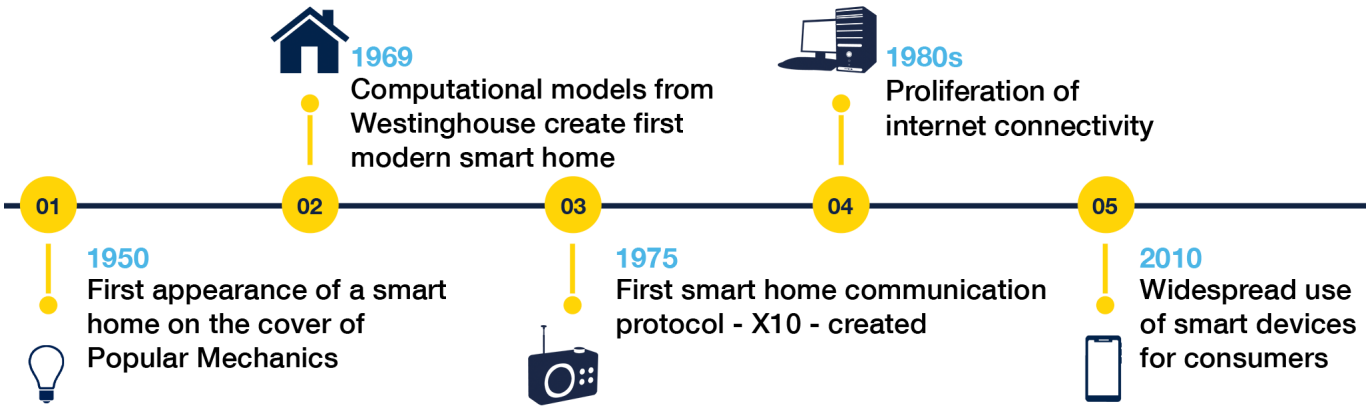


Figure 1 - The evolution of smart home technology from 1950 to present.

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STM32 MCU solution for Matter:
The promise of seamless device interoperability in smart homes

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SMART HOME PROTOCOLS

In order to understand why Matter evolved as a response to the fragmented smart home market, it's important to first explore the landscape of connected devices and the various standards used in modern home automation.

Ethernet and Wi-Fi

At the most basic level, all of these devices must offer two critical characteristics to the end user: security and ease of use. These features are often contradictory, and historically more secure devices were the most difficult to set up and integrate. Depending on the application, the market is further divided by throughput. Devices that require high data rates for streaming video or music are typically not energy constrained, whereas low data rate devices, like peripheral sensors, are often battery powered and sometimes inaccessible. To address these different requirements, a handful of communication technologies have risen to the surface over the last decade, all of which offer high levels of security and user friendliness. For high throughput applications, wired Ethernet and Wi-Fi have become ubiquitous. For low throughput, the 802.15.4 standard has taken a prominent role, most commonly within the Thread and ZigBee architectures.

Ethernet has been a mainstay networking technology since its introduction in the early 1970's, and in conjunction with the Internet Protocol (IP), serves as one of the key technologies making up the internet as a whole. Standardized as IEEE 802.3, Ethernet is commonly used for building local area networks (LAN) that allow computers to communicate with each other at high data rates over wired connections. In the smart home application space, certain devices like video cameras, televisions, and home assistants can be directly wired into an Ethernet LAN.

Wi-Fi can be thought of as the wireless extension of Ethernet, allowing LANs to be formed without any physical cables. Built on top of the same standard and specified under IEEE 802.11, Wi-Fi and ethernet coexist in most homes today, and form a flexible and powerful backbone for connecting any number of smart home devices.

Figure 2 - An example of the modern smart home.

Matter

Shown in Figure 3 (right), Matter is a high-level standard layer that builds upon IP connected devices networked using Ethernet, Wi-Fi, or Thread. Its main goal is compatibility and interoperability between devices, apps, and networking hardware.

In the past, low-power sensors and control devices required proprietary hardware hubs and applications in order to connect them to the larger home network or the internet. The result was a fragmented ecosystem where the end user might have a mashup of different hardware, software, and connectivity options. For example, a home owner might have installed a Wi-Fi network, then purchased a Zigbee-based door lock, and would then like to control it using an Amazon home assistant from their Apple phone. While achievable, the resulting solution is inelegant, requires many moving pieces, and is fragile should any of the software or hardware be updated in the future.

