FUTURE-PROOFING THE SMART HOME

matter *promises plug-and-play interoperability that will spur growth*

> **The Connectivity Standards Alliance's Matter (previously Project CHIP) promises to deliver what Smart Home needs to meet its full potential. Here's why we're on board.**

1 INTRODUCTION

At first glance, the **Smart Home** market seems to be thriving. Revenue has been gaining momentum in recent years, as device manufacturers and service providers leverage several trends, including expansion in the **Internet of Things (IoT)**, increased interest in home automation, and growing demand for cloud-connected devices in the home.

Consumers around the world are installing a wide variety of devices that make their homes more convenient, more energy efficient, more entertaining, and more secure. And yet, while Smart Home has grown faster than many other consumer segments there is much more upside potential if smart home devices provided significant improvements to the user experience. Addressing obstacles that limit the user experience will drive adoption.

The main obstacles to growth have been lack of standardization and technical complexity. At present, the market is fragmented, with different connectivity protocols (Zigbee, Thread, Bluetooth, Wi-Fi, etc.) operating on different ecosystems (from Amazon, Apple, and Google, among others), that it's confusing to know how to proceed and difficult to develop and support for.

On the demand side of the equation for consumers, the number of options can be overwhelming and the lack of interoperability can lead to overly complicated installations, cobbled together to support a mix of incompatible technologies or a range of smart devices working independently of each other.

Focusing on the application layer and network transport layer and for service providers supporting a given ecosystem, there is the added burden of having to verify which devices are compatible with the selected approach.

To make matters worse, this drag on growth is coming at a time when Smart Home is poised to deliver more than ever. There are a number of exciting new capabilities – including artificial intelligence, interactive video, and more advanced sensor technology – that promise to make Smart Homes dramatically more responsive, intuitive, and secure thereby significantly improving the end user experience. Developers are already demonstrating some of these capabilities, and they are impressive. But unless something is done to resolve the issue of fragmentation and create greater interoperability, these new capabilities will fail to deliver on the promise of Smart Home. Resolving these issues will result in major improvement to the user experience, making it simple, effective and helpful.

Fortunately, industry leaders are taking steps to resolve the issue of fragmentation. Matter aims to use standards and certifications to create interoperability. The goal is to create a common language for Smart Home protocols so devices will be able to communicate freely, without translation, and to define certification programs that help guide development and buying decisions.

Matter was initiated by the Connectivity Standards Alliance (previously Zigbee Alliance), a prominent industry standards organization in the IoT. It has attracted some of the biggest names in technology and stakeholders from across the Smart Home industry, including semiconductors, systems, software, and consumer goods.

Focusing on the application layer and network transport layer, the Matter Working Group will create a standard designed to improve compatibility, simplify provisioning, and increase security. With Matter in place, device manufacturers and service providers will have a more scalable and sustainable way to introduce innovative products. And, the Smart Home will deliver the kind of plug-and-play interoperability that consumers want. All this will make it easier for consumers to select, install, and enjoy Smart Home functionality.

NXP is on the Connectivity Standards Alliance Board and is a contributor to Matter. We view the effort as a necessary step in enabling Smart Home growth and are using our deep experience in processing, connectivity, and security to help define and implement the Matter standard.

This paper takes a closer look at the origins and implications of Smart Home fragmentation, explains how Matter will improve compatibility, and highlights the aspects of Matter most relevant to NXP's approach to innovation in Smart Home.

2 HOW WE GOT HERE

Application/ Accessory	Thermostat	Light Switch	Door Lock	Light Bulb	Fan	Garage Door	Audio System	Smart Speaker	Sprinkler Control
	Security System	Appliances	Smart Sensors	Spa/Pool Control	Window Covering	Power Outlet	Hub/ Bridge	Doorbell	
Voice Assistant	Alexa (Amazon)	GVA (Google)	Siri (Apple)	Tingting, xiaoQ, Small Q (Tencent)	DuerOS (Baidu)	Xiao AI (Xiaomi)	AliGenie (Alibaba)	Embedded Voice	
Home Control Ecosystem		Mi Ecosystem	OCF	Smart Things	HomeKit	ZCL (Zigbee)	Weave		
Transport	Wi-Fi	Ethernet	Zigbee	Thread	Z-Wave	Sub 1GHz Proprietary	Bluetooth LE	UWE	NFC

