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MATTER

DELIVERING ON THE SMART HOME IoT PROMISE

csa connectivity standards alliance   WiFi ALLIANCE

The commonly accepted growth rate for the number of smart home IoT devices shipped per year is 20-25%, leading to a projected installed base of more than 27 billion units by 2025. Despite the undeniable success of the smart home IoT paradigm, adoption of IoT by consumers and businesses have thus far suffered from a major shortcoming when it comes to connecting and using smart IoT devices from different manufacturers: Lack of interoperability. Matter 1.0 — the first version of the local, IP-based, open-source application layer protocol was launched by the Connectivity Standards Alliance in Novermber 2022 — resolves this pain point entirely by creating a single, standardized framework for devices, apps, and networking equipment to communicate over Wi-Fi, Thread, and Ethernet while adding functions for legacy smart home device support and Bluetooth Low Energy (LE) for easy onboarding.

Matter is poised to help create a consistent user experience for setup across the formerly siloed and proprietary smart home IoT ecosystems of major manufacturers including Apple, Amazon, Google, Samsung, and others. A vast community of silicon vendors, device OEMs, development platform providers, and ecosystem providers — several hundred members in all — are now committed to the new standard and contributing to its continued evolution and deployment. Matter brings significant benefits throughout the value chain, including for retailers. Beyond interoperability, Matter simplifies the user experience, increases purchasing confidence for consumers, fosters increased focus on innovation by manufacturers, and is hence poised to deliver a transformational boost to the smart home IoT ecosystem at large. It also promises improved performance, better reliability, and better security for smart home IoT.

The leading smart home ecosystem brands such as Amazon, Apple, Samsung SmartThings, and Google have been rolling out their services globally for decades. Millions of people all around the world are familiar with their user experiences and interfaces (UX/UI). The sheer convenience of knowing how things work keeps people loyal to a specific ecosystem provider. The providers have seamlessly integrated their user interfaces into various devices people use daily: smartphones, tablets, smart speakers, TVs, and more. For a user of smart home products, it is so easy to buy devices supporting their favorite ecosystem and control all their devices through the same user interface — whether a mobile app, smart speaker, or TV. Additionally, devices of a specific manufacturer supporting the same ecosystem can usually be combined, automated, and controlled through the ecosystem, delivering extra user value.

This report takes an in-depth look at the technological basis for Matter, its drivers, its inherent opportunities, as well as the challenges ahead in unlocking a multi-billion-device surge in smart home IoT growth, new applications, services, and use-case value.

Table of Contents

EXECUTIVE SUMMARY

The Importance of Matter to the Wi-Fi Industry

Interview with Kevin Robinson,
CEO & President of the Wi-Fi Alliance

Matter's Journey from Inception to First Release

Interview with Chris LaPre,
Head of Technology,
Connectivity Standards Alliance

The Importance of Matter to the Wi-Fi Industry

Interview with Kevin Robinson,
CEO & President of the Wi-Fi Alliance

How important is Wi-Fi for Matter and vice-versa?

Wi-Fi® lays the foundation that supports Matter, and Matter is a key element for growing the Wi-Fi IoT ecosystem. Wi-Fi's extensive capabilities and pervasive global connectivity make it uniquely suited to support IoT products, applications, and use cases. In turn, Matter is a home IoT connectivity standard that works at the application layer and leverages the inherent strengths of Wi-Fi to deliver interoperability between home IoT devices. When paired together, Matter over Wi-Fi CERTI-FIED™ imparts a sense of trust in users as they choose from a wide range of IoT devices that offer enhanced simplicity, interoperability, reliability, and security.

What are the biggest Wi-Fi industry opportunities regarding Matter?

Wi-Fi CERTIFIED and Matter together have the opportunity to fulfill the long-anticipated vision of home IoT. Wi-Fi is already ubiquitous with nearly 20 billion devices in active use, many of them IoT devices, but the barrier of application and service fragmentation prevented the level of mass consumer adoption in the IoT segment experienced by Wi-Fi in other product categories. By offering a more seamless experience, Matter and Wi-Fi will make a growing number of residential use cases more accessible to the user and drive the next phase of industry growth.

What role does Wi-Fi certification play within the Matter framework?

Matter certification requires Wi-Fi CERTIFIED as an essential ingredient in Wi-Fi IoT devices. This provides tangible benefits to users by ensuring that they will have a secure and easy-to-use experience with their devices, regardless of device vendor.

What impact will Matter have on the growth of Wi-Fi IoT?

We expect Wi-Fi CERTIFIED and Matter to create a profound impact on the growth of Wi-Fi IoT devices. The IoT market is predicted to reach as many as 27 million devices by 2025, and we expect that this number will only continue to grow as Wi-Fi CERTIFIED and Matter work to enhance the interoperability and dependability of IoT devices. This will be crucial as complex residential applications emerge, including smart home devices like smart plugs and door locks — all of which demand a seamless user experience.

What Wi-Fi standards are expected to play the most important role for Matter — now and in the future?

Wi-Fi 6 is playing an increasingly important role in IoT devices. While we tend to focus on its greater network capacity, multi-gigabit data rates, and lower latency, Wi-Fi 6 includes important tools to meet the needs of device vendors in the IoT space. Wi-Fi 6 delivers longer battery life and consistent performance even in homes and MDUs with large numbers of devices contending for the same spectrum. Wi-Fi also brings valuable tools for managing challenging network environments. For example, Wi-Fi Data Elements provides a standardized set of the most important key performance indicators for Wi-Fi network health, such as how many devices are on the network, use of bandwidth, signal strength measurements, and free airtime. Service providers can use this data to proactively and more effectively identify and resolve Wi-Fi network issues—often before a customer notices a problem.

Any particular segments and/or Wi-Fi IoT use cases you would like to highlight?

The potential use cases I am most excited about are those that fully leverage the incredible diversity of device categories and brands enabled by Matter running over Wi-Fi. For example, I can see a scenario where a motion-sensing camera detects a food delivery person walking up my driveway after dark. My home automation automatically turns on the coach lights on the front of my house and pops up a notification on my flat panel TV as I'm relaxing with my family. When the video doorbell rings, my movie is paused and replaced by live video from the front door. I grab my phone, which also received the doorbell notification, and initiate two-way audio to ask that they leave my delivery on the front step. Most importantly, all of this could happen using the camera, lighting, television, and smartphone brands I love. We may not be there yet, but these are the types of experiences that are only possible with agreed, interoperable industry standards.

Matter's Journey from Inception to First Release

Interview with Chris LaPre,
Head of Technology,
Connectivity Standards Alliance

How did the Matter initiative start?

It is probably fair to say that Matter was incubated as a result of Connectivity Standards Alliance member meetings starting as far back as 5-6 years where smart home IoT challenges and solutions were discussed at length. These included issues with interoperability, security, data privacy, and more. It took about three years to get from initial idea to the first Matter release.

What to you is most important about Matter as it stands today?

I believe our members have come together very effectively not only to solve all the most pressing IoT issues including interoperability, onboarding, security, and so on, but also to create framework principles for a standard that will last many, many years into the future. With all the tremendous support and strong contributions from our members, it truly has become an IoT connectivity standard for today, for the future, and for all connected things.

What do you believe will be the most immediate impact of Matter?

With many devices already supporting Matter, no question the standard will impact the entire smart home IoT ecosystem in the short term. Perhaps the most important single impact is that it will build consumer confidence in smart home IoT. Consumers will quickly sense that they don't need to be tech experts or fear smart home devices and instead simply enjoy all the conveniences offered by the modern smart home. This will transform the market.

How do you make sure Matter lives up to the industry's high expectations?

That is a big question and the answer probably requires an answer in several parts. First of all we're constantly improving and expanding the standard with two new releases per year. Secondly, we have put in place an outstanding certification program that makes sure that Matter products deliver the quality and consistent user experience that users expect and want. Finally, the standard itself makes use of tried and true technologies such as Wi-Fi, IPv6 networking, Bluetooth LE for onboarding, and more. We've simply designed a standardized application framework for consistently applying these excellent technologies.

How do you envision Matter evolving in the coming years?

We believe we've created a standardized foundation for connecting things in general. Smart home IoT urgently needs to be addressed but future use-cases may include connected buildings, healthcare, industry, even smart cities, wearables, and even connected vehicles. All of this is part of a broader vision of the Alliance for Matter and all of it is on the Alliance's long-term roadmap. We believe Matter will deliver tremendous new business opportunities for the entire IoT ecosystem and that Matter will have a lasting, positive quality-of-life impact on society as a whole and introduce innovations we probably can't even imagine today.

What opportunities does Matter bring to for example telcos and cablecos?

One of the most exciting things about Matter is that we've created — I believe — an unprecedented and universal foundation for IoT service innovation. One can imagine all kinds of intelligent services — home automation, person-alization, the extensive use of AI and cloud — delivered by service providers of all kinds for the home and the enter-prise. It is truly exciting to be part of such a potentially massive transformation and opportunity.

FUTURE USE-CASES

Connected Buildings

Healthcare

Industry

Smart Cities

Wearables

Connected Vehicles

1.0 Drivers for Matter Adoption

1.1 Basic and Behavioral Drivers

Broadband growth

Every smart home is first and foremost a broad-band-connected home. While it is theoretically possible for non-connected households to benefit from some types of IoT, in reality this is extremely rare. Globally, about 1.2 billion homes now have broadband access of some form, with an increasing fraction having access to fiber or high-speed cable connectivity. By 2030 this figure should be approaching 2 billion residential sites. While there will still be some with comparatively slow sub-30 Mbps connections, it will be common for consumers to have access to 100Mbps+ or Gigabit broadband, with fixed-wireless and satellite connectivity helping reach more remote or hard-to-connect homes.

Desire for home automation

For decades there has been a desire for home automation — whether that meant light-switches with mechanical timers, basic thermostats, or coffee machines brewing in tandem with a morning alarm clock. Early examples of smart-home systems have been around for many years. Now much more sophisticated options are both possible and affordable. Consumers are increasingly being given the option of better types of in-home automation — from robot vacuum cleaners and lawnmowers to smart blinds and curtains. Advances in sensors, software, cloud-based control, connectivity, and mobile apps are together increasing the scope of the marketplace.

This trend is likely to continue, especially in countries with aging populations and a desire for better quality-of-living and in-home healthcare. The growing adoption of automation throughout society — from self-driving cars to room-service robots in hotels — will tend to habituate people to greater use in the home as well, especially for cumbersome or repetitive tasks.

2023   2030

2 billion

homes will have broadband access by 2030

Everything-from-home

The pandemic and its after-effects have led to a much greater focus on the home. Many workers now split their week between an office (or other formal workplace) and a residential setting. Home learning and telemedicine have seen significant growth as well. As a result, over the last three years there was also a huge surge in investment in home appliances, fitness systems, entertainment products, connected kitchen products and better lighting and ventilation.

While some of these sectors have now seen drifting enthusiasm as people are able to go back to the gym or movie-theater in person, there has been a permanent uplift in home electronics. Perhaps more importantly, people are now much more capable and confident in using everything from a video doorbell to a connected exercise bike. To many, the idea of remote health-monitoring no longer feels unusual or unwelcome. This fundamental shift in smart home acceptance might have occurred anyway, but it seems to have been accelerated as a side-effect of the pandemic years.

One of the smart home surprises of the last 5-10 years has been the importance of voice assistants with smart speakers now often seen as the central hub of the smart home. While many users started with information or entertainment requests ("Alexa, what's the weather today?" or "Hey Google, switch on the radio"), a significant fraction have extended their scope to interacting with IoT devices. Starting points are often smart plugs or lightbulbs, with growing adoption of more sophisticated routines and device interactions.

Energy efficiency

The desire to reduce wasteful consumption of power, water, and heat is a growing driver of smart home technology. A combination of short-term energy cost rises, coupled with longer-term awareness of climate change, has led to much greater emphasis on new devices and systems. Some of this has been driven by individuals wishing to reduce their CO_2 footprint — or just their monthly utility bills.

Many governments have been pushing adoption of smart meters, as well as offering subsidies for electric vehicles and chargers, heat-pumps, solar panels, and other systems. There have been significant replacement cycles for low-energy lighting, shifts from gas to electric heating, and even the outright replacement of old housing-stock with newer properties designed to be climate-friendly from the ground up.

While there is also some concern about the "embedded carbon" in electronics — and the power consumed by networks and cloud-computing platforms — the balance is strongly towards the smart home as an enabler of Net Zero, as well as lower energy bills.

Other drivers

There are numerous other background trends that underpin the adoption of smart home products — and therefore also the simplicity of Matter as a further catalyst. Some of these include:

- Growing availability of high-quality whole-home Wi-Fi, attached to excellent broadband, increasingly capable of 100 Mbps or even more than 1 Gbps. The greater the area of the home and surroundings with good wireless coverage, the greater the potential for IoT adoption

- A shift of the smart home marketplace from individual smart devices to more integrated experiences and solutions. This is driving interconnection of clusters of devices, often linked to Cloud services, smartphone apps, and the web.

- Greater focus on cybersecurity and reliability for in-home systems, driving the need for IP-based connectivity and authentication, plus the ability to update firmware and software for in-service devices.

- Links between devices in the home and external organizations, such as healthcare agencies, employers, utility providers and municipal authorities. Reliable and secure IP connectivity to end-devices is essential, including the ability to support encryption and VPNs end-to-end.

Alexa, what's the weather today?

1.2 Smart Home Device Forecasts

The market for smart home devices is believed to be in the range of a billion units per year, and growing quite rapidly. The introduction of Matter is expected to accelerate adoption further both by increasing the number of homes likely to start using IoT and also increasing the number of devices installed (and used) in each home.