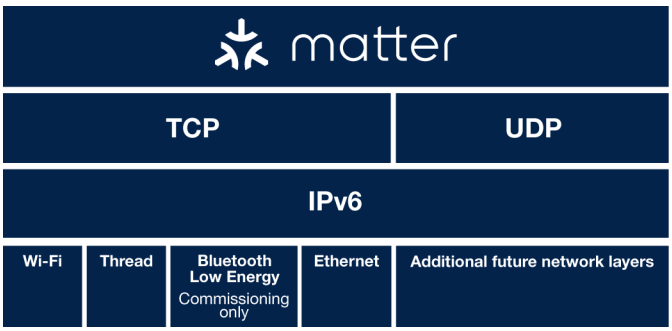

Figure 3 - Matter and its basis of IPv6 and Wi-Fi, Thread, BLE, and Ethernet.

With Matter, all the same stakeholders can guarantee that their devices work together and can be networked to each other with ease.

IEEE 802.15.4 and 2.4-GHz Mesh Networks

To address the need for wirelessly networked devices that are battery powered, lower data rate, energy optimized protocols were developed such as IEEE 802.15.4, which offers mesh networking for low latency, low speed sensor and control applications. Mesh networking allows devices to connect to each other and pass data throughout the entire mesh of devices. This enables long range communication with low power transmitters and eliminates the need for a central hub or router. The IEEE 802.15.4 standard was developed in 2003 in the 2.4 GHz band. In general, these types of networks are referred to as wireless personal area networks (WPAN) and are geared toward transmission ranges of 10 to 30 meters at data rates of at most 250 Kbit/s. In the home automation space, they are well suited for simple devices like light switches or small, battery powered sensor nodes. Devices can be connected to each other using a mesh network topology and are secured using well established encryption techniques.

The first widely adopted protocol built on 802.15.4 was introduced in 2005 as Zigbee. It became popular among IoT device makers and could be easily integrated into traditional IP based home networks by using a Zigbee hub. For the better part of two decades, Zigbee continued to mature and gained a host of features including longer range, enhanced security, and new routing topologies.

In 2016, another 802.15.4 standard arrived on the scene, with very similar features to Zigbee, and a few critical differences. This new protocol, called Thread, also offered low-power mesh networking in the 2.4 GHz band. Its key advantage, however, was that Thread devices were IP addressable. As long as the mesh network contained what's known as an "border router" (an Ethernet or Wi-Fi device also containing a Thread radio), then Thread devices could be accessed using traditional internet-based tools. This offered manufacturers and developers flexibility in the way their devices were interfaced across multiple networks and user applications. It is worth noting that unlike Zigbee, Thread is agnostic to the application layer, which is the highest layer in a protocol that determines the interface to the end user. This requires developers to build out their own solution for a given application, rather than leaning on a predetermined specification.

Thread has continued to gain support and evolve over the last several years, fueled by the fact that it is based on proven open source standards. In 2019, several of the largest consumer product companies including Apple, Google, Samsung, and Amazon announced an alliance to use Thread, Wi-Fi, and Bluetooth Low Energy (BLE) to promote interoperability and compatibility among smart home devices. This new system was titled "Project CHIP" (Connected Home over IP) and is poised to define the future of home automation. In 2021, the Connectivity Standard Alliance (CSA) is created and project CHIP is rebranded "Matter."

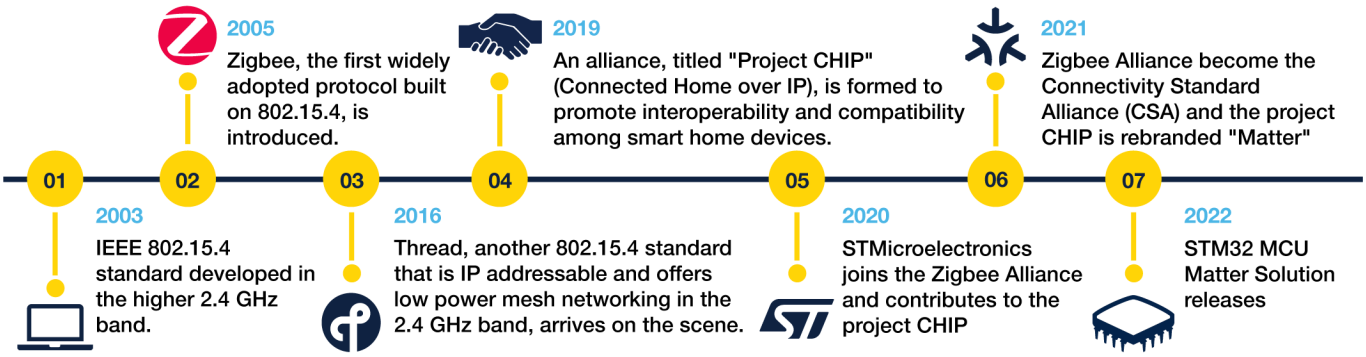

Figure 4 - The history of wirelessly networked devices toward Matter.