(✦ matter spans Smart Things, HomeKit, ZCL (Zigbee), Weave)

One reason why Smart Home is so fragmented is that it covers such a broad category of use cases, and these various use cases are supported by protocols that evolved at different times and for different reasons. Also, these use cases are driven by ecosystems that are designed to operate on their own, without interacting with other ecosystems. The presence of so much diversity, in terms of application frameworks and ecosystems, has made Smart Home a remarkably complex environment to work in.

Protocol Possibilities

Network protocols that support Smart Home use cases started appearing decades ago. In that time, the need for varying levels of power and data rates has led to the development of different wireless protocols and, as a result, many Smart Home environments use a mix of protocols.

For example, sensors, door locks, and other devices that require a low data rate for control and configuration, need to be very power-efficient. The standard requirement is that a given device needs to run for two to five years on a single small-sized battery. The short-range network protocols that support this kind of low-power operation include Zigbee, Thread, Bluetooth Low Energy (Bluetooth LE), and Bluetooth Mesh. Thread and Zigbee PRO are mesh technologies based on the IEEE 802.15.4 radio providing for robust networks with Thread being based on IP. Bluetooth LE is designed for point-to-point communications. At the other end of the spectrum, you have devices like video cameras, and appliances with large, interactive screens, which use more data and consume more power. These devices require a Wi-Fi connection. Depending on the end application, one or multiple protocols will be used. For example, Bluetooth LE is often used to join devices to an existing home automation network and then Thread or Zigbee to interact with other devices on the same network.

Application Framework

These various low- and high-power protocols serve different purposes and need to be able to co-exist in the Smart Home environment, but each protocol uses a different application layer (or language) for network communication. With Wi-Fi, the options are HTTP, MQTP, and CoAP, with Bluetooth it's GATT, Zigbee uses Zigbee Cluster Library, and with Thread options include HomeKit, Weave or Dotdot (ZCL over IP). For these protocols to work together and co-exist in a single Smart Home environment, translation mechanisms are needed.

If a Wi-Fi light switch, for instance, is going to control a Zigee lightbulb, a translation mechanism needs to be built into the gateway that connects the two devices. The problem is that there's no standard definition of what makes a light switch or a lightbulb, so there's no standard way to translate between the two. What's more, translation is complicated, requiring an extra step in design and operation. There is simply no easy way to bridge Wi-Fi, Bluetooth LE, Zigbee, and Thread without having an engineer write dedicated code to enable.

For consumers to have the seamless experiences they want from their Smart Home installations, the ecosystem has to support translation. Any device that claims to work in a given ecosystem needs to be tested and confirmed by the respective ecosystem provider. Different operating environments approach translation differently, so it's not possible to build a single device that operates in every situation. Translation needs to be managed on what is essentially a case-by-case basis, with specific mechanisms developed for just about every product delivered to market.

Device manufacturers can choose to save time and effort by designing for a single environment, at the risk of losing opportunities in other environments, or can spend the time and money required to create multiple SKUs of the same product, each designed for a different environment. Either way, there are significant business risks associated with the decision.

Ecosystem Diversity

At the same time that there are many different Smart Home protocols in play, there are many different operating environments or ecosystems for Smart Home currently in use worldwide. Each ecosystem is associated with a particular company.

A look at the situation in the United States gives a snapshot, with different companies using different points of entry, depending on their background. With Amazon, Apple, and Google, for example, the voice assistants and smart speakers used as the point of control are associated with distinct operating environments. Comcast, on the other hand, has approached Smart Home from their position as a leading provider of internet, phone, and TV service, with Smart Home services offered as add-ons. Samsung used their acquisition of SmartThings, an early entrant in home automation and the IoT, as an entry point. Samsung and Comcast both use an approach that is similar to that of Amazon, but a device that works in their similar ecosystems may or may not work in the Apple or Google ecosystems.

amazon

Amazon

The popular Alexa voice assistant from Amazon uses the Zigbee protocol with the Zigbee Cluster Library (ZCL) application layer. Zigbee was one of the earliest protocols used in home automation and there are millions of Zigbee-based products already deployed in the market. This has made it easier for Amazon to offer a wide range of devices that are interoperable with Alexa. Comcast and Samsung also use ZCL.