Popular smart home ecosystems such as Amazon Alexa, Apple HomeKit, Samsung SmartThings, and Google Home have millions of loyal users worldwide. They are familiar with the user experience and user interface of their favorite ecosystem and know how things work — like how to set up a new device. The vast user bases of the popular ecosystems help IoT device makers to boost their product sales quickly and globally. Ecosystems also enable device makers to create automated solutions out of many devices, fueling the sales of a broader product line and increasing their share of consumers' or households' pockets. Additionally, the ready-made, tested, and field-proven ecosystem user experience and interface, already familiar to millions of users worldwide, reduce device makers' market risks and product development costs.
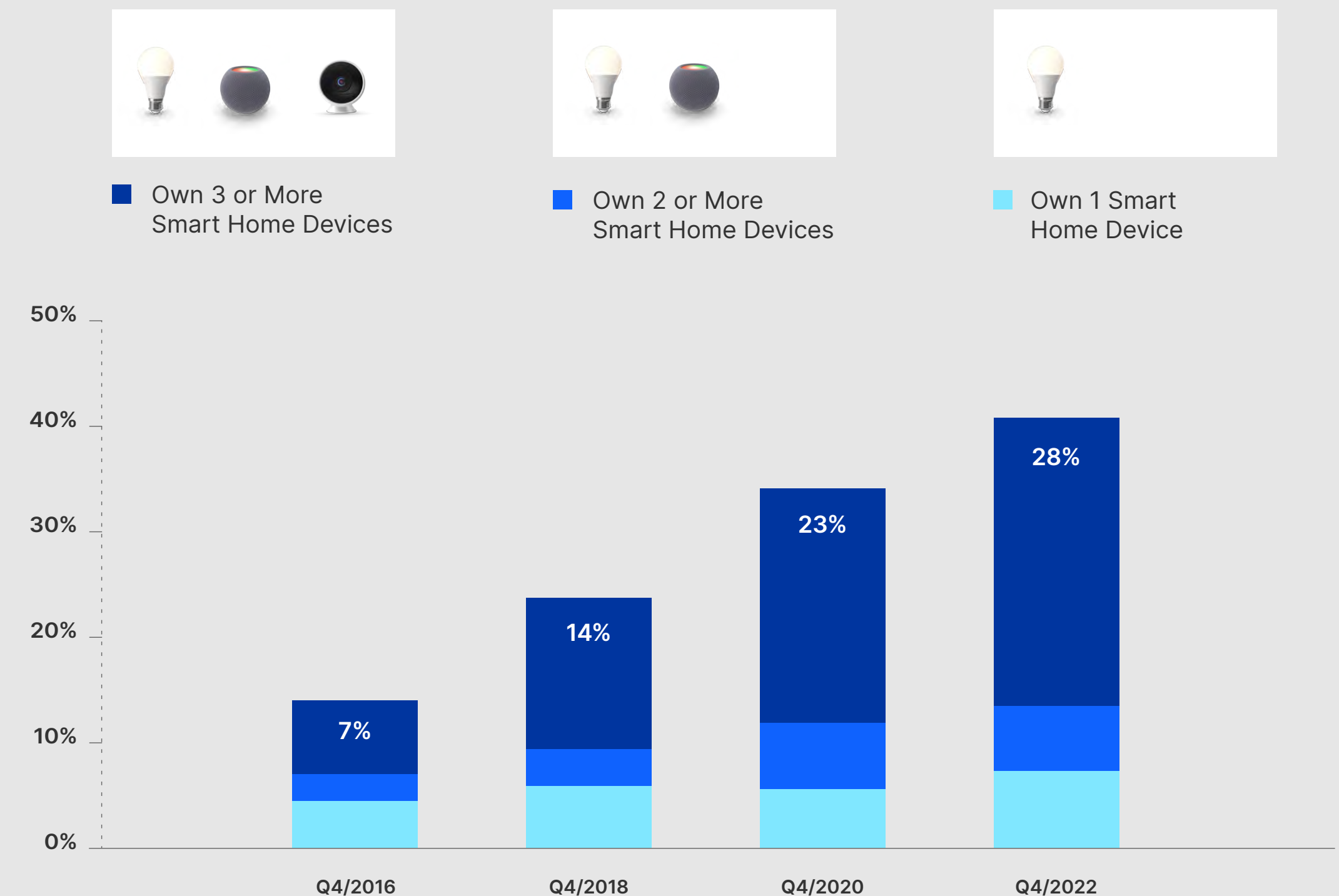
Globally, there are about 1.3 billion homes with fixed broadband connections of some type[1], a figure which is still growing due to adoption in developing markets. This is the theoretical maximum for potential smart home growth for Matter, although a few non-broadband homes may have some standalone IoT devices connected with cellular or LPWAN.
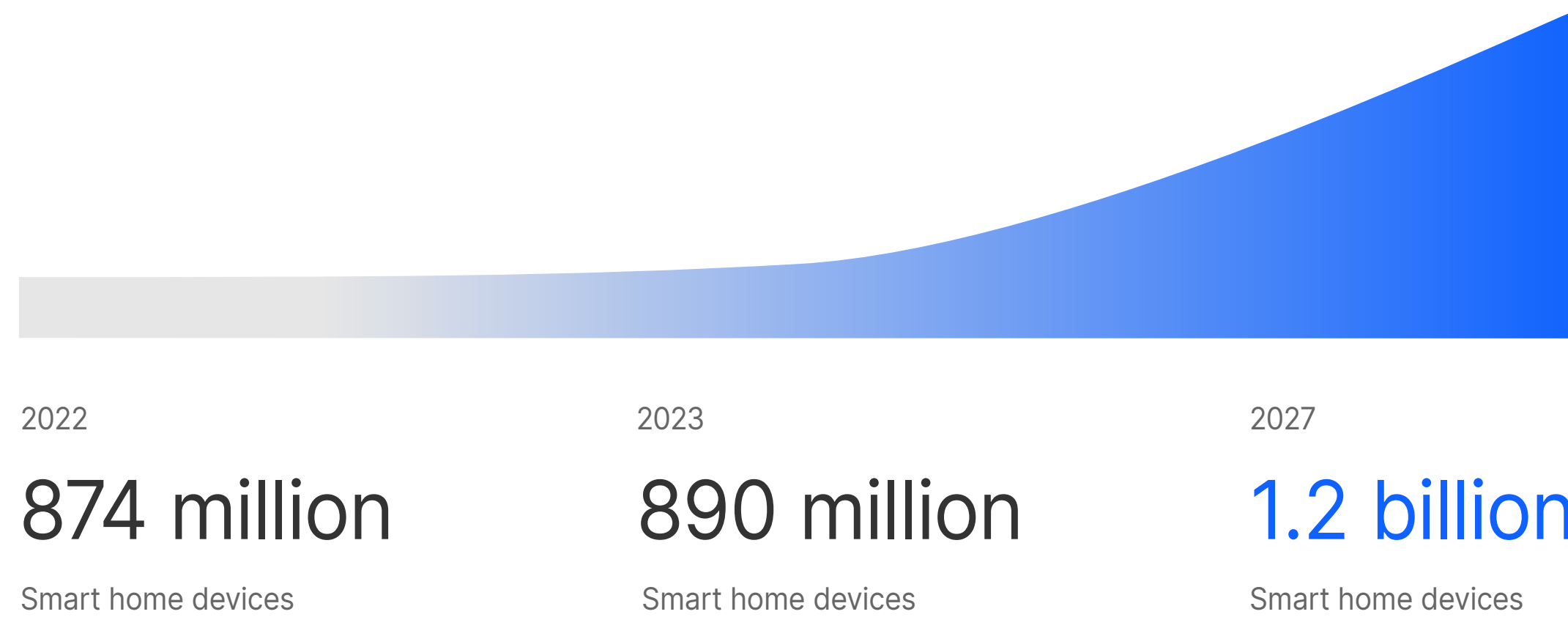
Definitions here can be tricky — is a connected alarm with five sensors one unit or five/six? Smart TVs are supported in Matter 1.0, but are not really "IoT" devices in the conventional sense. But they could be considered as part of a smart home. In the below we reference some leading analyst firm smart home forecasts.

Research firm Omdia estimated[2] that in 2022 the installed base of smart home devices reached about 2 billion in total globally. Omdia further stated that about 55% of broadband households in the US had at least one smart home device installed by end 2021, compared to 21% for EMEA, while Asia and Oceania had a penetration rate of about 14% in 2021.

Parks Associates is somewhat more conservative about adoption. It estimates[3] 41% of broadband households in the US have one or more smart home devices installed but the numbers exclude smart TVs and speakers. Its recent analysis suggests that numbers of both smart homes and multiple devices per home are rising, at least in the US.

Number of Smart Home Devices Owned

- Own 3 or More Smart Home Devices
- Own 2 or More Smart Home Devices
- Own 1 Smart Home Device

@ Parks Associates

2022
874 million
Smart home devices

2023
890 million
Smart home devices

2027
1.2 billion
Smart home devices

Research firm IDC has estimated[4] shipments of around 874m smart home devices in 2022, with a forecast of about 890m in 2023 and 1.2 billion for 2027. IDC's numbers for 2022 were lower than those of 2021 owing to a pandemic-driven spike in earlier years followed by supply-chain and semiconductor issues in 2022.

Rising consumer awareness of smart home devices and the cost savings, convenience, and energy efficiencies delivered by such devices continue to drive demand despite inflationary pressures. IDC says networked video entertainment devices — such as smart TVs, streaming sticks, and Internet-connected set-top boxes — made up the largest volume of shipments.

In general, non-IoT entertainment / audiovisual devices may not always be best-categorized as 'smart home' products but there is a broad correlation between these and other more utilitarian products. Also note that smart speakers in particular often act as hubs or bridges for other IoT products.

Home monitoring and security products such as cameras, doorbells, and door locks, as well as smart lighting and video entertainment products, will account for the largest share and experience the highest growth in the coming years with smart lighting devices expected to grow fastest.

A number of solution vendors also report useful figures on smart home device usage. Cloud-based Wi-Fi vendors have a good view of connected devices although they likely have less visibility into products connected with alternative wireless standards.

Our Estimate

A reasonable target for growth might be adding 50 million new homes annually to the smart home device marketplace and selling perhaps 3-4 new devices on average per year into the existing smart home base. But there are a lot of variables and hard-to-predict factors — not least the growth and adoption of Matter itself. If major ISPs and other service providers begin major market initiatives or if new "must-have" categories emerge with viral adoption there could be a considerable upside to this forecast.

Worldwide Smart Home Device Forecast by Shipment Volume, Market Share, and 2023–2027 Growth Rate

(Shipments in millions)

Device Category	2023 Shipments*	2023 Market Share*	2027 Shipments*	2027 Market Share*	2023–2077 CAGR*
Video Entertainment	284.4	31.9%	315.4	26.5%	2.6%
Home Monitoring/ Security	197.8	22.2%	279.7	23.5%	9.0%
Lighting	111.7	12.5%	243.6	20.5%	21.5%
Smart Speaker	111.7	12.5%	130.9	11.0%	4.0%
Thermostat	25.9	2.9%	31.5	2.6%	5.0%
Others	159.5	17.9%	230.7	19.4%	9.7%
Total	**890.9**	**100.0%**	**1,231.8**	**100.0%**	**8.4%**

Source: IDC Worldwide Quarterly Smart Home Device Tracker, March

*Table Notes: All values are forecast estimates

Plume reported that the average US household now has 20.2 connected devices based on an analysis of 41 million homes and 2.2 billion connected devices. In Europe, the average number per household is 17.4, with Japan reaching 10.3. While smartphones, computers, tablets, and smart TVs make up the majority of devices, smart speakers, connected lighting and appliances also account for a sizable number.

A rough estimate is that about 300 million homes world-wide have at least one smart device (including TVs and speakers) but that the average 'smart home' probably has around 8 smart devices in total at present.

That average may fluctuate over the next few years depending on the balance of new homes becoming 'smart' versus additional devices sold into existing IoT-centric homes. Both are important numbers for OEMs and service providers — as is another (unstated) figure of homes that abandon IoT devices because they are too difficult to onboard or operate, or offer little value.

[1] www.point-topic.com/post/global-broadband-subscribers-q3-2022

[2] omdia.tech.informa.com/pr/2022-aug/omdia-global-installed-base-of-smart-home-devices-exceeds-2bn-devices-in-2022

[3] www.parksassociates.com/blog/article/04112023

[4] https://www.idc.com/getdoc.jsp?containerId=prUS50541723

Growth in Average Number of Connected Devices per Home by Category (Global)

55% Camera

43% Doorbell

38% Hub

25% Lightbulb

24% Speaker

23% Plug

22% Smart TV

19% Thermostat

1.3 Smart Home Growth Categories

The most important product categories within the broader smart home sector are:

- Home Automation Controls & Lighting
- Consumer Electricals & Appliances
- Entertainment & Smart Speakers / Voice Assistants
- Security And Access-Control Products
- Health & Fitness

Each of these top-level categories includes multiple separate products with continued innovation and differentiation in many areas. In addition, various other niche categories are also important, such as connected clothing, luggage/ pet tracking tags, and connected vehicles stored at or near home, such as electric cars, e-bikes, and drones.
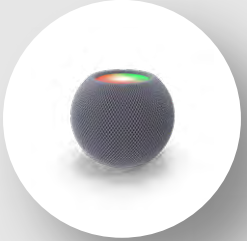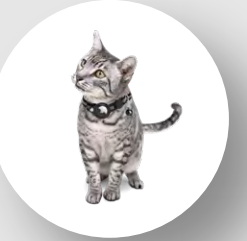
Some of these products are intended to be used on a standalone basis, such as smart refrigerators. Others tend to be deployed as a cluster of related devices, such as security cameras and motion sensors, or integrated HVAC (heating, ventilation and air conditioning) systems.

It is arguable whether emerging categories such as AR/VR headsets and glasses should be classed as 'IoT' devices in a smart context. Smart TVs and games consoles cannot really be considered new smart home products. From a connectivity standpoint, their demands on networks are sufficiently extreme that they merit a separate discussion. That said, TVs are included within the Matter universe and may turn into smart home IoT hubs in their own right.

Home Automation & Lighting	Consumer Electricals & Appliances	Entertainment & Smart-Speakers	Security & Access Control	Health & Fitness	Other Smart Home Products
Light Bulbs	Smart Blinds	Voice Assistant	Door sensor	Exercise Bike	Pet Tracker
Smart Plugs	Aircon Unit	Smart TV	Motion sensor	Smart Mirror	EV Charger
Light Switches	Boiler	Surround Speakers	Door locks	Fitness Watch	Solar Panel
Dimmers	Robot Vacuum	Set Top Boxes	Garage door	Glucose Sensor	Drones
LED Switch	Fridge / Freezer	Streaming Sticks	Security cameras	Eldercare Devices/ Alarms	Smart Clothing
Power Strip	Oven / Cooking Appliances	Toys	Smoke & CO detectors	Cardio / Blood Pressure Cuff	Personal Robots
Light Sensor	Lawnmower	Karaoke	Smart doorbell	Weigh Scales	
Temp Sensor	Pet Feeder		Smart animal door	Other Fitness Equipment	
HVAC Control	Gardencare		Access control	Sport Gear (e.g. Balls, Boots)	
Smart Meter					
Thermostat					
Water Pumps					

Delivering on the Smart Home IoT Promise | 12

1 Drivers for Matter Adoption   **2** Challenges for the Traditional Smart Home   **3** The Matter Protocol   **4** Get Involved

1.4 IoT Service Providers

While many smart home device purchases are made by consumers (or sometimes landlords including building owners, see section below) the world of IoT today includes an increasing emphasis on various forms of intelligent IoT services, which incorporate both product and remote management components.

While this is not an entirely new concept (remotely managed and monitored alarms have been available for decades, for instance) the growth of new and better-integrated smart home ecosystems has driven this much further in recent years. There are several categories of service providers that are helping drive adoption of residential IoT systems:

- Telcos, cablecos, and ISPs such as Comcast, SKTelecom, and Deutsche Telekom, which are aiming to add value to their broadband subscribers' connectivity by providing additional functions. There are various approaches and product categories here — some attempt to add voice-assistant features to gateways or set top boxes, turning them into hubs. Others offer standalone systems such as home security or lighting, perhaps with partners. A number of combined ISP/utility companies are exploring linkages with smart meters and energy-management.

- Alarm and monitoring specialists such as ADT, SECOM, and SimpliSafe are looking to expand their historic businesses, either individually or through partnerships. They may use smart home devices such as new sensor types, to add capabilities for monitoring or emergency response — or even ensure that pets can enter the house without tripping alarms.

- Other organizations such as housing associations, insurance companies, healthcare agencies, and government departments may specify — or supply — certain products (or define standards and compliance rules).

- Major cloud and Internet platform companies both operate their own ecosystems and can be expected to create more of their own device-based services and solutions. As well as smart speakers, they are also involved with video doorbells, thermostats and even vacuum cleaners (with the acquisition of iRobot by Amazon in 2022). Google also owns a state in security company ADT.