WHAT ARE THE BENEFITS OF MATTER?

Matter ensures seamless interaction between connected smart homes and smart building devices across different IP technologies. The standard ensures that multiple brands can interact smoothly and securely ensuring data privacy.

- Low-power solutions for battery-operated devices
- Comprehensive ecosystem for rapid development
- Multiprotocol wireless support required for Matter
- Strong security and data privacy mechanism to protect consumers

Bluetooth Low Energy (BLE) and Provisioning

Bluetooth is often referenced as an important part of the Matter implementation. While Bluetooth does have networking capabilities, its purpose in the Matter ecosystem is purely for provisioning, and not actually a requirement. Matter devices can be provisioned and added to a network in a variety of ways, but BLE is one of the easiest and most user friendly. Specifically, the Bluetooth Low Energy (BLE) wireless protocol is a lightweight, easy to implement method for securely communicating with a hardware device before bringing it into a network. Wi-Fi credentials, settings, and even authenticity checks can be performed from any smartphone or even other BLE capable hardware. The user simply points their phone camera at the device QR code, and the rest happens automatically. This method of onboarding using BLE has become popular among many existing manufacturers, and all but guarantees that a user can connect to a newly purchased device with minimal friction.

STMicroelectronics offers state-of-the-art, easy-to-use Bluetooth Low Energy solutions with systems-on-chip (SoC), baluns, and STM32 microcontrollers all supported with a rich evaluation and development environment for reducing time to market.

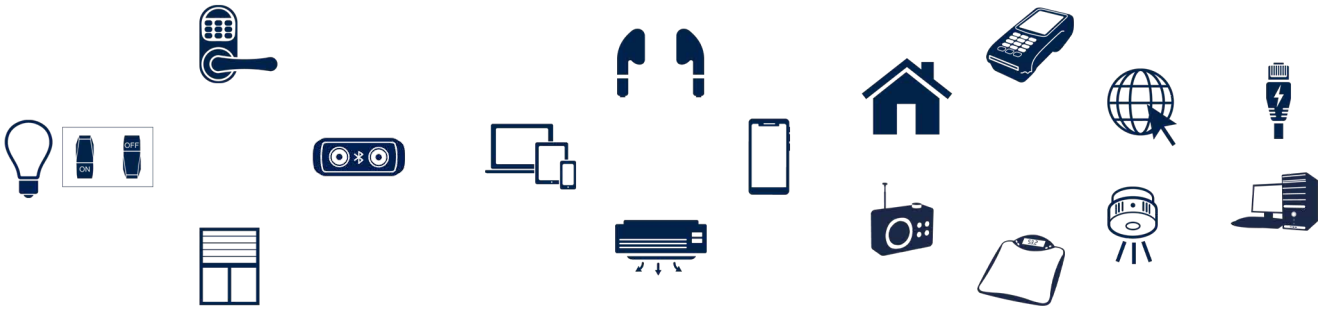

Figure 5 - System topology showcasing the many different types of devices.

THE EVOLUTION OF MATTER

Given the long history of smart home connectivity, it's no wonder that some confusion has surfaced surrounding the organizations involved in the development of Matter. Starting in 2002, as a response to the early development of the Zigbee standard, a group of companies came together to form the Zigbee Alliance. Their stated goal was to "ignite creativity and collaboration in the Internet of Things, by developing, evolving, and promoting universal open standards that enable all objects to securely connect and interact." At the time, the Zigbee protocol was the clear forerunner in IoT connectivity. The Zigbee Alliance, however, soon expanded their expertise beyond just 802.15.4, and began to focus in other areas such as green energy, home entertainment, and applications that were outside the scope of just Zigbee. As a result, in 2021 the alliance was rebranded as the Connectivity Standards Alliance (**CSA**).