Apple

The company's HomeKit is an application layer that lets end users communicate with and control connected accessories in their home. HomeKit works with the Siri voice assistant and, at present, is closely aligned with Thread, Bluetooth LE and Wi-Fi.

Google

Having acquired Nest, a company known for their smart thermostats, Google introduced the Nest-created Weave application layer. Google also supports Thread.

Specialty service providers

Another type of ecosystem, created and supported by specialty service providers, adds an extra layer of complexity to the Smart Home landscape. These service providers offer dedicated, subscription-based services for turnkey home automation supported by ongoing maintenance and monitoring contracts.

In the United States, one such company is ADT, a specialist in electronic security that now protects homes with professionally installed and monitored alarm systems for fire, intrusion, and senior safety. ADT specifies the devices to be installed in a home and maps the functionality of each device into their software and cloud platform. If they want a window sensor to indicate if the window is open or closed, for example, they work with the device manufacturer to configure the feature and link it to their system, so ADT can take action if there's an indication that something unexpected has happened with the window.

Service providers like ADT are also likely to dictate several other operating parameters, such as the networking protocol, provisioning mechanism, security algorithms, and application layer. This can create challenges for any device manufacturer that supplies to multiple service providers, since they need to comply with so many differing specifications.

What this means for security

Effective security is a necessary part of any IoT device, since hackers often target connected devices when they want to gain unauthorized access to the broader network. With Smart Home, though, security takes on added importance, since so much of the data that Smart Home deals in is private and needs to be protected. Even something as simple as a cloud-connected thermostat can indicate when you're home and when you're not, or provide a way in to the network that contains all your personal information.

Smart Home is about improving your daily routines and habits, and what can be convenient for you can be useful to criminals. Without the right security and privacy measures in place, Smart Home has the ability to increase what cyber professionals refer to as the "attack surface" of your home, putting your privacy and safety at risk.

The security mechanisms used to protect devices and the network vary from ecosystem to ecosystem. In particular, the methods used to let a device gain access to the network, in what's termed provisioning, can vary quite a bit. Provisioning needs to include authentication and authorization of devices before joining the network. Device manufacturers have to learn and support the approach used by each ecosystem they work in. The high degree of protocol and ecosystem diversity makes it harder to approach security as a whole, since there are so many different individual actions and vulnerabilities to protect.
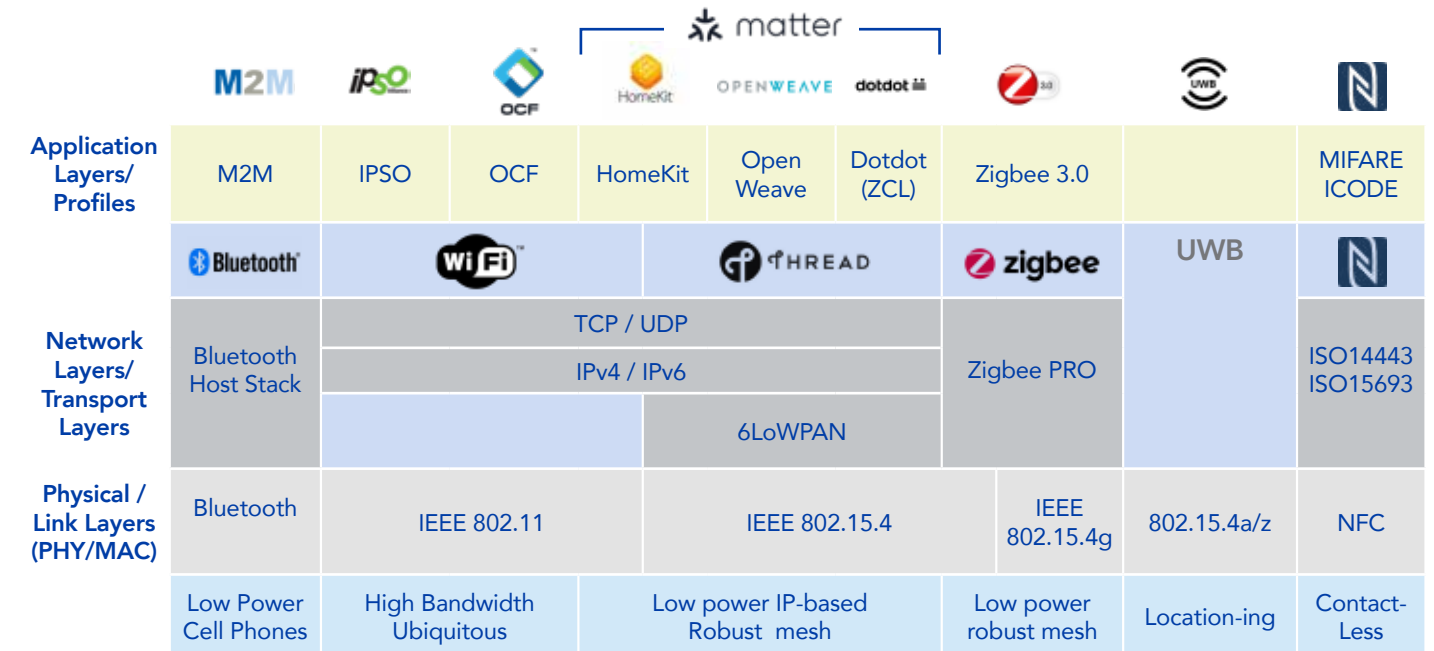
The Importance of Secure Provisioning