Central to the provision of remotely managed smart home services is easy device onboarding, effective monitoring, update and backup capability, and secure networks. There are also likely to be increasing needs to integrate between different subsystems — for instance between alarm systems and healthcare. Also, such SPs will also want to be able to switch easily between different device suppliers, either to mix-and-match different products, or to mitigate risks from supply-chain and inflation challenges.

1.5 Types of Homes and MDUs

IoT systems sold to landlords and property owners differ from those aimed at residents living in their own smart homes. Landlords of rental homes may require dedicated sub-systems for their domains of responsibility, such as heating or security. They are less likely to onboard new devices 'casually' in the way their tenants may purchase a new lamp or healthcare appliance on a whim.

A large proportion of the world's population lives in apartment blocks or 'multi-dwelling units' (MDUs). In some countries upwards of 70% of the population live in MDUs. MDUs are often managed by a landlord, housing association, or facilities-management company — perhaps taking responsibility for functions such as lighting and heating, perhaps with centralized provisioning of broadband and Wi-Fi.

There are various categories of MDUs with differing IoT and smart-building needs:

- Standard new-build apartments, which will likely feature good connectivity and some smart-building IoT and systems for communal spaces.

- Mixed-use buildings which combine apartments with retail or restaurant/café facilities, plus perhaps office space as well.

- Luxury apartments, which may have gym rooms, outdoor areas such as pools, or dedicated parking structures. In this case security and automation / concierge requirements will be a driver for IoT deployments.

- Student accommodation, with highly demanding and often tech-savvy users.

- Social housing, which may have regulatory requirements, including perhaps IoT for energy management, security cameras, etc.

- Retirement homes, which may need to support medical and healthcare devices, with strong ease-of-use requirements.

- House conversions for example into 2-5 apartments.

For both rental properties and MDUs, some home IoT capabilities will be delivered via B2B channels at a building-wide level, while individual tenants or apartment-owners will still buy their own appliances and other products via the usual retail channels. All of the above are targets for new Matter-capable smart IoT solutions.
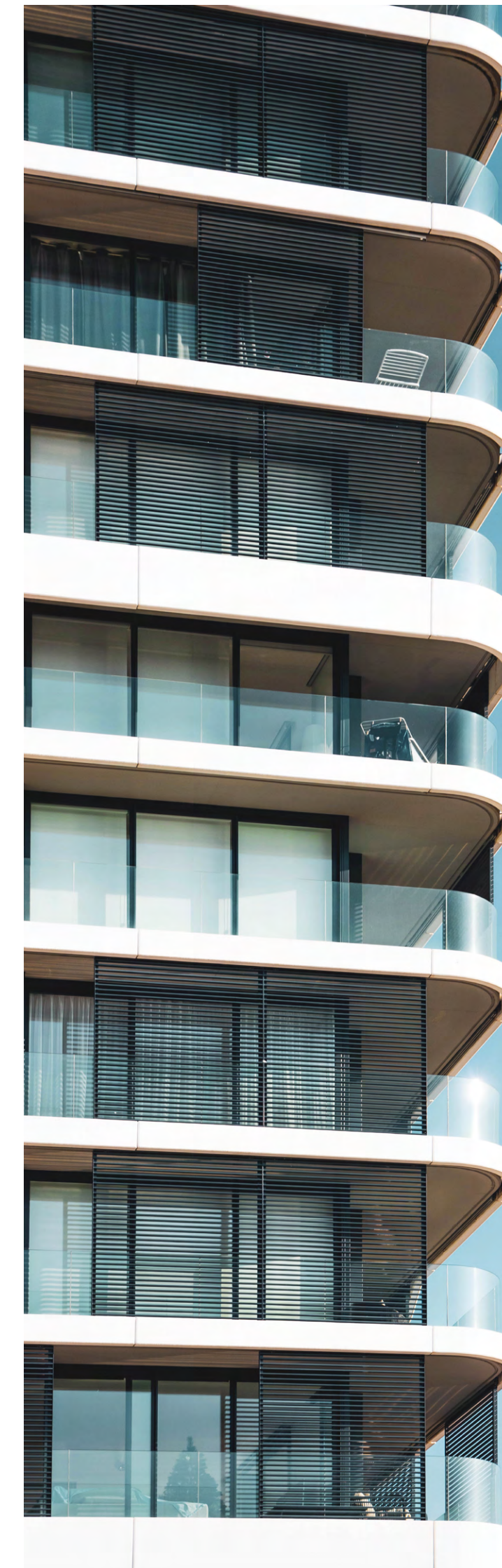
MDUs count
for up to

70%

of the housing,
in some countries.

100 million

homes now have smart speakers

2.0 Challenges for the Traditional Smart Home

There has already been substantial growth in adoption of smart home devices. More than 100 million homes now have smart speakers with further large groups using individual connected devices such as vacuum cleaners, doorbells, or smart lighting products. If smart TVs and utility meters are included, the numbers are likely to be upwards of half a billion homes using some sort of connected device beyond phones and PCs.

However, there remains a large gap between 'casual' smart households with a handful of isolated products and those that have truly embraced automation with multiple home systems. Matter aims to change this.

There are a number of reasons for this historic gulf between the expansive vision and the in-market reality of consumer IoT. This section considers the separate challenges and concerns involved on both the demand and supply sides — that is, frictions experienced by consumers with today's smart home ecosystems plus parallel issues facing vendors and service providers. Understanding these complexities highlights opportunities for the Matter standard as well as the problems it is designed to solve.

2.1 Barriers for Consumers

Lack of interoperability

The key challenge that Matter seeks to address is interoperability. There are innumerable individual consumer IoT devices and brands. But while self-contained families of products — such as Philips Hue lighting or Sonos audio products — work well together there is much less cross-brand collaboration. There are multiple layers of interoperability to consider: Networking, user control, data management, Cloud-based features and so on. Matter is primarily focused on connectivity, device onboarding, and basic control functions.

Smart home users experience the ecosystem challenges from the opposite perspective as device makers. Users are confused because smart home products are fragmented into different silos, and the smart home devices of one ecosystem cannot be controlled by the smart speaker or app of another ecosystem and vice versa. Users might need several apps, gateways, and subscriptions for managing and controlling their devices, increasing the hassle at home and wasting money. Consumers hesitate to buy new devices because they can't be sure whether they will work with the other devices at home, slowing down the smart home adoption.

Delivering on the Smart Home IoT Promise | 15

1 Drivers for Matter Adoption   **2** Challenges for the Traditional Smart Home   **3** The Matter Protocol   **4** Get Involved

As well as IoT-centric product vendors there are also much broader and more expansive smart home ecosystems, notably Amazon Alexa, Apple Home, Google Home, and Samsung SmartThings. These organizations license their brands and provide third party products with access to key functions via developer kits and APIs (application programming interfaces). But again, there is little intersection between these different IoT 'universes'.

This has led to a range of interoperability problems for users. A new lightbulb may not work properly with an existing platform while a smart energy meter might not work well with a solar panel and EV charging system. A Bluetooth-connected device will not work with a Zigbee or Z-Wave hub or controller. Each may use a separate mobile app, each with different accounts and passwords. A seemingly simple task — such as switching off all the lights in a room — may not be possible without proper interoperability.

Matter brings universal interoperability between products of different smart home ecosystems and brands and simplifies device setup and usability. It's an application-level protocol built from the best pieces of existing tried-and-true protocols, including Google Weave, Apple HomeKit, and Zigbee. Matter uses three of the world's leading wireless technologies — Wi-Fi and Thread for operation and Bluetooth Low Energy for easy device setup.

Fear of technical difficulties

While some smart home early adopters can be classed as 'enthusiasts' other consumers have limited technical abilities — or simply do not have the willpower to battle complex configurations and settings for new devices. Some will have experienced previous headaches using wearables, smart TVs, or even just Wi-Fi access points. They may be unfamiliar with words that readers of this document may take for granted, such as "onboarding", "Cloud" or "bridge".

For such people, the idea that a future home might include tens or even hundreds of separate devices, each with their own setup process — and worse, their own diagnostics mechanisms — is an obstacle to starting on the journey in the first place. Having a variety of separate hubs, bridges, gateways, routers, and mesh-nodes may be another obstacle.

While they may be open to a service provider as a channel to simplification (and support) that still does not help with physical installation of new devices in most cases. In addition to these worries, many existing smart devices are actually complicated to install. They may need manual entry of a Wi-Fi password, which people may not know immediately and need to look up. They may need an app to be installed first, perhaps with complicated instructions for setting up a new vendor account (and another password).

Simplifying — and unifying — the user journey for the smart home is essential. Users are accustomed to some devices working very easily together, such as setting up new earbuds with a phone. There is no reason why smart home IoT devices cannot share this type of pain-free experience.

Security and privacy concerns

Consumers — and also governments and other groups such as consumer-protection agencies — are rightly concerned about the security of households' IoT devices and the networks they use. There is a broad range of potential risks and threats here, but some of the problems include:

- Direct risks of surveillance, especially by cameras or microphones

- Potential for harming physical security, such as by hacked smart locks

- Health and safety risks, for instance where heating systems, EV chargers or fire alarms are compromised

- Potential for smart homes to be affected by malware or ransomware attacks

- Vulnerabilities in IoT products that could allow a bad actor to obtain wider access to home networks

- Difficulty of updating software and firmware to the latest versions

- Misuse of stored data derived from smart home devices (or their Cloud-based back-end platforms)

- Remote control of groups of devices to form parts of "botnets" for massive denial-of-service attacks elsewhere.

Concern about such issues can have a number of impacts. Some users may reject any form of smart-home products entirely. Others may limit adoption just for non-essential applications, or constrain them to specific rooms of the house. Other users may be more permissive — but then later experience some form of security-related incident that undermines their confidence.
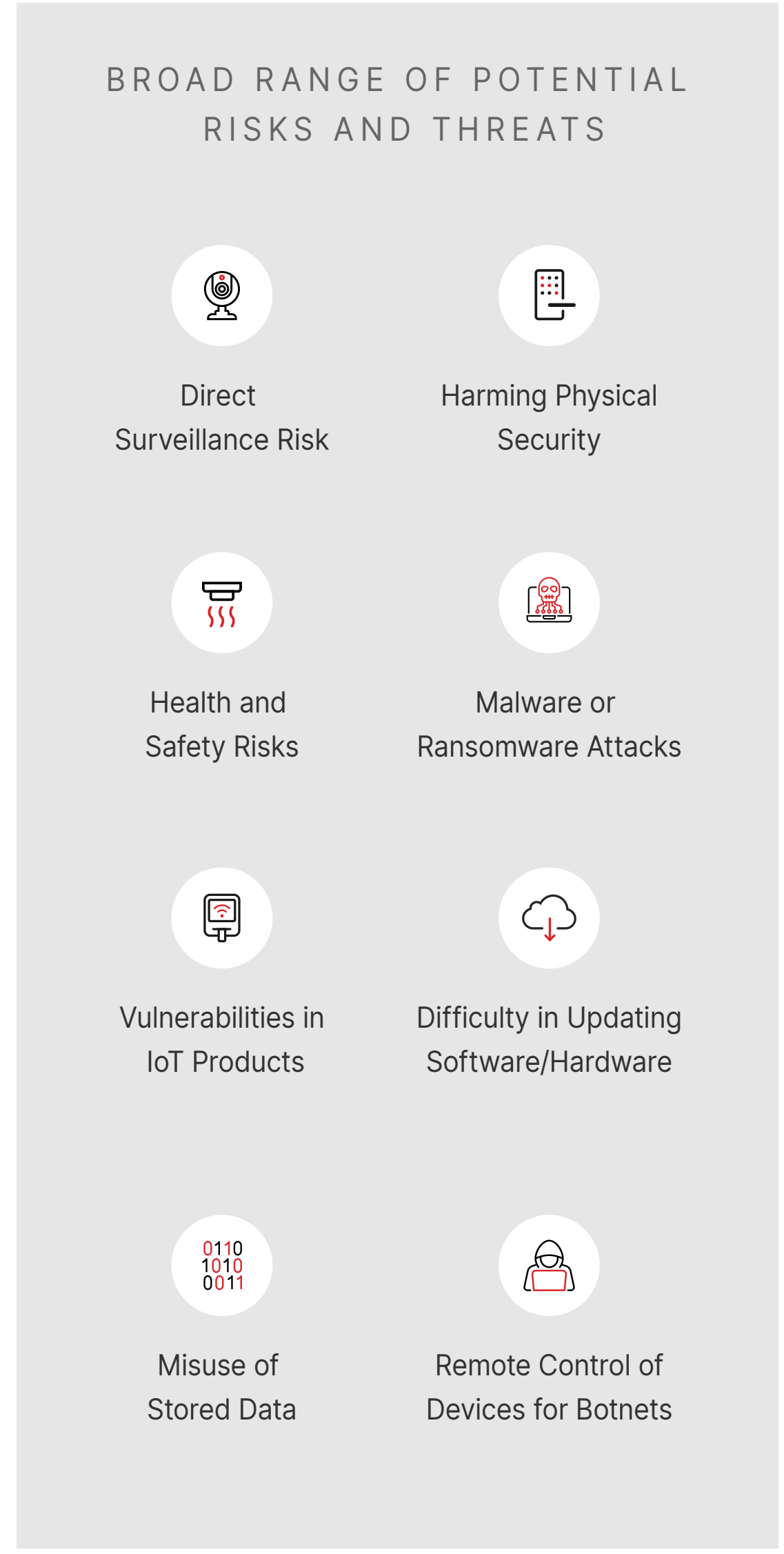
Ecosystem lock-in

Many consumers have a level of loyalty to certain brands – such as Apple or Samsung smartphones, Google online services, or Amazon Alexa. However, an increasing number of people are wary of being 'locked-in' to these broader ecosystems or have perhaps experienced problems where they have tried to blend multiple worlds in the past.

Increasingly, the sheer reach of the major platforms – from devices, to content, to smart homes, to in-car entertainment, and even healthcare – is becoming an overt concern. While there is often a high level of convenience associated with ecosystem lock-in there can also be challenges, for instance when someone moves home, or even just receives an incompatible gift. There are also associated issues with data lock-in and portability.

This issue is exacerbated in households where people deal with multiple ecosystems already – perhaps some family members prefer Android, others like Apple. Some may have a familiar Amazon Alexa, but a new partner or roommate may be a Google or Samsung fan.

This type of ecosystem lock-in is therefore starting to look uncomfortable, especially in a home environment which is inherently 'multi-personal'. It should also be noted that competition authorities may start to take a dim view of smart home lock-in, especially if it affects long-lived systems such as heating and electricity.

A separate issue concerns the smaller vendor-led ecosystems in the smart home space, where new market entrants are positioned at the center of multiple device categories, via apps and hardware hubs/controllers. Some of these companies will inevitably exit the market, especially during economic downturns. There should be adequate mechanisms in place to ensure that users' devices are not left stranded – and that they can be easily migrated to alternative platforms.

BROAD RANGE OF POTENTIAL RISKS AND THREATS

Direct Surveillance Risk

Harming Physical Security

Health and Safety Risks

Malware or Ransomware Attacks

Vulnerabilities in IoT Products

Difficulty in Updating Software/Hardware

Misuse of Stored Data

Remote Control of Devices for Botnets

Multiple ecosystems to meet needs

A common smart home model is where consumers effectively create a hybrid system made from a collection of products from different brands, some of which may need dedicated hardware hubs or bridges. In many cases this will develop "organically" as users buy separate isolated systems and only try to link them at a later date.

In some cases, there may be external parties driving ecosystem decisions — utility companies may provide smart meters, alarm and monitoring companies will have preferred solutions, health authorities may supply specific telemedicine devices, and landlords or building owners may have their own smart-building systems.