In 2019, a new endeavor was born to finally standardize the fragmented home automation market, and several companies came together to form the "Connected Home over IP" project (CHIP). Amazon, Apple, Google, Samsung, and the Zigbee Alliance (soon to be **CSA**) were the first companies to spearhead the effort, with a focus on maximizing compatibility and ease of use for smart home devices including mains power plugs, electric lights and switches, door locks, thermostats and HVAC controllers, blinds and shades, home security sensors, and televisions and streaming video players.

Project CHIP was then rebranded as Matter in 2021 as other companies, such as IKEA, Huawei, and Schneider joined the team, and the **CSA** took on its new name.

Matter is the first protocol that truly gathers all in the chain of connected devices under one umbrella. At the top level, Google, Apple, Facebook, and Amazon are offering Matter-enabled smart assistants. Device vendors have integrated Matter into their smart phones, tablets, and other electronic controllers. Home automation manufacturers are building Matter-compatible switches, sensors, and appliances. Integrated circuit companies like STMicroelectronics are designing matter into their chips, ensuring compatibility with Wi-Fi radios, BLE radios, and other required hardware features.

This vertical integration of the Matter standard is a primary reason why its adoption is so notable and likely to change the smart home connectivity landscape. For the first time, smart homes will be capable of living up to the higher-level promises of sustainability, energy conservation, and convenience. For example, homeowners and energy providers can work together to set goals and incentives based on actual home appliance data. In turn, appliances can be optimized to meet those goals through automated scheduling, reporting, and functional customization. At the end of the day, users within the matter ecosystem will enjoy the benefits of optimized performance, a customized experience, and overall cost savings, while other stake holders can make good on their promises of sustainability and profitability.

MATTER IS HERE TO STAY

It has taken nearly 75 years to arrive at a standardized technology to realize the original vision of a smart home. Matter leverages the power and stability of IP addressing on top of mature connectivity standards to guarantee interoperability among wired and wireless devices across numerous applications. This offers benefits both the consumer, who desires a seamless experience and frictionless setup process, and the manufacturers, who don't have to build out an entire walled ecosystem of products and can instead rely on third party apps, designers, and developers to quickly bring products to market.

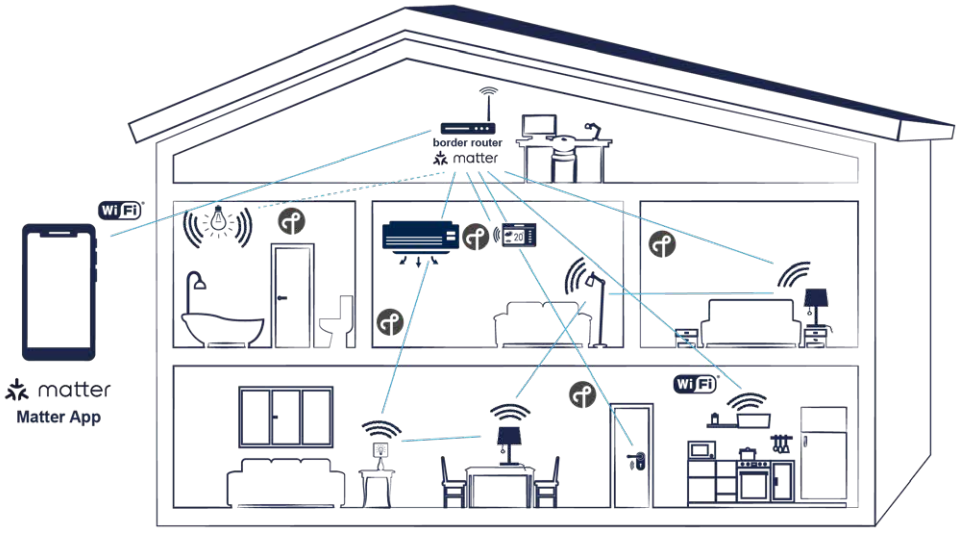

Figure 6 - The matter built smart home.

As shown in Figure 6, a Matter-built smart home will contain Wi-Fi devices, wired devices, Thread devices, and an internet gateway. Smart home assistants will act as Matter controllers allowing the consumer to easily onboard new devices to their network over Bluetooth Low Energy.

For legacy devices, users have two options for adding them to a modern Matter system. If the device supports IP-based communication over Wi-Fi, Ethernet, or Thread, then the manufacturer can offer a path to upgrade for Matter compatibility. If instead the device uses a non-IP communication system, then Matter offers a path for specialized bridges to integrate it into the Matter ecosystem. In either case, the goal of a unified smart-home protocol should be achievable and assuage any fears of making existing hardware obsolete.