Secure provisioning gives an IoT device a unique identity. Without an ID, the device can't join the network or use the network to send and receive data. How the device ID is managed and stored, as part of provisioning, has implications for how protected the device is from hacks.

Fragmentation Prevents Growth

Today's device manufacturers have to support many different but similar products that aren't interchangeable. This is expensive, wasteful, and resource-intensive. The diagram gives a snapshot of how complex it is to design for the IoT in general and Smart Home in particular. Developers have to consider more than a dozen formats for the layers that cover physical/media, network, and transport, and multiple formats for the application layer. Navigating the options is serious challenge for even the best of development teams.

			matter					
M2M	iPSO	OCF	HomeKit	OPENWEAVE	dotdot	Zigbee	UWB	NFC
Application Layers/ Profiles								
M2M	IPSO	OCF	HomeKit	Open Weave	Dotdot (ZCL)	Zigbee 3.0		MIFARE ICODE
Bluetooth	WiFi		Thread			zigbee	UWB	NFC
Network Layers/ Transport Layers								
Bluetooth Host Stack		TCP / UDP				Zigbee PRO		ISO14443 ISO15693
		IPv4 / IPv6						
		6LoWPAN						
Physical / Link Layers (PHY/MAC)								
Bluetooth	IEEE 802.11		IEEE 802.15.4			IEEE 802.15.4g	802.15.4a/z	NFC
Low Power Cell Phones	High Bandwidth Ubiquitous		Low power IP-based Robust mesh			Low power robust mesh	Location-ing	Contact-Less

Today's Smart Home is a Complicated Mix of Protocols and Applications

The complexity of designing for Smart Home also makes it harder to innovate. With so many protocols and ecosystems to support, it's that much harder for Smart Home applications to become truly helpful. This is a discouraging situation at the best of times, but right now, it's especially so. That's because, technology for Smart Home is at an inflection point, ready to take functionality to the next level.

Several important trends, including artificial intelligence, interactive video, augmented and virtual reality, and sophisticated sensing technologies, are coming together to create Smart Home capabilities that are truly seamless. Building on what's referred to as context-aware or ambient computing, Smart Home has the potential to become much more intuitive and efficient while becoming more personal and sustainable.