In some cases, there will still be multiple applications and controllers in use. To most customers it will be unclear why an app used for their remote vacuum cleaner should also be monitoring their garage door or an implanted insulin pump. In reality some level of 'hybrid smart home' adoption is inevitable. But if there are options to reduce the complexity, it should be of benefit to consumers and the wider market.

Multiple platforms to learn how to use

A particular issue around platform fragmentation is that of the learning and familiarity requirements needed. The learning curve may relate to device/ecosystem-specific terminology, different in-app icons and menu structures, voice commands and prompts, unique approaches to creating groups or rules, re-connecting devices after moving house, and more.

While advanced device features will always need specific controls there is no reason that basic smart home functionality — from initial setup to day-to-day normal operation — should have such a diversity of user experiences. Consumers are used to standard look-and-feel and design language across many smartphone and laptop applications, and this should be replicated in common user-journeys and workflows within the smart home as well.

2.2 Barriers for Suppliers

Not only consumers have experienced friction in the past evolution of the Smart Home space. Until some of the catalysts discussed in Section 1.1 emerged, especially the rise of smart-speakers and the four major ecosystems, the consumer IoT market was highly fragmented and appealed mostly to enthusiasts, especially in large self-contained homes.

Device providers have had to navigate a complex landscape of wireless technologies, mobile apps, Cloud, and security challenges and unclear go-to-market paths. Specialists in narrow vertical sectors such as lighting, home appliances, or home security have had to develop skills or partnerships in many areas outside their traditional competence. As a result, a huge amount of effort has been spent on "reinventing the wheel" for basic enablers, rather than differentiating on core capabilities, user interfaces, and product design.

It was also difficult for service providers and retailers to participate effectively — and this has largely remained so, even in the era of Alexa and HomePod. In theory third parties such as ISPs, utility companies, mobile operators, alarm providers, and 'prop-tech' smart building specialists should have been able to develop growing and sustainable businesses, yet the success stories of scaling have been rare.

Again, Matter seeks to smooth out some of the rough edges by improving interoperability and standardizing some of the layers. This section looks at the supply-side challenges in recent years through the lens of Matter as the driver of change and evolution.

Multiple SKUs

One of the challenges for retailers and device suppliers has been the need to support multiple ecosystems especially in physical retail stores. Often it has been necessary to stock multiple versions of the same or similar products, compatible with Amazon, Apple, Google or Samsung smart home ecosystem platforms.

This has knock-on ramifications in terms of shelf-space, warehouse management, stock control, forecasting, staff training, customer support, and returns — and the suitability of smart home products as gifts or impulse purchases. Many of these factors also apply to online retailers as well as brick-and-mortar stores.

A parallel set of issues apply to the equipment vendors themselves — and their supply-chains in both directions — to component manufacturers, and to distributors/retailers. The ability to use Matter-capable devices as a 'one size fits all' alternative should be a major benefit in reducing SKUs (stock-counting units) for smart home retail and manufacturing.

Ecosystem lock-ins

It is not just consumers that are at risk of lock-in. Many device and sub-system manufacturers have had to focus on just one or two of the major smart home ecosystems, given the resource requirements needed to develop and support software, certification, and testing for each.

This also means that some larger IoT providers need to implicitly help strengthen rivals for other areas of their businesses, even if they are themselves keen to carve out a sustainable position in the value chain. While many have used hubs and specific wireless mechanisms for this purpose, this has been inefficient and has created 'silos'.

Finally, ecosystem lock-in can limit device developers' addressable marketplaces — for instance if they become constrained just to the sub-set of households that use one or other of the major platforms.

Cost inefficiencies

Many of the issues with the current consumer IoT market ultimately relate to economic factors for suppliers. They need to allocate a sizable proportion of their R&D budget (whether inhouse or through contractors) to areas which ultimately have low value-add in their products, such as integration of custom wireless implementations, developing and testing onboarding mechanisms, creating new security protocols, and so on. They also need to replicate efforts (and costs) on everything from packaging to marketing.

The ideal scenario involves amortizing the costs of both product development and ongoing bill-of-materials, distribution, and support over the largest number of shipped products. A secondary benefit of standardized components can be mitigating extra costs from supply-chain glitches, or inflation.

Time-to-market delays

A key challenge for smart home suppliers and service providers is accelerating the time to market, both for individual new products or more highly integrated solutions comprising multiple elements. The need for extensive testing and certification — perhaps with many separate ecosystems — can cause significant delays, especially if problems are encountered.

There are also other sources of delay that vendors need to consider — supply-chain friction for proprietary or single-source components, additional acceptance testing by service providers or retailers, more complex and time-consuming design of packaging and multiple marketing messages, 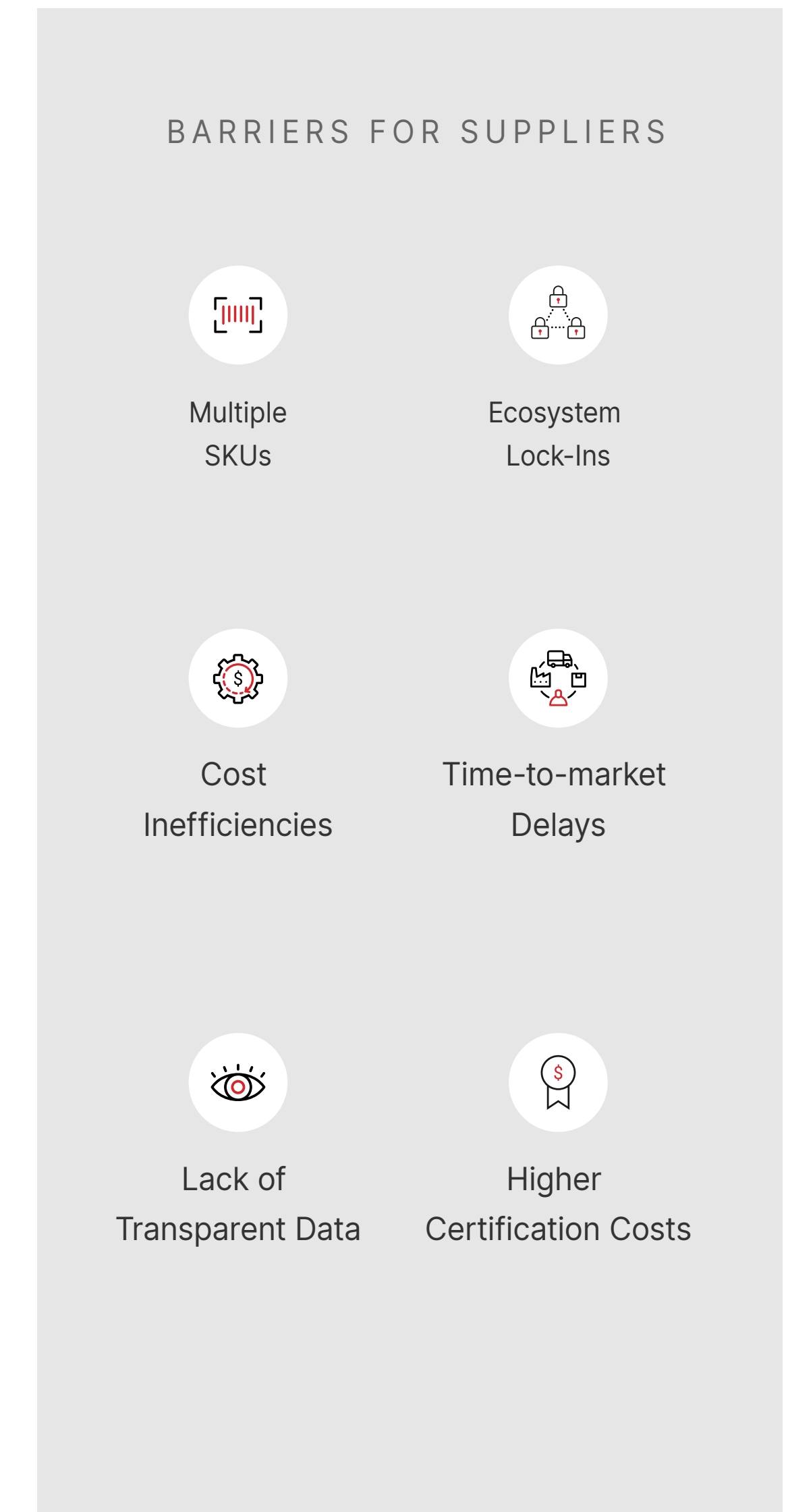and so on. While there will always be prod-uct-specific potential delays, for various reasons, the ability to short-circuit some common bottlenecks is invaluable.

Customer hesitancy

While early adopters of a technology will often conduct significant background research or even enjoy the process of becoming a 'smart home enthusiast' this cannot work for true mass-market adoption. Most users will be unwilling to invest time and energy in diagnosing problems, looking up explainer videos, or trying to access complex configurations and settings menus. One failed attempt to hook up a basic product — perhaps a plug or lightbulb — can negatively impact consumers' views of the overall smart home value proposition.

There are plenty of other examples where familiar brands, logos, and certifications help consumers gain familiarity and trust. The universally recognized Wi-Fi logo is a good example.

Enjoying a unified experience for setting up smart home devices and applications — dependent on a standardized and certified architecture with a recognized brand — should go a long way to address mainstream consumer wariness. Critically, it should increase the proportion of 'works first time' installations, which should reduce the number of smart home IoT skeptics and help generate additional pull-through sales when users recognize that the smart home can actually be simple.

BARRIERS FOR SUPPLIERS

Multiple SKUs

Ecosystem Lock-Ins

Cost Inefficiencies

Time-to-market Delays

Lack of Transparent Data

Higher Certification Costs

Lack of transparent data collection for support

Inevitably some smart home users will encounter issues and will contact their device vendor, retailer, or service provider for assistance. They may also look for assistance from in-app help functions and online forums.

But in order for that assistance to be provided effectively, data will need to be collected securely for the support agent (or chatbot). This may include product type, serial numbers, software versions, usage data, or any adjacent equipment like a hub or border router.

Having codified standards for this type of data is important — especially where users may have multiple devices and ecosystems operating within a single home. In particular service providers will need to integrate smart home IoT into their broader customer-support platforms, so that they can holistically investigate reported issues to determine the root cause — perhaps the device, perhaps a Wi-Fi issue, or even a broadband infrastructure glitch.

Higher certification costs

Another corollary of multiple ecosystem participation by vendors comes from certification overhead. Each smart home ecosystem typically has its own procedures and costs for ensuring compliance with various characteristics in terms of connectivity, security, brand compliance, app store access, and so forth.

Each product may need to undergo multiple sets of testing and certification procedures, perhaps at different labs around the world. This brings in additional logistical headaches, the need for more prototypes to be made available, employing consultants, ensuring compatibility with other products and previous versions for backwards-compatibility, and so forth. Greater levels of commonality and standardization should reduce this set of overheads and costs.
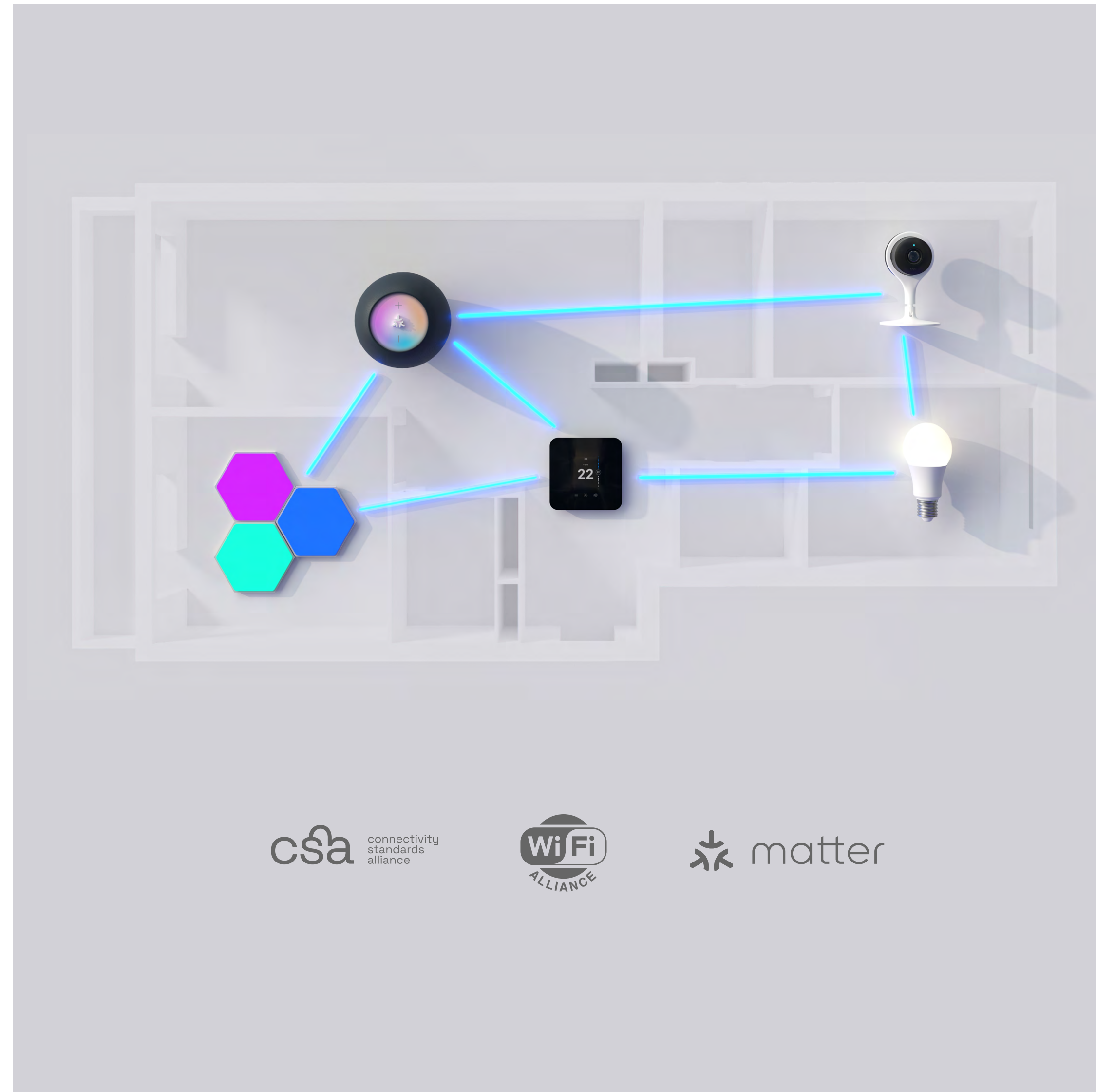
3.0 The Wi-Fi Alliance, the Connectivity Standards Alliance, and Matter

1 **Shared Goals and Objectives**

2 **Coordinating Efforts for Seamless Integration**

3 **Leveraging Expertise and Resources**

The Wi-Fi Alliance and the Connectivity Standards Alliance (formerly known as the Zigbee Alliance) have been at the forefront of shaping and advancing wireless communication technologies. These two organizations play pivotal roles in ensuring devices can communicate effortlessly across various platforms and ecosystems. Through their collaboration, they seek to enhance interoperability, security, and efficiency to meet the growing demands of the Internet of Things (IoT) and next-generation connectivity solutions.