While the COVID pandemic put the brakes on the roll-out of Matter, it has since regained momentum and is achieving market visibility. Matter devices were one of the focuses of CES 2023, and the platform is predicted to outpace the combined growth rates of all other smart home connectivity ecosystems combined.

As shown in a **2023 Statista forecast** and expressed in Figure 7, smart home revenue is steadily growing across all segments. Most importantly, each of the segments is a prime target for matter compatibility. With the **CSA** and most of the biggest names in consumer electronics helping to bolster the effort, it seems all but a foregone conclusion that Matter will be the de-facto standard for home automation in the coming decades. Matter devices were a main focus of CES 2023, and the platform is predicted to outpace the combined growth rates of all other smart home connectivity ecosystems combined.

STMicroelectronics has invested in a complete product portfolio for each of the different Matter device types, offering low-power solutions for battery-operated devices, a comprehensive ecosystem for rapid development, multi-protocol wireless support, and industry-leading quality assurance. This focused support speaks to the level of commitment that chip makers and hardware designers are making to Matter.

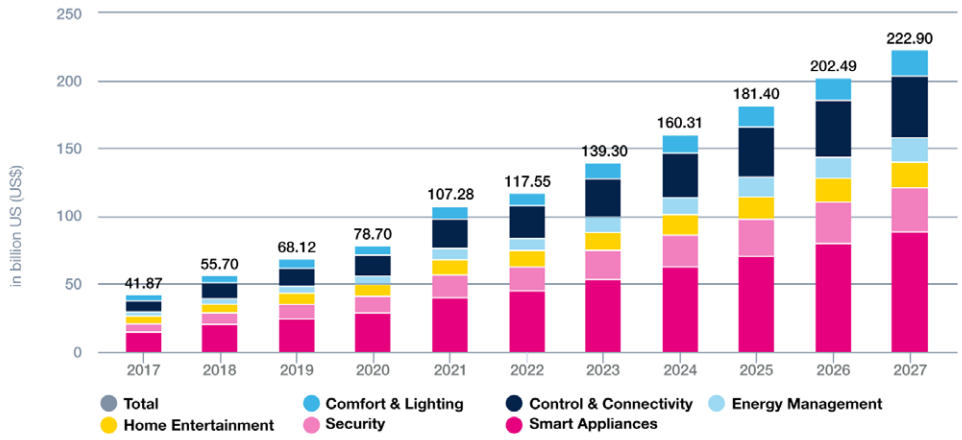

Figure 7 - Smart home revenue by segment from 2017 forecast through 2027, courtesy of Statista.

MATTER AND STMICROELECTRONICS

When it comes to building Matter hardware, a few minimum requirements must be met:

- Minimum 1 Mbyte of Flash and 200 Kbytes of RAM (CSA recommendation)
- Connectivity of either Wi-Fi, Ethernet, or Thread
- Compliance with IPv6 through TCP or UDP
- Onboarding over Bluetooth Low Energy or standard network provisioning
- Running the Matter protocol application including necessary encryption algorithms

To achieve these requirements and offer a complete, one-stop Matter development platform, STMicroelectronics has introduced the STM32WB series of devices. These chips satisfy all the requirements for bringing a Matter product to market.

As with all of ST's microcontroller products, our dual-core, multiprotocol wireless **STM32WB** microcontrollers are also supported by the popular STM32Cube development platform, enabling easy device configuration, providing mature driver libraries, and delivering the development tools to accelerate the development process. In addition, ST provides full-featured example projects with ready-to-use sample code for for Border Router, end device, and Matter to non-Matter technologies bridge. The end device example is complete with Bluetooth Low Energy onboarding and Thread connectivity.

STMicroelectronics is committed to the success of developers using the Matter standard and plans to continue growing the line of Matter capable microcontrollers. To learn more, and begin developing Matter applications today, visit: **www.st.com/stm32-matter**

> "Smart home devices should be secure, reliable, and seamless to use. And with Matter, they are."
>
> - The Connectivity Standards Alliance

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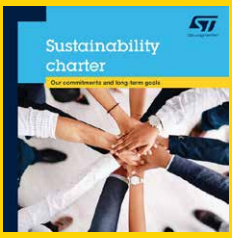

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