A mirror that displays your calendar as you get ready for your day. A plumbing system that monitors water flow to find leaks and can shut off the water supply if a pipe bursts to prevent damage. Refrigerators that can suggest recipes based on what you have on hand, and ovens that use cameras to ensure baked goods don't overcook. An entryway that senses your direction of movement, turns on the porch light, uses facial recognition to disarm your security system, sets your indoor lights and temperature to your preference and unlocks the door as you approach and then rearms your security system and relocks the door once you've passed through.

All these things are possible today or will be soon. However if consumers have to work too hard or pay too much to add these conveniences to their home networks, these new capabilities will fail to take hold. In other words, the need to address fragmentation is not just an issue for today, but a necessary step for creating a foundation on which the next generation of Smart Home systems can be built on.

[AI icon]	**Artificial intelligence and Machine Learning**	[AR icon]	**Augmented and virtual reality**
[voice icon]	**Voice assistants**	[sensing icon]	**Sophisticated sensing technology**
[video icon]	**Interactive video**	[computing icon]	**Advanced computing at the edge**

Learning from the past

This is not the first time the consumer electronics industry has faced problems with fragmentation its associated limits on growth and innovation. Something similar occured when USB (Universal Serial Bus) was introduced. A quick look at USB's history can inform how to move ahead with Smart Home.

In the 1990s, just about anything you attached to your computer – a mouse, a printer, a hard drive – had its own cable, plug, and port. There were serial and parallel ports, PS/2 connectors, SCSI cables, and, if you had an Apple computer, a Firewire cable. All these interfaces required software support, and any time you installed a new device, it required a driver installation, multiple reboots, and sometimes even a hardware change or two.

With the introduction of USB, computers needed only one type of port for most peripherals, and the devices essentially configured themselves once connected to your computer. You could buy a printer or a scanner or an external hard drive without worrying about physical device configuration or having to resolve resource conflicts. Plug it in, and you were ready to go. (The term "plug and play" actually predates USB, but USB helped make it a familiar, everyday phrase.)

USB made lifer easier for consumers, but it also helped rejuvenate the computing market. As the standard continued to evolve, and offered higher data rates, developers started creating new, higher-performance peripherals, such as external CD drives and mobile-phone chargers. There are now billions of USB devices in the world, and the pain of connecting computer peripherals seems like ancient history.

The same kind of simplifying, unifying, and inspiring approach is what's needed now for Smart Home. And, fortunately, work is underway to deliver just such an approach.

> *To increase adoption and spur growth, Smart Home needs to deliver seamless, plug-and-play experiences.*

3 ENTER MATTER

Oftentimes, the most effective and efficient way to address fragmentation is through an industry-wide effort driven by an independent organization. In the case of Smart Home, we now have an industry-wide effort driven by the Connectivity Standards Alliance, an organization originally founded in 2002 to guide development of the Zigbee standard, but which now focuses on broader technologies for the future of the IoT.

In December 2019, the Zigbee Alliance, now Connectivity Standards Alliance, announced a new initiative, with the temporary name "Project Connected Home over Internet Protocol," now called Matter. The Matter Working Group's mission is to develop and promote the adoption of a new, royalty-free connectivity standard to increase compatibility among Smart Home products, with security as a fundamental design tenet." The long-term goal is to simplify IoT development, increase compatibility for consumers, ensure security and privacy, and create truly smarter homes.

Initiated by Amazon, Apple, Google, Samsung SmartThings, Connectivity Standards Alliance board member companies IKEA, Legrand, NXP Semiconductors, Resideo, Samsung SmartThings, Schneider Electric, Signify (formerly Philips Lighting), Silicon Labs, Somfy, and Wulian and >160 other member companies, the initiative is broadly supported.

The initiative brings together the largest ecosystems in Smart Home, including major personal assistant technologies available today, while also including important stakeholders from across the industry, including leaders in semiconductors, systems, software, and consumer goods.

Compatibility and Interoperability

Matter aims to make Smart Home both compatible and interoperable, so it's easier to design, deploy, and manage Smart Home devices. Products that are compatible can function in the same ecosystem without software conflicts, while products that are interoperable can function across different ecosystems without software conflicts.

The Working Group will create a platform, supported by ecosystem-agnostic technology, that lets Smart Home devices communicate with each other on any IP network, using a common language. The platform will draw on the best of today's market-proven protocols and ecosystems, including Apple HomeKit, Google Weave, and the Amazon ecosystem, which uses Zigbee Cluster Library.