The Wi-Fi Alliance

The Wi-Fi Alliance, established in 1999, is a global non-profit organization that brings together technology companies to promote and enhance Wi-Fi technologies. Its primary goal is to ensure seamless connectivity across Wi-Fi devices, regardless of manufacturer, by establishing industry standards and certifying products that adhere to those standards. By working with leading industry players, the Wi-Fi Alliance enables widespread adoption of Wi-Fi and drives continuous innovation.

The Connectivity Standards Alliance

Initially founded as the Zigbee Alliance in 2002, the organization rebranded as the Connectivity Standards Alliance in 2021 to reflect its broader focus on multiple connectivity technologies. Connectivity Standards Alliance is a membership-driven consortium of companies aiming to develop, promote, and certify standards for various wireless technologies, including Zigbee, Matter, and others. These technologies are particularly vital for IoT applications as they enable low-power, cost-effective, and secure communication between devices.

Driving Innovation and Industry Adoption

Both organizations recognize the importance of interoperability to deliver a cohesive experience for consumers. By working together, the Wi-Fi Alliance and Connectivity Standards Alliance seek to create harmonized standards that allow devices using Wi-Fi and other wireless technologies to coexist and interact seamlessly. This collaboration helps bridge the gap between different communication protocols and ensures that devices can communicate efficiently, regardless of their underlying technology.

Matter leverages inherent strengths of Wi-Fi to deliver interoperability between devices using a common application layer and data model, allowing devices to communicate across multiple IP network technologies. Wi-Fi is uniquely suited to support IoT products and applications with its wide-ranging capabilities and proliferation as a global standard. Matter over Wi-Fi benefits from these Wi-Fi CERTIFIED competencies while connecting over 19.5 billion installed Wi-Fi devices.

- Standards-based, interoperable technology: A wide range of device manufacturers and common Wi-Fi standards deliver a growing range of IoT applications that vary in performance, power, and latency requirements
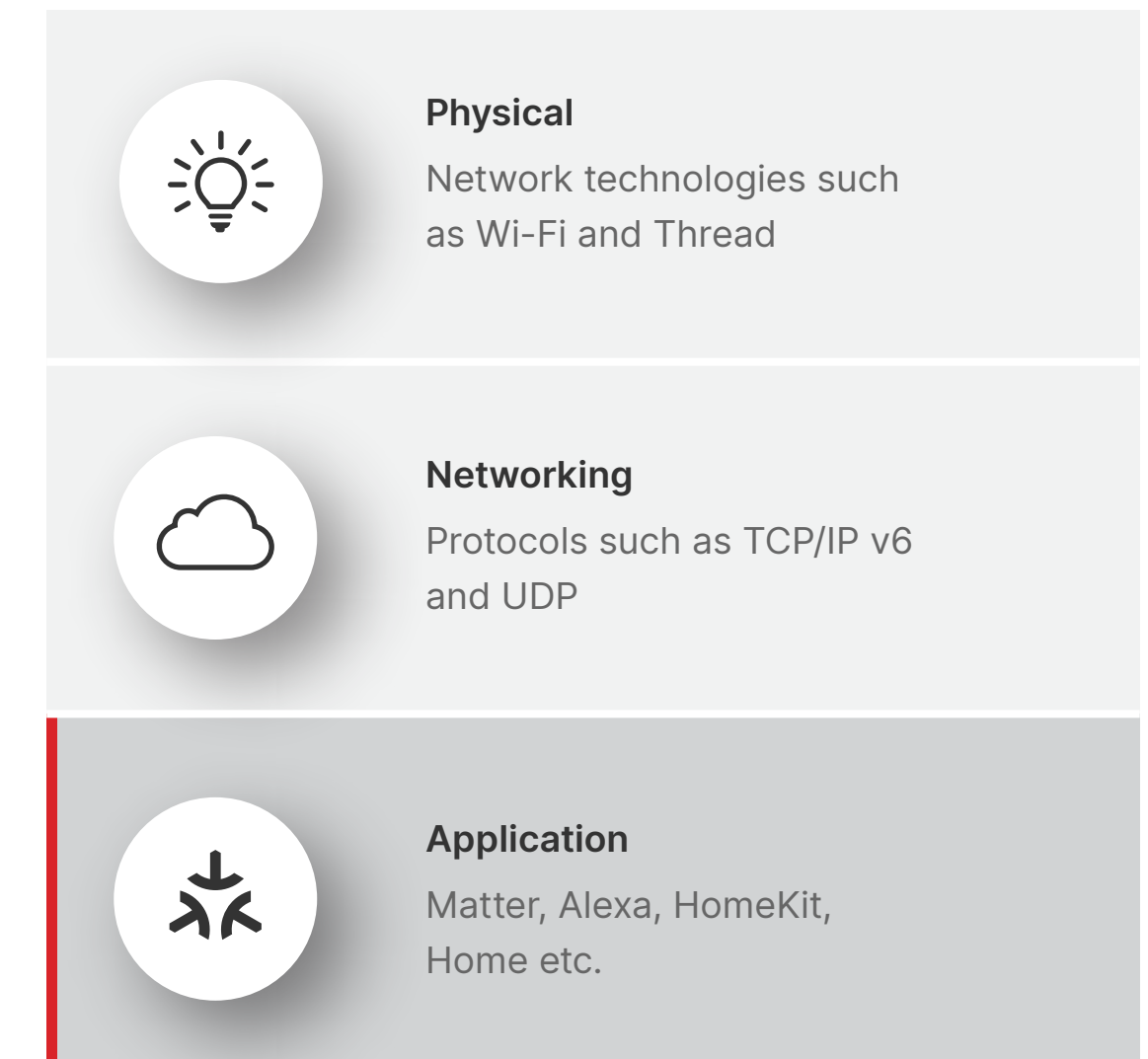
- Pervasive connectivity: Seamless control of IoT devices through smartphones and tablets connected to 19.5 billion Wi-Fi devices in use

- Proven WPA3™ security: Proven WPA3™ security to protect information exchanged in personal and enterprise environments

- Cost effective, simple deployment: An easy-to-deploy and cost-effective foundation that requires no separate gateways or specialized skills to deliver IoT applications

- Backward compatibility: Stands the test of time, minimizing risk of premature obsolescence and ensuring legacy devices can easily connect

- Location awareness: Wi-Fi Location™ delivers sub-meter-level location information that allows a range of location-aware IoT services for industrial and smart city environments, such as asset management, network management, and geo-fencing

- Reliable, sophisticated connectivity: Wi-Fi 6 and Wi-Fi 6E networks deliver sophisticated network efficiency, diagnostics, management, and optimization capabilities, allowing devices such as manufacturing robots and drones to remain connected even as they move or "roam" throughout home or industrial networks

- Flexible network topology: In addition to a traditional Wi-Fi connection through access points, Wi-Fi CERTIFIED EasyMesh®, Wi-Fi CERTIFIED Wi-Fi Aware™, and Wi-Fi CERTIFIED Wi-Fi Direct® offer a variety of network topologies to different IoT environments for scalable and customizable options

Source: "Wi-Fi CERTIFIED™ and Matter provide ideal IoT connectivity

The collaboration between these two groups brings together expertise from diverse backgrounds, including telecom, consumer electronics, and industrial and commercial. As they develop new standards, they encourage adoption by a broader range of manufacturers, further accelerating the growth of connected ecosystems. This, in turn, enhances user experiences and expands the capabilities of IoT devices in both residential and commercial settings.

By collaborating on interoperability, security, innovation, and simplicity, they pave the way for seamless connectivity across an ever-expanding array of devices and applications. Their efforts drive the adoption of reliable and efficient IoT solutions, ultimately enriching our lives through a connected, smart, and secure ecosystem. As technology continues to evolve, the collaboration between these two industry-leading alliances remains essential in shaping the future of wireless communication.

Matter operates at the third (application) tier of a 3-tier architecture

Physical
Network technologies such as Wi-Fi and Thread

Networking
Protocols such as TCP/IP v6 and UDP

Application
Matter, Alexa, HomeKit, Home etc.

The Matter protocol is aimed at reducing the dependencies between devices and IoT platforms such as Amazon Alexa, Apple HomeKit, and Google Home. It should enable easier product certification, simpler and common onboarding for users, and a consistent (and secure) set of connectivity options.

3.1 Design Principles of Matter

The underlying design goals and principles for the Matter protocol are:

- Native IP architecture for the smart home

- Standardized and reliable network connectivity options

- Simplicity for device onboarding and administration

- Accessible royalty-free and open-source software with democratic contributions by members

- Inherent security

- Trustworthy and transparent certification processes

- Cloud-friendly systems, but with full offline capabilities as well

- Blending standardized basic functions with enablement of software and use-case extensibility and product/vendor differentiation

- Power, compute, and memory efficiency

- Wide availability of Matter components (e.g. semiconductors) and tools

- Ability to provide backward compatibility / integration with existing legacy IoT devices and hubs

Matter's native IP architecture is important as it means that devices are inherently Internet/Cloud-capable without the need for additional hubs and gateways. But while there is a strong synergy between Matter and Cloud-based IoT services, there is also well-engineered capability for continued local control of in-home networks and devices if broadband connections or cloud services experience outages.

Reliability of the Matter standard is achieved by applying field-proven and well-known standards such as Wi-Fi and IPv6. The first release of the Matter protocol is based on Wi-Fi, Ethernet, and Thread network layers for data transport plus BLE (Bluetooth Low Energy) for commissioning (onboarding) of new devices. Thread is a mesh-capable low-power wireless technology based on IEEE 802.15.4 standards. Products using these technologies still require normal development and certification from the relevant bodies (such as Wi-Fi Alliance). Others such as 4G/5G cellular are not currently supported but may be considered in future.

The Matter software platform is open source: anyone can contribute to the GitHub repository. The source code is available at no cost. Ecosystem members large and small have contributed to the implementation with the lead sponsor of this paper — Silicon Labs — being one of the most prolific. Using Matter is royalty-free although use of the Matter logo on commercial products and packaging requires devices to be certified by the Connectivity Standards Alliance.

The underlying principle here is to standardize core functions while still enabling product vendors to differentiate in hardware and for higher-level software functions. In addition to allowing consumers (or landlords/building owners) to create and operate their own local smart home IoT networks, the architecture provides a platform for a variety of other innovative use cases. Examples include:

- Managed smart home IoT networks delivered by a variety of service providers

- The use of AI for personalization of networks, recognizing device preferences, inferring room layouts, suggesting device groups and clusters, or making recommendations for configurations or additional functions.

- Intelligent automation — for instance closing blinds during the sunniest part of the day, or optimizing for energy efficiency or variable-cost utility supplies.

- Sophisticated building management, for purposes such as physical or cyber-security, or for tracking and implementing software updates appropriately

These functions can leverage both local real time processing and data (such as historic consumption patterns) in the Cloud. Because Matter is a standardized application-layer protocol, the user journeys or UX for Matter-certified devices are likely to be functionally similar although use cases and the design/performance of the devices themselves may differ widely.

Another core design principle of Matter is simplicity. It is designed not only to be simple for users to interact with but also simple for developers. The intention is to limit repetitive tasks in product creation, reduce the need for low value-add work on underlying connectivity, and to shorten times to market for devices.

Chipset choice and tool availability should increase with standardization and the attendant economies of scale by suppliers. Leading IoT silicon providers — such as this report's sponsor Silicon Labs and others — already offer software development environments that allow developers to start working rapidly, with support for Matter over Wi-Fi or Matter over Thread.

Matter has been designed specifically for the IoT, which requires low processing overhead so that computational power required for devices (MCUs) is minimal, with memory requirements of less than 128kB RAM and less than 1 MB flash memory.

Matter Devices   Matter Controller   Thread Border Router   Matter Bridge

3.2 Network Topology & Device Roles

The Matter standards define a stereotype of a local (home) network architecture with associated roles for different nodes and devices. These include:

- **Matter Devices:** IoT end-devices themselves in various pre-assigned and defined categories (discussed separately in this report)

- **Matter Commissioners:** Devices capable of onboarding or "commissioning" others over BLE. Typically this will involve a smartphone, tablet or similar device, either with an app performing the commissioning function, or as a native function of the underlying operating system (e.g. iOS or Android) itself.

- **Matter Controllers:** Devices which act as the hubs for one or more Matter 'fabrics', performing key pre-defined functions for controlling onboarded devices. Such functions might be — for example — on/off/dim for a lightbulb, or a timer function for a connected plug or smart blinds. Matter controllers will often be smartphones either supported natively by the OS itself, or separate apps. Additional more complex functions may be supported in specific vendor products or applications outside of the Matter definitions.

- **Thread Border Routers:** These connect Wi-Fi devices to Thread devices and vice-versa. They perform the following functions:

  - **Network translation:** The border router translates Thread networking protocol messages into standard IPv6 messages that can be transmitted over other IP networks such as Wi-Fi.

  - **Routing and connectivity:** It manages the routing of messages between devices on the Thread network and devices or services on other IP networks, ensuring that data is correctly sent and received.

  - **Network management:** The border router helps maintain the Thread network's health by providing management and monitoring functions, ensuring that the network remains stable and reliable.

  - **Security:** It plays a role in maintaining the security of the network by managing secure connections between the Thread network and other IP networks, including handling encryption and decryption processes.

- **Matter Bridges:** These link Matter controllers and devices to other (legacy or proprietary) IoT protocols including Zigbee, LoRa, and Z-Wave.

Wi-Fi-capable home gateways and mesh extenders are also implicitly recognized as part of the Matter network architecture. It is important to note that devices can support multiple roles at the same time and that all Matter devices can communicate with each other via IPv6 regardless of chosen transport protocol.

Many of these functions can be combined together in a single device or application especially where only basic functionality is needed or where integrated "ecosystems" are supplied by vendors. There will be other scenarios or customer groups where it makes more sense to separate out the capabilities perhaps if they are added over time.

It seems likely that most smart homes will end up with:

A home broadband gateway, which includes a Wi-Fi access point and (if it is newly-supplied) a Thread Border Router function

One or more Wi-Fi mesh extenders or smart speakers, which can also support Thread and Matter. These may belong to different fabrics / ecosystems.

One or more smartphones, which can act as commissioners and controllers for Matter devices, using a mix of native OS functions and vendor/SP apps.

Various smart home Matter devices. Some of these will support a Thread mesh capability.