Timeline and areas of focus

The Matter Working Group with 1,400+ contributors is working diligently on the version 1 specification, with its associated open-source implementation so manufacturers can begin to deploy products with Matter technology in late 2021. The Working Group's efforts focus on several key areas.
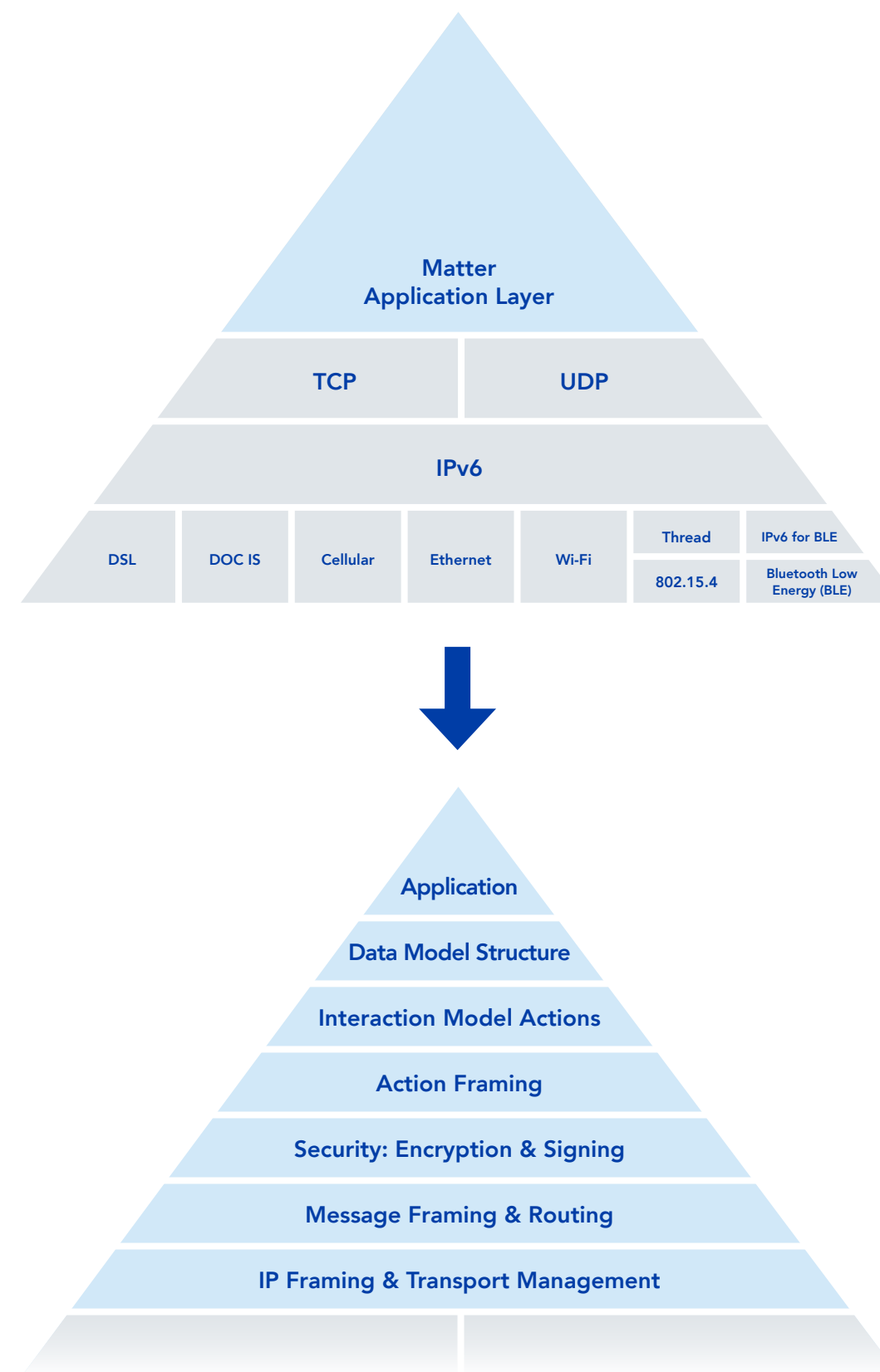
1. IP-based connectivity

The new platform will use Internet Protocol (IP) as the basis for connectivity. This will enable devices to communicate using one familiar, widely used protocol, without translation. Using IP will also make it easier to create consistent cloud and device data models, which in turn makes device design and deployment both simpler and more cost-effective.
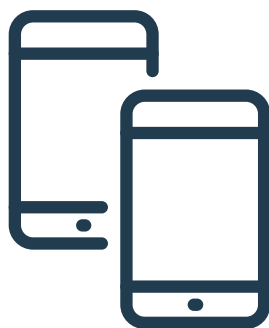
Why choose IP? Because IP remains the principal protocol for relaying data across networks. IP addresses are what make a device "findable" on the network, so data can be sent to and from the device. Also, IP routing is what moves data packets from one connection point to the next, and is was essentially makes the present-day internet possible.

Matter will make use of IP to create a dedicated application layer for Smart Home. The IP protocol will provide methods for device addressing, routing, host-to-host communication, and other mechanisms for transporting data. Standardizing on IP significantly reduces the need for translation because it enables devices to communicate with one another without having to repackage data or packets. Standardizing on IP in the application layer also makes it easier to address important issues like data security and how to safely provision devices onto the network.

Choosing IP-based connectivity lets Smart Home standardize on the sub-components of the network layer, including TCP/UDP for the transport layer, which are familiar parts of internet-based communication. Matter will begin with support for Thread and Wi-Fi for communications and Bluetooth LE for provisioning.

Matter will Unify the Network Layer and Simplify the Application Layer

TCP	UDP

IPv6

DSL	DOC IS	Cellular	Ethernet	Wi-Fi	Thread	IPv6 for BLE
					802.15.4	Bluetooth Low Energy (BLE)

Matter Application Layer

Application

Data Model Structure

Interaction Model Actions

Action Framing

Security: Encryption & Signing

Message Framing & Routing

IP Framing & Transport Management

2. Standard device definitions

Matter will define a common standard for what a device is, with a definition of its attributes. The standard will include include ways to manage the complete device life-cycle, including provisioning/onboarding, removal, error recovery, and software updates. To encourage development and make development efforts more cost-effective, the standards will be royalty free and open-source.

The result will be a universal framework and model for device designers to follow. With device manufacturers conforming to these models, there will be uniformity and interoperability across product lines, with simpler, easier installation and operation for consumers. Device manufacturers will be able to focus on innovation, since integration with Amazon, Apple, Google, and other ecosystems will be much easier. Device designers can also choose the appropriate network protocol that best fits their application, be it high-power or low-power, without having to create translators.

### 3. Comprehensive approach to security

Matter identifies security as a "fundamental design tenet," which means the working group will continually examine ways to improve security. The goal is to make Smart Home more resilient and reduce the number of attack points in connected devices. Security is one of the reasons why IP is the foundation for Matter, since IP includes market-proven algorithms and infrastructure that implement routing, switching, and firewalling in robust and resilient ways. Also, IP works with transport protocols like TCP and UDP, thereby creating opportunities to deliver end-to-end security and privacy when devices communicate with other devices, apps, or services.

4. Guidelines for certification

Matter will define a common framework for connectivity, with support for network testing and certification, along with a set of test plans to be used with all major ecosystems. Device manufacturers and test labs will have clear guidelines to follow for certification, and consumers will have an easier time selecting options because certified products can be trusted to work as expected in their given ecosystem.