A subset of homes will use Matter Bridges either to connect existing legacy devices or in some cases to extend the Matter fabric to new (and still proprietary) device clusters.
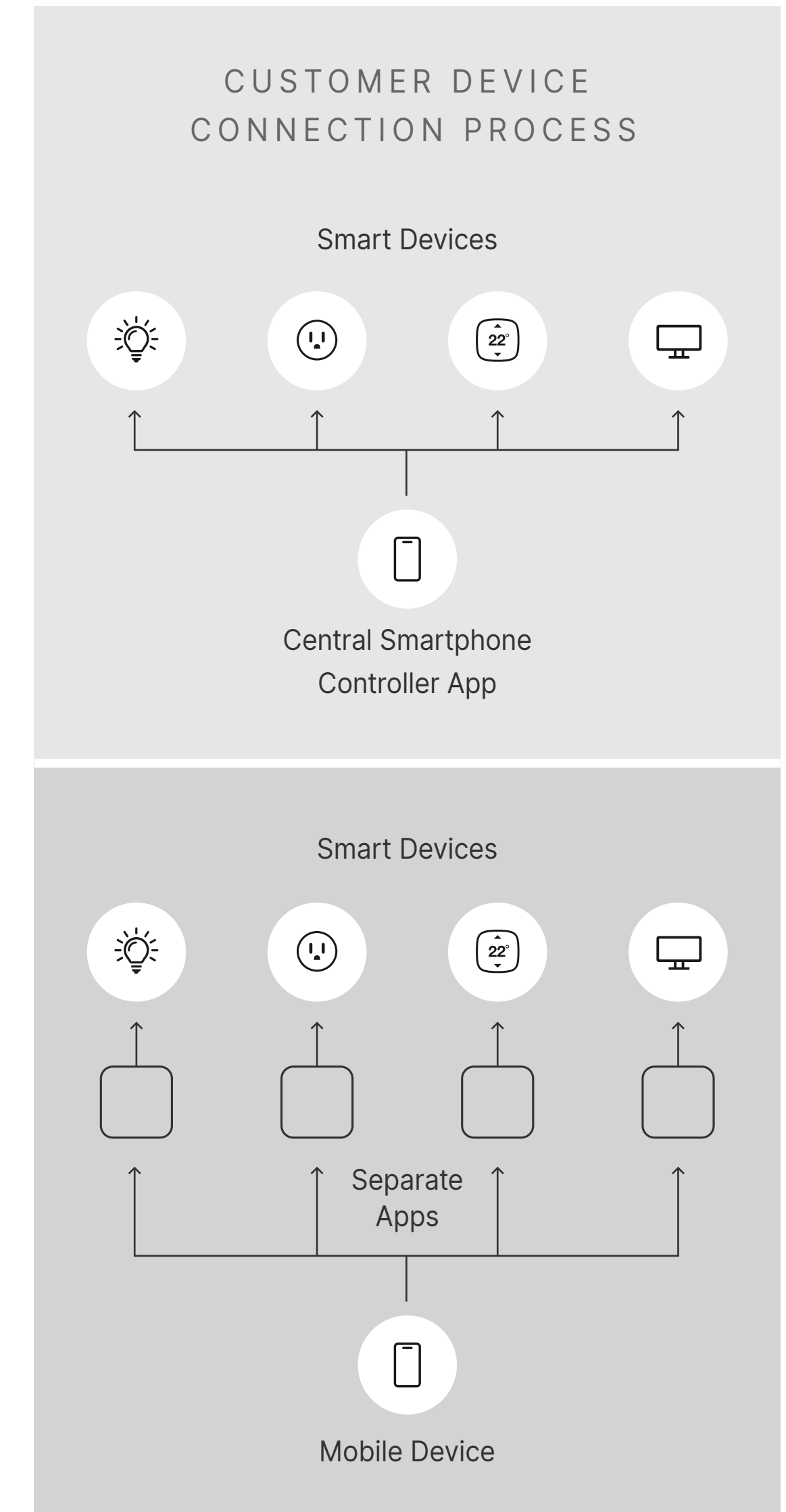
Some visions of the market suggest that in the medium term it is likely that most device-specific apps will disappear — in a similar way that few head-phones need a separate app. Most consumers do not want five, ten, or twenty apps to control all their home devices. What is less clear is which UX layers will remain from the various possible candidates:

- Native device OS

- Central smartphone controller app (either the same brand as the handset or that of a third party such as Amazon Alexa)

- Branded smart home apps from service providers, such as the home ISP, mobile network, or perhaps a dedicated managed service provider

- Separate apps for home automation (e.g. heating, security), health, fitness and entertainment devices

The likelihood is that a mix of customer inertia and / or apathy, ecosystem lock-in, and bundling with other systems will drive clarity over time. However, in some countries or demographics there may be local issues — such as much-loved local home system brands, or perhaps regulatory interven-tion — that may lead to different outcomes.

Support for new Matter device types is driven by Connec-tivity Standards Alliance members' priorities and the tech-nical definition of use-cases. Project teams are considering devices such as security cameras, home electrical appli-ances, robot vacuums, smoke/carbon monoxide sensors, electric vehicle charging, and home energy management.

Future developments may include toys, health and wellness devices, but these are likely further out, or perhaps may fall under other Connectivity Standards Alliance initiatives.

CUSTOMER DEVICE CONNECTION PROCESS

Smart Devices

Central Smartphone Controller App

Smart Devices

Separate Apps

Mobile Device

Delivering on the Smart Home IoT Promise | 26

1 Drivers for Matter Adoption   **2** Challenges for the Traditional Smart Home   **3** The Matter Protocol   **4** Get Involved

# 3.3 Matter over Wi-Fi, Matter over Thread

Matter supports Wi-Fi and Thread wireless transport technologies. The two are largely complementary, although Wi-Fi is currently the most popular choice as measured by the number of smart home devices deployed (Thread is comparatively new).

In most cases Wi-Fi also forms the main IP network backbone for hundreds of millions of homes across the globe, connecting both IoT devices and compute/entertainment-oriented products such as laptops, tablets, smart TVs, games consoles and smartphones. Most Cloud-delivered services in the home will transit Wi-Fi at some point, either via a standalone home gateway or (increasingly) a whole-home mesh network.

Wi-Fi is in most cases will remain a prerequisite for at least some parts of a Matter-based network. Thread devices require border routers to connect to the Wi-Fi backbone (or Ethernet backbone), unless home gateways have Thread capability built-in. Given that most gateways are expected to have long lifetimes, it may be costly for ISPs to supply upgraded Thread-based replacements routinely for existing subscribers.

For additional reliability and interoperability, Matter devices using Wi-Fi are required to be certified by the Wi-Fi Alliance in order to also be Matter certified by the Connectivity Standards Alliance. Matter can run above any certified Wi-Fi device of any generation including Wi-Fi HaLow. According to the Connectivity Standards Alliance several hundred Wi-Fi devices have already been certified for Matter only a few months following the release of the first Matter protocol.

The growing use of camera modules, real-time sensors, and display screens even on basic products may shift connectivity choices towards Wi-Fi in the future rather than towards narrowband options. In addition, the growth of service/subscription-based products for the smart home, often linked to data collection, storage, and analytics, will also drive the need for better IP-based in-home connectivity and onward (secure) broadband links to the Cloud.
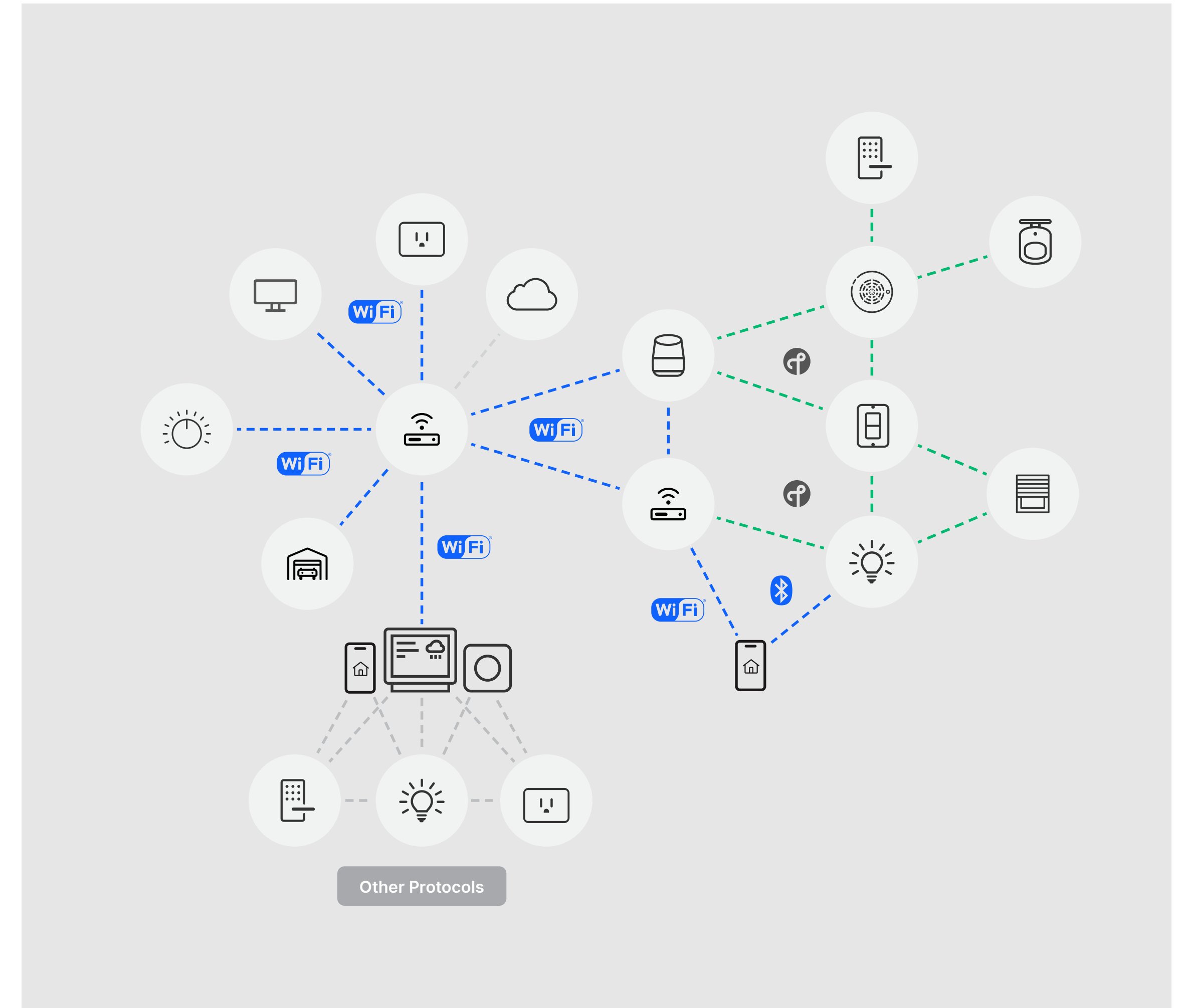
Performance improvements

Will Matter improve the performance and reliability of smart home networks and services? The short answer is a yes and the reasons are multiple but fairly obvious. First of all, Matter devices need to be certified to carry the Matter logo, which means they will need to go through rigorous interoperability testing and adhere strictly to the requirements of the standard. The Matter logo and certification process is in this sense a stamp of quality and a credential that the device will function up to at least the requirements of the Matter standard.

There is no law stating that IoT devices need to be Matter compliant — but in that case they would not be permitted to carry the Matter logo. Similarly, Wi-Fi-based devices using the Matter designation will also be required to be Wi-Fi certified, which removes another frequent source of errors, lack of interoperability, and malfunction.

Why smart home IoT developers should consider Wi-Fi 6

Historically most smart home IoT devices have used basic versions of Wi-Fi — often relying just on the 2.4GHz band and earlier variants such as Wi-Fi 4/5 (802.11n or .11ac) with lower-cost components. These have typically had significant technical limitations, as discussed above.

The Wi-Fi6 standard — which was released in 2019 — is gradually being adopted for wireless IoT applications, driven partly by the need for better, more reliable multi-user performance in locations with a high density of devices. Given that smart homes may have twenty or more Wi-Fi devices, this emphasis is becoming more urgent. It uses techniques including MU-MIMO (multi-user, multiple in/out) for better beamforming and simultaneous streams as well as OFDMA radio waveforms to support more bandwidth. This is important — for example — when used for HD video from security cameras.

Wi-Fi 6 also represents the first time IoT device and ecosystem developers are able to control device "wake cycles" and hence drive down and better control power consumption for Wi-Fi-connected IoT devices. The Target Wake Time (TWT) feature is expected to drive more mass-market adoption of battery-operated Wi-Fi-connected IoT devices, such as sensors, actuators and similar products.

While initially comparatively costly, the price-points of Wi-Fi 6 chips has fallen in recent years, which combined with Matter support may change the calculus for all but the lowest-margin IoT devices in future.

Future Wi-Fi 6E/7 for 6 GHz IoT

Although many in the Wi-Fi industry rightly focus on the opportunities offered by the newly allocated 6GHz unlicensed band, it should be recognized that most home IoT products are unlikely to exploit 6 GHz spectrum in the near future. In general, the two key design requirements for consumer IoT are:

- Low cost of manufacturing
- Good range including hard-to-reach areas of a home, garden, and surrounds such as basements, sheds, and external walls and rooftops

For this reason, many of today's IoT products and corresponding chipset platforms still use the 2.4 GHz band only, which offers good range and good penetration through walls and floors. Using this band also typically means more affordable components and hence lower device costs.

But there are exceptions to this: High-definition video cameras and displays, smart TVs, and AR/VR wearables are likely to be higher-margin devices in need of more bandwidth. These will tend to employ higher performance Wi-Fi perhaps including the new 6 GHz band as well as the more typical 5 GHz band. Add to this that Matter would likely be well-optimized for the new sub-1 GHz 802.11ah version of Wi-Fi (Wi-Fi HaLow) which is specifically designed for low-power and long-range usage.

3.4 Matter for Legacy Devices (Zigbee, Z-Wave, & Others)

For many users — and also device developers — integrating existing legacy smart home devices into a Matter network will be an important consideration. While some homes will be completely new to adopting IoT and can be 'Matter-only' the majority of initial Matter product sales are likely to be made to homes with heterogeneous device environments.

Today, many smart home devices use different connectivity technologies to those included in the Matter standard. These have included Zigbee, Z-Wave, Bluetooth, LoRaWAN, DECT and a wide variety of proprietary alternatives — as well as wired ethernet and USB connections. A number of devices (such as alarms) use cellular radios — either normal 4G/5G or low-power NB-IoT and Cat M. Some devices such as wearables act as peripherals to mobile phones, essentially acting as extensions to their cellular or Wi-Fi connections.

The question is then what happens to legacy devices already in homes or to existing (and new) product portfolios that lie outside of Matter's current reach.

It is important to recognize that many important device designers and manufacturers have sunk time and effort into creating excellent products and ecosystems that use other network technologies. They may also have advanced functions and applications that do not map exactly to Matter's specifications.

They will want to protect their investments and engineering skills and ensure that their customers' existing systems are not left stranded. They will often want to keep smartphone apps to allow configuration and use of advanced features. It is unrealistic to expect an immediate or total cut-over to Matter, Thread, and Wi-Fi.

Support for legacy Zigbee and Z-Wave devices is especially important since the installed base of such devices worldwide is in many millions. Z-Wave alone cites 3000+ devices and 100+ million shipped smart home devices[1]. Careful thought is needed to smooth the transition and boundaries between legacy devices, any relevant hubs and smartphone apps, and a new Matter network and controllers.

We believe that bridges — plus appropriate multi-protocol software platforms — will be an important means to incorporate legacy devices into existing smart home fabrics. Many vendors are unlikely to want to abandon their existing hub strategy or capabilities and IPR relating to non-Matter connectivity. Bridges should ideally have developer-facing APIs that abstract any underlying complexities from linking Matter and non-Matter ecosystems.

The Connectivity Standards Alliance — which oversees Matter was historically known as the Zigbee Alliance, so the Connectivity Standards Alliance and its members pay close attention to this migration. Zigbee is being updated for better support and coexistence, for instance with meshing and enhanced hub specifications. Zigbee Direct will add support for BLE as a way to connect smartphones with individual devices.

But the other technologies' ecosystems are unlikely to sit still and wait for Matter's focus on Thread and Wi-Fi to displace them. They will likely continue to improve their propositions and look to compete directly or indirectly. Some may seek to have their technologies included as official additional options within Matter, although it is unclear how non-IP based networks could be treated on a level basis.

Overall, these issues will increase the importance of Matter bridges — but also means that specific vendors may carefully scrutinize their timing to avoid cannibalization and replacement of their existing customer bases. Some vendors are likely to be more interested in getting their Matter controllers into the market, or selling new Matter-enabled devices, before looking at legacy device support.

The bridging option outlined above means that Matter's legacy device support allows consumers to incorporate existing smart home devices into a Matter fabric indirectly via bridges, and then gradually migrate to a full Matter-compliant network as the network expands or is updated.

[1] https://www.z-wave.com/learn
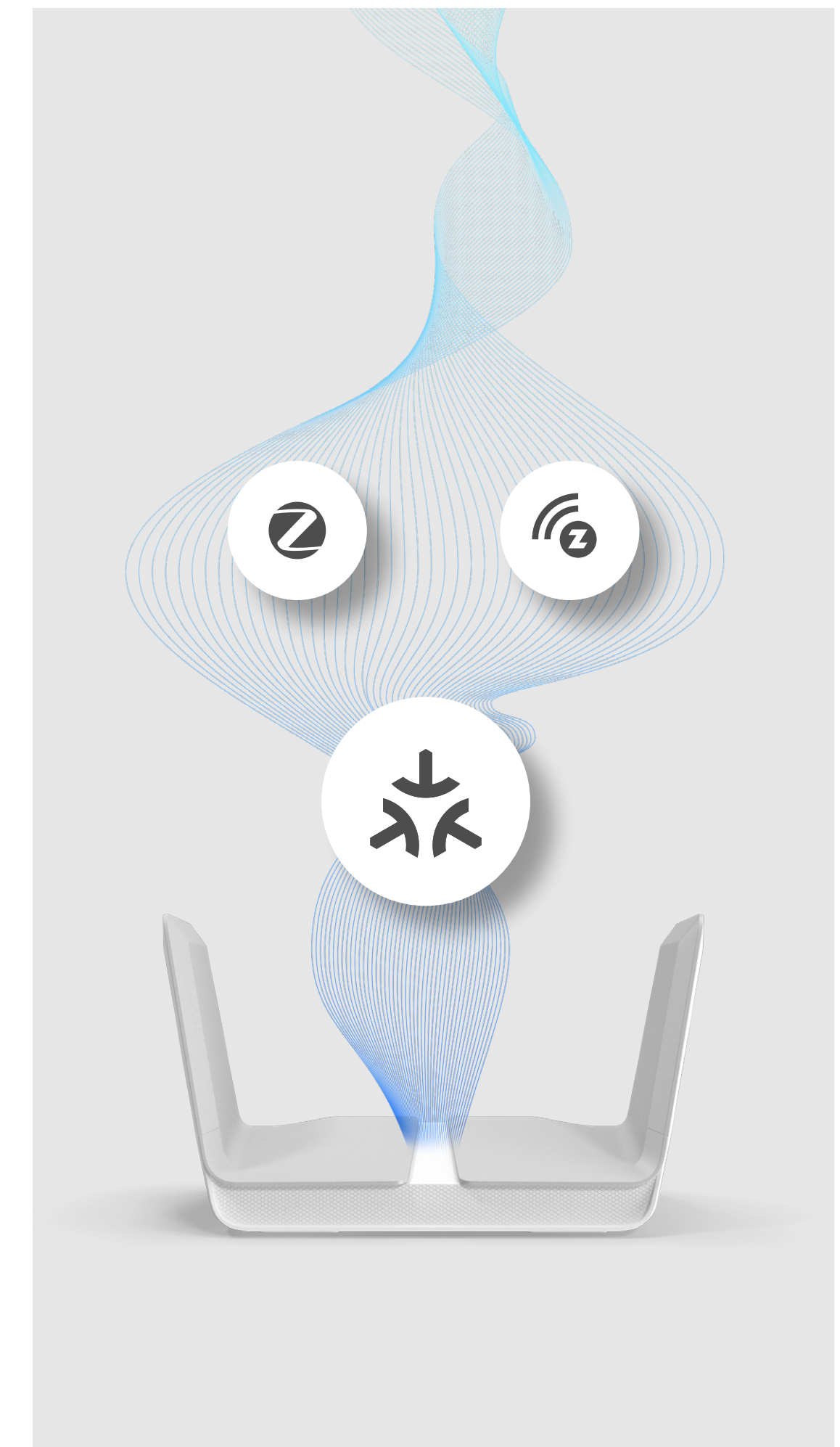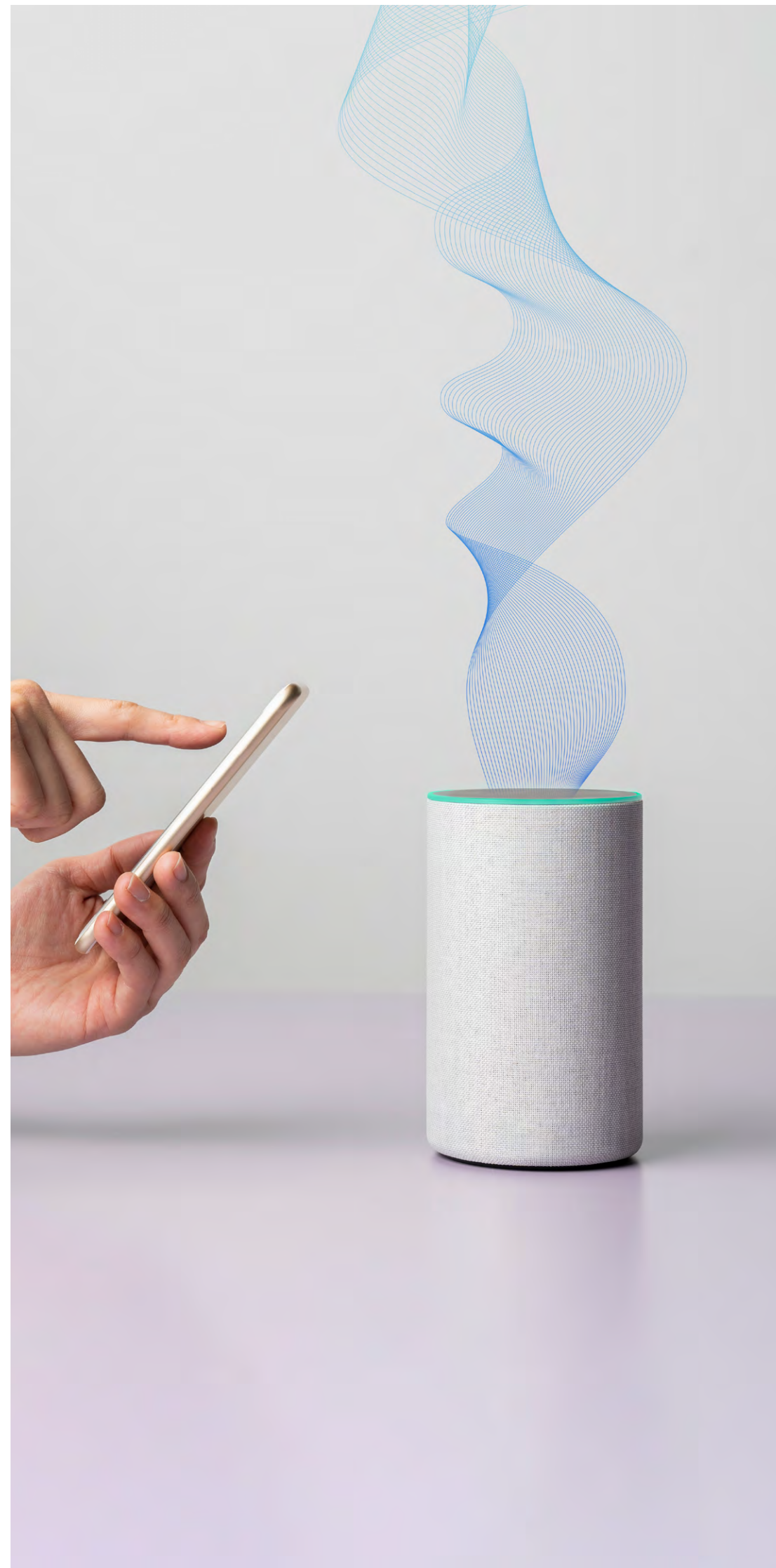
3.5 Ease of Onboarding and Multi-admin

Interoperability is the primary feature of Matter in that all certified Matter products are required to interoperate seamlessly regardless of manufacturer and smart home device ecosystem as well as regardless of their role (device, controller, border router, bridge, etc.). This primary function of Matter is expected to drive faster smart home device uptake via increased consumer purchasing confidence — but also critical for future uses of Matter in other segments such as industry, healthcare, automotive, and so on.

Another critical component for vastly improving the smart home IoT user experience is onboarding of devices. Matter has streamlined and carefully defined the onboarding (commissioning) process for smart home IoT devices. Onboarding processes for different devices are not expected to be exactly identical but functionally equivalent and comprising a few easily recognizable steps. Currently — for non-Matter devices — studies show that some 36% of users experience difficulties in setting up smart home devices by themselves[2]. The aim of Matter onboarding is that such difficulties will be a thing of the past for the vast majority of smart home IoT users.

All Matter devices use a setup code accessible in the form of a QR code, a number written on the device, or number residing in an app. In some cases apps may advise the user of the discovery of a new Matter device via text or even voice messaging. The communication with the device during the setup phase takes place via Bluetooth LE. The final part of the process is taken care of by Matter's multi-admin functionality, which permits the user to add the device to his or her Matter smart home networks of choice.

Multi-admin is another marquee feature of Matter and one that holds great promise in driving smart home IoT market growth by removing barriers to consumer freedom of choice, installation, and use. For consumers, Matter allows smart home devices to connect to hubs and other devices from a multitude of compatible ecosystems — even at the same time.

This means that a device can form part of several smart home networks concurrently and can be managed from a variety of Matter controllers also belonging to different ecosystems. The multi-admin feature removes a great deal of confusion and complexity from consumers' smart home IoT device purchasing decisions and adds real use case value in that for example sensors or other types of IoT devices can be used in various contexts. For example: A motion sensor can be used for both a lighting system and a security system.

The Matter standard requires that certified Matter devices support at least five so-called 'Matter Fabrics' — 'Fabric' in this case meaning an individual ecosystem network for example within the home.

And of course for manufacturers the multi-admin principle shortens time to market and reduces development costs because they no longer need to create an entire family of device versions for the sole purpose of linking a product to various smart home IoT ecosystems each requiring compliance with a proprietary protocol. One Matter certified device is enough.

[2] https://csa-iot.org/newsroom/setting-up-devices-with-matter/

3.6 An Open-Source Approach to Development

Open-source development is at the core of the Matter concept. Code for the Matter reference implementation is available to all manufacturers on an open-source, royalty-free basis including security modules. Any member of Connectivity Standards Alliance may contribute to the standard with a wide variety of ecosystem members (both large and small) having participated already. The contributions from firms such as Apple, Google, Amazon and this report's sponsor Silicon Labs helped accelerate development of the protocol.

The objective has been to maximize ecosystem breadth in terms of device designers, software developers and service providers, while reducing barriers to new market entrants. This also ties in with product quality, where it is essential that even the smallest supplier can create secure, reliable and interoperable solutions — dedicating most of their resources to IoT function and user experience, without attempting to "reinvent the wheel" in critical areas such as security. An additional benefit is that broader community participation in creating the underlying stack should result in additional use-cases being captured by the process.

While the platform itself is without cost, use of the Matter logo on commercial products and packaging requires devices to be certified by the Connectivity Standards Alliance.
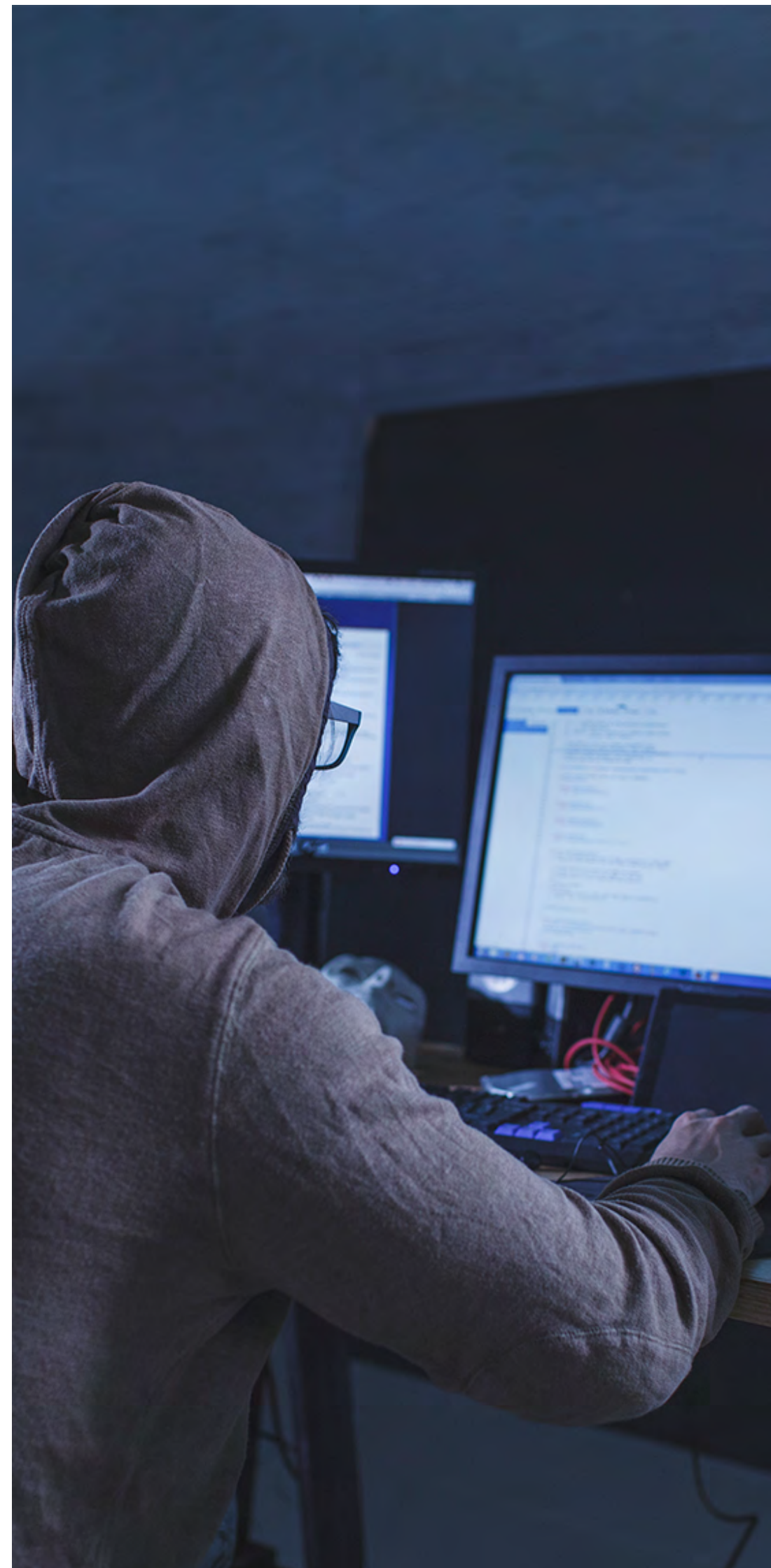
3.7 Focus on Security and Privacy

Smart home consumers are naturally concerned about security and privacy. Device manufacturers are equally concerned as are future ISPs providing or perhaps even controlling Matter-capable devices for example as parts of a smart home ISP bundle or Cloud-based service. Security threats include product malfunction through remote control, DDoS attacks, data & privacy breaches, intellectual property theft, and some breaches could even result in potential harm to humans. Security breaches can be very serious indeed and systems must be designed to protect against them.