Project Connected Home over IP Approach

IP-based connectivity	Royalty-free use	Open-source software
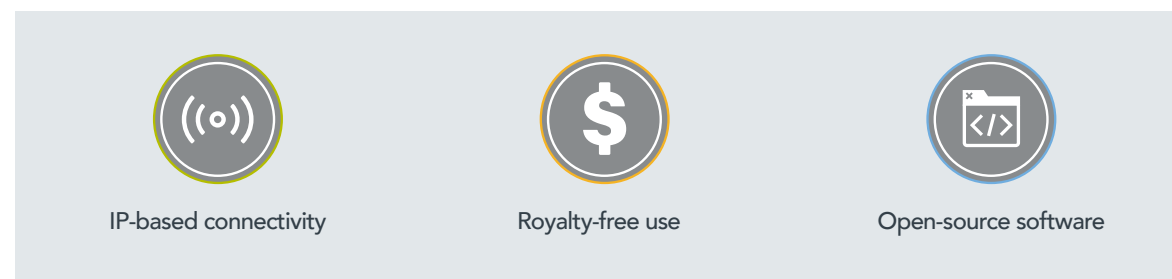
4 WHAT MATTER MEANS FOR THE FUTURE

Matter is a major step forward for Smart Home because it eliminates fragmentation by letting devices communicate via IP without needing to repackage data or packets. This is a dramatically simpler approach than what exists today. Also, with the backing of Apple, Amazon, Google, and other major players, the initiative has the critical mass needed to create ease of development for manufacturers and ease of use for consumers.

Device manufacturers will have a single application layer to deal with, instead of half a dozen, and because this unified application layer will be based on IP, designers will be able to choose the IP-based networking protocol or protocols best suited for their product, whether it's based on high 802.11 WLAN or a low-power version of 802.15.4 WPAN with Thread. The presence of common device models will accelerate adoption, deployment, and revenue, and will encourage innovation. Also, device manufacturers will be able to remove the burden of having to build and maintain a cloud service or app to maintain and service their devices. Consistency across devices and applications will create opportunities for expansion, too, as device manufacturers can cross over from home automation in the consumer sector to building automation in the commercial and industrial sectors.

For consumers, interoperability and certification will make it easier to select, install, and enjoy Smart Home products. The initial installation will be quick and hassle-free, and adding new components to the setup will be similarly easy. There won't be any more need to download and install different software components for each use case, and no need for extra (expensive) devices, such as dedicated hubs, gateways, translators, and proxies, to connect devices.

Moreover, Smart Home will become future-proof, because developers and service providers will have more flexibility and lower risk in delivering products, existing home networks will be able to accept new devices more easily.

Easier to develop. Simpler to use. Better for everyone.

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WHAT WE BRING TO MATTER

NXP has always been a strong contributer to standardization efforts, certification programs, and open-source initiatives. We firmly believe that Matter will bring significant value to the Smart Home in particular and the broader IoT in general.

We're in a leading position to contribute to Matter, because the main objectives of the initiative – compatibility, connectivity, and security – are directly aligned with our strengths. We maintain one of the most comprehensive portfolios for the IoT, with an exceptionally wide selection of advanced options for broadly adopted computing and wireless protocol needs which are supported by trusted, banking-level security. We're drawing on that expertise to help Matter meets its goals.

What's more, our decades-long history of innovation in computing, connectivity, and security gives us unique insights when it comes to developing a platform for Matter. It gives us an edge when focusing on software enablement to ensure this new approach is easy for developers to adopt flexible to support a variety of use cases and supporting architectures and makes it easier for us to deliver future-proof solutions for a variety of device types, gateways/routers, edge compute nodes and end nodes, that evolve over time with Over-The-Air (OTA) updates.

NXP Advantages in Smart Home

Advantages	Solutions
Edge processing intelligence	Low power LPC/Kinetis MCUs, high-performance crossover i.MX RT MCUs, advanced processing i.MX Application Processors and networking Layerscape processors
Network flexibility	Thread, Zigbee, Bluetooth LE, Wi-Fi, Ethernet, 5G, NB-IoT
Ambient awareness	AIoT, UWB
Simplified provisioning	NFC, Bluetooth LE
Security	Secure elements, embedded security

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GET INVOLVED

Device manufacturers can begin preparing for the new standard by working closely with their ecosystem partners to align their roadmaps.

Any Connectivity Standards Alliance members interested in participating in its development effort can join the Matter Working Group. For more information, visit the Matter website at www.buildwithmatter.com.

To learn more about NXP's support for Matter, and our approach to Smart Home platforms, visit **www.nxp.com/matter.**

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