To protect users Connectivity Standards Alliance has designed Matter to meet exacting security standards from manufacturing of devices through to installation and maintenance. As a starting point every Matter device is authenticated and every message is encrypted. Matter security is self–contained and does not rely on the security of other protocols below, which also means there is no need to add additional security features on top. A Matter reference implementation (code) including security modules is available to all manufacturers on an open-source basis. Security in Matter is designed with resilience and agility in mind, Connectivity Standards Alliance says.

For security and privacy all Matter devices are required to provide proof of identity via certificates so that data can only be shared between 'trusted' devices. In general Matter applies the principles of GDPR in its design. Add to this that WPA2 (Wi-Fi 4, Wi-Fi 5) and WPA3 (Wi-Fi 6) standardized security and encryption protocols are incorporated in any certified Wi-Fi device also certified by Matter. Matter devices are also required to support OTA (over-the-air) firmware updates either by means provided by the Matter itself or via proprietary means.
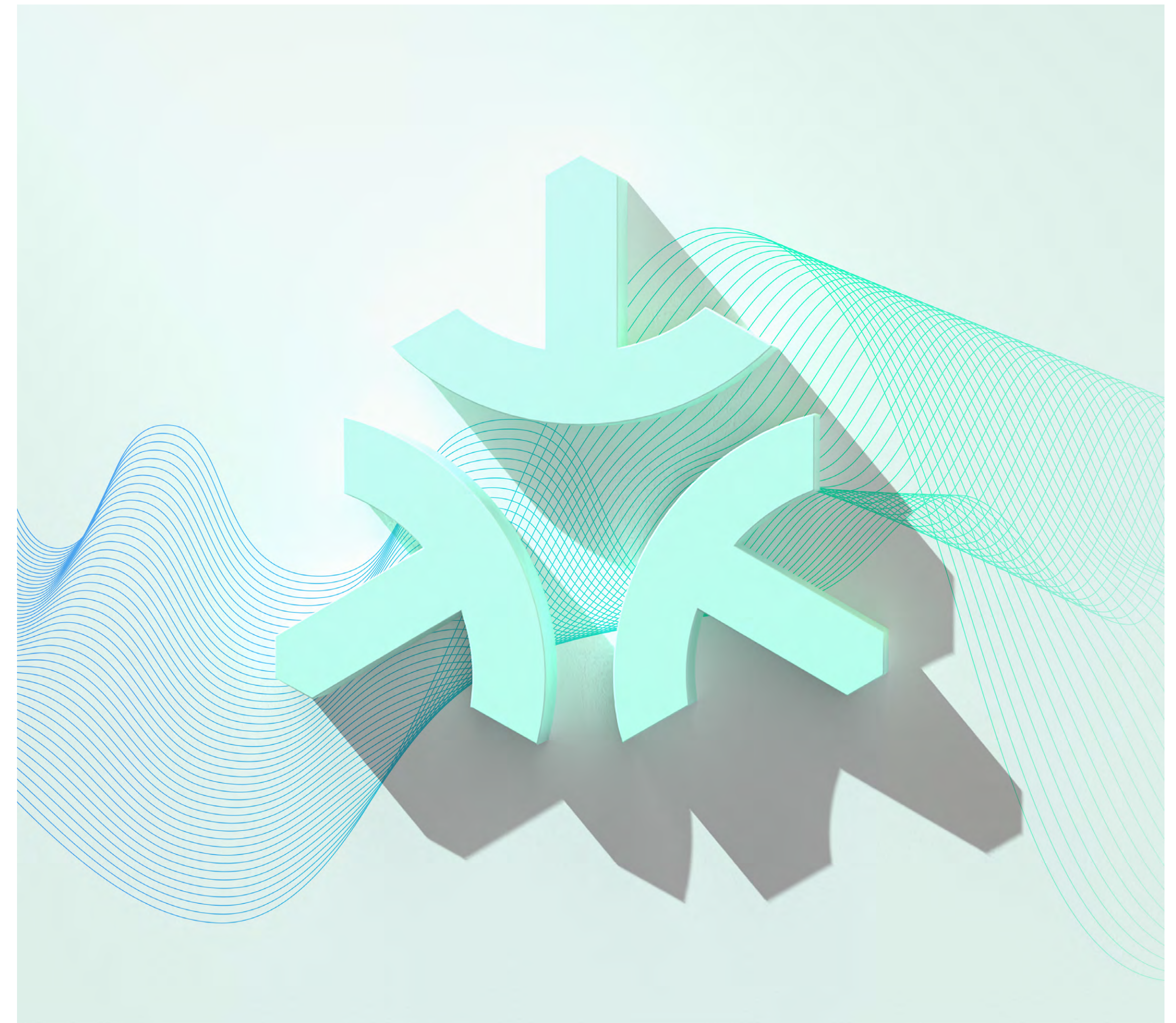
Delivering on the Smart Home IoT Promise | **31**

1 Drivers for Matter Adoption   **2** Challenges for the Traditional Smart Home   **3** The Matter Protocol   **4** Get Involved

'Trusted Roots' (PAAs) & services for issuing Matter certificates

All Matter devices must be issued with certificates of authenticity and the scheme to deliver and maintain such certificates has been meticulously crafted — for maximum security — by the Connectivity Standards Alliance and contributing companies and organizations. The hierarchy of the scheme includes PAAs (Product Attestation Authorities, otherwise known as 'trusted roots') and PAIs (Product Attestation Intermediates).

All manufacturers are required to act as PAIs in order that they (or another accredited service) can issue Device Attestation Certificates (DACs) to individual Matter devices. The DACs provide immutable identities to each Matter device, they ensure authentication of all Matter devices, and maintain an accounting trail back to trusted root sources. As a result, it is nigh on impossible for rogue manufacturers to create knock-off Matter devices that jeopardize security. The Matter security mechanisms use blockchain (distributed ledgers) so that authentication takes place locally and does not require Internet access for any verification.

In the hierarchy of Matter security a 'trusted root' PAA — such as Digicert — issues a PAI to the member (typically a member) from Digicert's PAA. The member can then issue DACs that can be signed by Digicert as the trusted root. In the end the DAC of a device will contain a product ID and a vendor ID, which will uniquely identify and follow the device throughout its lifecycle.

Matter is the first time at least within a decade that a new and comprehensive application-layer security and privacy protocol has been created from scratch to serve connected devices. The method makes sure that only Matter certified and authenticated devices can connect to a Matter home network while maintaining Matter architecture of multi-admin and multiple controllers as needed. It also allows secure unicast, multicast, as well as secure software updates.

Delivering on the Smart Home IoT Promise | 32

1 Drivers for Matter Adoption   **2** Challenges for the Traditional Smart Home   **3** The Matter Protocol   **4** Get Involved

3.8 Certification and Testing

Certification of Matter products takes place at independent, authorized test laboratories accredited for Matter testing by Connectivity Standards Alliance. To speed up time to market including certification, Connectivity Standards Alliance has made sample application libraries for certain device types available for free. Connectivity Standards Alliance also says the goal is fully to automate testing so as to shorten device development times.
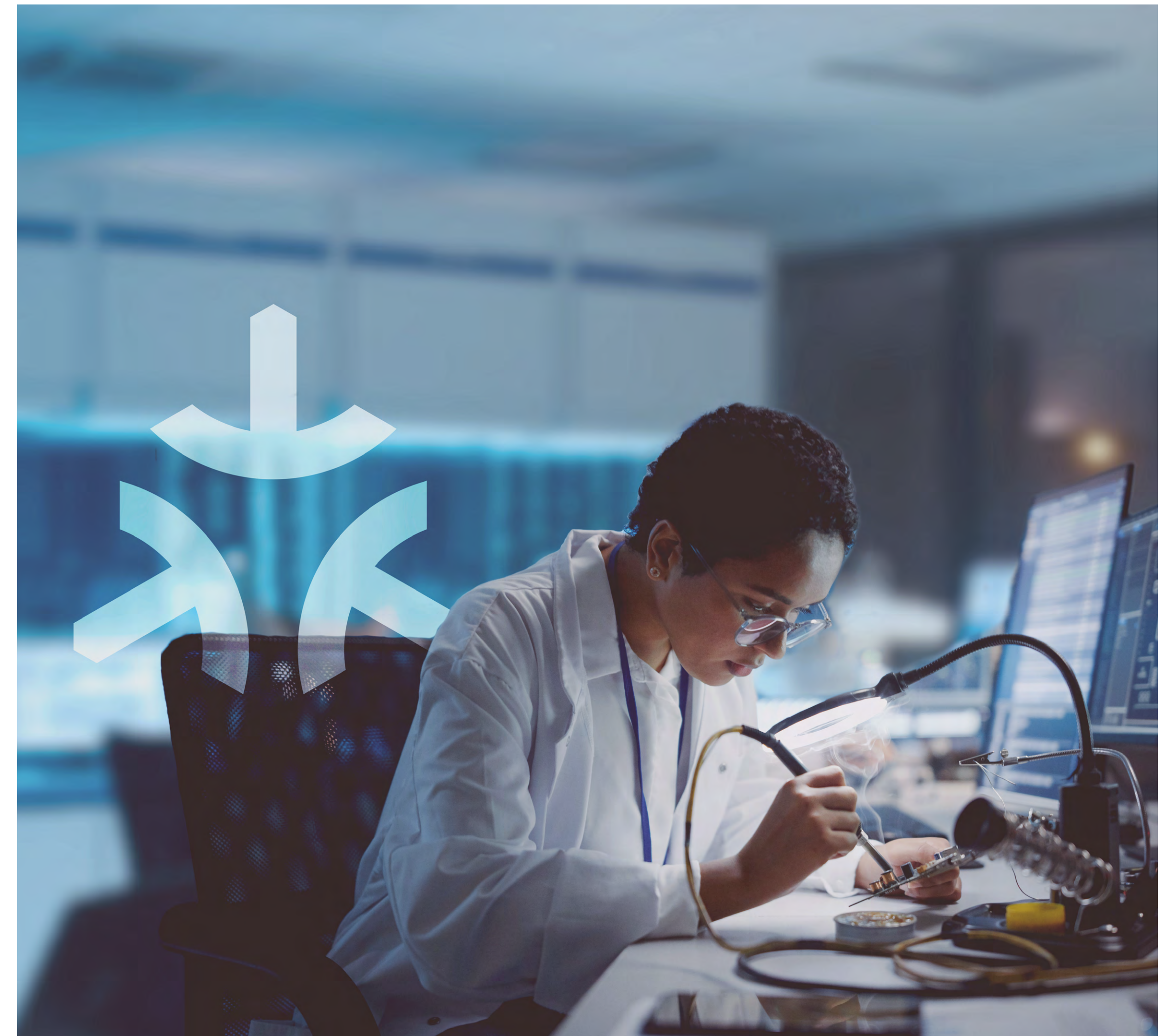
As noted above, use of the Matter logo requires device certification, to give customers confidence that smart home devices will work together out-of-the-box whether from a single supplier or a diverse range of brands.

The focal points of Matter certification include:

- Interoperability: Devices must work together seamlessly, regardless of the brand or manufacturer.

- Security: Devices must be proven to be secure and protect the privacy of users.

- Ease of use: Devices should be easy to set up and use.

- Future-proof: Devices are designed to be future-proof, meaning they will continue to work with new classes of devices and other updates, as they are developed.

The overall certification process includes pre-certification testing, formal testing, and test-harness training to the Matter smart home standards.

One crucial choice that needs to be made early on is the selection of a network transport option for your device. Since Matter is an IP-based protocol that operates as an application layer on top of technologies like Wi-Fi and Thread, a network transport layer that achieves the necessary certifications from relevant standards organizations is required. Appropriate certification is also required if a Matter device use Bluetooth Low Energy (LE) for commissioning (which many do). By ensuring any of these technologies used in your devices are properly certified by the appropriate standards organization early on, you will be prepared to complete the appropriate Connectivity Standards Alliance Attestation of Network Transport Protocol forms during the application process.

Delivering on the Smart Home IoT Promise | **33**

1 Drivers for Matter Adoption   **2** Challenges for the Traditional Smart Home   **3** The Matter Protocol   **4** Get Involved

4.0 Get Involved

The Connectivity Standards Alliance brings together a global consortium of companies to develop and promote an open, standardized approach to connectivity. For developers in the rapidly evolving tech landscape, joining the Connectivity Standards Alliance can bring a myriad of benefits and opportunities.

Interoperability and Compatibility
Developers who engage with the Connectivity Standards Alliance can contribute to shaping these standards, leading to better integration between devices from different manufacturers and minimizing compatibility issues.

Innovation
This collaborative environment fuels innovation by allowing developers to share ideas, insights, and best practices, which can lead to the creation of novel products and services. The Connectivity Standards Alliance's working groups offer a platform for developers to drive innovation and collectively solve technical challenges.

Early Access to Emerging Technologies
By participating in the development process, developers can influence the direction of these technologies and ensure that they align with their own projects and goals.

Market Growth and Adoption
By aligning their projects with these standards, developers can tap into a larger customer base and reach a wider audience. This can lead to faster market adoption and increased demand for their products

Influence and Impact
Developers who actively participate in Connectivity Standards Alliance working groups and committees have the chance to shape the future of connectivity technologies.

Active participation in the Connectivity Standards Alliance offers developers a unique chance to contribute to the advancement of global connectivity standards, drive innovation, collaborate with industry leaders, and gain early access to emerging technologies. By actively engaging with the Connectivity Standards Alliance, developers can position themselves at the forefront of the technology landscape, leading to enhanced career opportunities, increased market presence, and the satisfaction of playing a pivotal role in shaping the future of connectivity.

Silicon Labs

About Silicon Labs

Silicon Labs is the leading provider of silicon, software, and solutions for a smarter, more connected world. Our industry-leading wireless solutions feature a high level of functional integration. Multiple complex mixed-signal functions are integrated into a single IC or system-on-chip (SoC) device, saving valued space, minimizing overall power consumption requirements, and improving customer end products' reliability. We are the trusted partner for the world-leading consumer and industrial brands and small and medium sized companies. Our customers develop solutions for wide range of applications, from medical devices to smart lighting to building automation, and much more.

Silicon Labs is a leading contributor to Matter specification updates and our broad wireless expertise spans building automation, smart home, industrial IoT, and other application areas to connect a wide range of networks and devices—regardless of the underlying network protocol.

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Prominent, influential & outspoken technology industry analyst, futurist and consultant, specialising in telecoms, wireless & IoT sectors. Numerous clients among global telecom operators, vendors, startups, regulators, investors and industry bodies. Speaks at 30+ conferences & other events per year.

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- Business strategy, technology evolution & telecom policy/regulation

- Impact of AI & blockchain on Internet & telco value chains

- Next-generation voice, video, UC & messaging technologies & business models

- 5G & 4G mobile broadband technologies (radio, core, policy) & services

- WiFi (offload / onload / connnection management)

- IoT & enterprise wireless, including private cellular, LPWAN, eSIM & spectrum strategy

- Broad futurism & implications for technology, government & society

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