A Basic Reference Model for Home Network Device Configuration

1.1 Introduction

Have you ever stopped and counted how many devices are connected to your home network? Beyond IT devices like PCs, smartphones, tablets, and printers, you may also find other devices connected to your home network such as game consoles and TVs, and even home appliances like rice cookers, air conditioners, and audio equipment that now come with Wi-Fi. It's commonplace for people to have two or more personal mobile devices these days, say a smartphone and a tablet, so in a family household, it's not at all uncommon for over 10 devices to be connected to the network.

Moreover, a much wider variety of devices can be found in the home than in the office. Most office IT equipment comes with standard tools for checking IP addresses and connectivity. But with TVs and other home appliances, it is not always easy to check the assigned IP address or MAC address, and the controls typically differ by manufacturer and model. On top of that, connectivity within the home involves a whole mix of things—common networking standards like wired Ethernet and Wi-Fi as well as dedicated audio cables and short-range links like Bluetooth.

And it's not necessarily the case that someone in any given household has some IT expertise. Many people reading this may have been asked to, say, fix a network problem at an aging parent's house and struggled to sort it out. Faced with the common refrain of "it won't connect" or "it doesn't work," there's currently no single way to determine whether the culprit is one particular device, a network misconfiguration, or a conflict with some nearby device. With there being few means of accurately assessing such a situation from afar, the result is that you generally have to go there in person to sort it out.

Not only is this state of affairs inconvenient, it can also affect the security of the entire network. There are real-world reports of vulnerabilities in home routers, webcams, and the like being exploited to conscript such devices into botnets involved in large-scale DDoS attacks. As home networks grow ever more important as everyday infrastructure, we need to move beyond the idea of individual devices merely being used to connect and instead think about how the system as a whole can be managed.

It is against this backdrop that the industry has long sought a common framework that would ensure interoperability and provide a systematic approach to the configuration management of multimedia devices in the home. This article looks at international standard IEC 62608-1 Ed. 2.0:2025, "Multimedia home network configuration – Basic reference model," developed within IEC TC 100 TA 18 (now handled by WG 31). We examine how it came to be formulated and the technical content it defines. I note that I have worked as a leader on this standardization effort since the first edition of IEC 62608.

1.2 The Need for Standardization

In an environment populated by a multifarious mix of devices like a home network, standardization is key to interoperability. There was a time when people preferred to buy all their appliances from a single manufacturer, but as the variety of products available grew more diverse, it became commonplace to mix and match products from different manufacturers. The cables and connectors that physically link devices have gradually been standardized. Even so, it was not uncommon for interoperability features to fail to work as expected when you connected, say, a TV and a content recorder from different manufacturers. Network connection methods and underlying assumptions also varied, and proprietary tweaks sometimes prevented data transfer between products from different manufacturers.

Standardization comes in several flavors, depending on how a standard comes about and what role it plays. International standardization broadly takes three forms.

1. De facto standards: Standards that take hold not through formal consensus but through broad market adoption. These are technologies developed by a particular company, or specifications set by a particular body (forums like the IETF or W3C), that became the industry standard through overwhelming market share or convenience. Many Internet protocols take this form, since "it works" is what matters most.

2. De jure standards: Standards established by official standardization bodies based on international consensus. Standards from the IEC (International Electrotechnical Commission), which we discuss here, as well as ISO (International Organization for Standardization) and ITU (International Telecommunication Union), fall into this category. Delegates from each country gather to deliberate and formalize standards under set procedures.
3. Consortium standards: Standards developed by industry alliances (consortiums) formed for a specific purpose. Examples include the USB standards from the USB Implementers Forum (USB-IF) and Wi-Fi from the Wi-Fi Alliance, Bluetooth from the Bluetooth SIG, as well as UPnP (Universal Plug and Play) from the UPnP Forum for automatic device discovery and DLNA (Digital Living Network Alliance) for multimedia sharing.

IEC 62608, which we discuss here, is a de jure standard set by an official international body.

To date, UPnP has made device discovery and control easy, and DLNA has established a mechanism for sharing multimedia content on top of UPnP. IEC 62608-1 references these standards as well. But while they succeeded at making specific services work, they fell short when it came to managing the configuration of the entire network as a single system. There was no "reference model" to provide an overview of the devices combined in a home network in terms of what configuration information they hold and how they behave.

The purpose of IEC 62608 is to integrate existing individual protocols and provide a common framework for managing the whole from a higher level. Standardization at this layer can be expected to have the following benefits.

- Unified management in multi-vendor environments: Lets you inspect the status of devices across a home network through a common model, without having to rely on manufacturer-specific management tools.
- Remote monitoring and diagnosis: Thanks to standardized configuration management, lets you accurately assess conditions and troubleshoot quickly from external locations.
- Adaptability to technological change: By defining a "basic reference model" that does not depend on any specific communication protocol, continuity in management methods can be maintained even as new communication technologies emerge in the future.

Standardization like this benefits users, but it is yet to come to full fruition, and IEC 62608 cannot yet be called widely adopted. Getting there required more than technical discussion. We also had to tackle issues arising from the scope and sphere of influence of standards organizations in Japan and abroad.

1.3 Organizational Challenges in Home Network Standardization

Historically, communication standards and device (product) standards have been managed by different government agencies and different standards bodies. Home appliances in particular have long enjoyed a strong, independent global market and community as standalone devices. But with the spread of the Internet and the networking of devices in recent years, the boundaries between these domains (scopes) have been blurring.

So standardizing home network configuration management required, in parallel with the technical work, coordination stemming from the scopes of the standards organizations and government agencies involved. As Figure 1 illustrates, a home network straddles two different standardization worlds, with the home gateway sitting at the boundary. The scope of each of those worlds is as follows.

- Left side: IEC/JEITA (the world of devices and appliances). This covers everything inside the home gateway—household TVs, audio equipment, white goods, and so on. Internationally, this is part of the IEC's (International Electrotechnical Commission) purview. In Japan, it falls under the Ministry of Economy, Trade and Industry, with JEITA handling the work. The focus is mainly on "functionality as a product."
- Right side:ITU/TTC (the world of communications

and the Internet). This covers everything outside the home gateway—the communication path out to the Internet. Internationally, de jure standards are handled by ITU-T and de facto standards by the IETF (Internet Engineering Task Force). In Japan, this falls under the Ministry of Internal Affairs and Communications, with TTC handling the work.

Users are able to use the services they do because their devices in the home and the Internet outside connect seamlessly through the home gateway. The home gateway doesn't just link the home to the outside Internet, it also handles address translation (NAT) and firewall functionality, and in technical terms, it is designed as a network device based on Internet-side specifications. It gives devices in the home the means to connect to the network, but managing those devices was never part of the discussion.

In formulating IEC 62608, we had to keep tabs on developments in both of these worlds. So we built an information-sharing framework. With JEITA as our hub, we participated in TTC on the communications side, and in turn, TTC members also participated in JEITA. The findings we came to through this domestic collaboration were then submitted in the form of a Japanese proposal to IEC international meetings.

1.4 Role of IEC TC 100 TA 18

The IEC (International Electrotechnical Commission), where the international standard was proposed, is an international standardization body founded in 1906 that covers electrical engineering, electronics, and related technologies. With over 90 countries participating as full and associate members, it sets de jure standards spanning energy (power generation and transmission), electroacoustics, multimedia, and telecommunications, along with related terminology, symbols, compatibility, measurement, performance, and reliability.

The IEC's work is divided among Technical Committees (TCs) that handle a particular field. TC 100 (Audio, video and multimedia systems and equipment), which received this standard, specializes in audio, video, and multimedia systems and equipment. Beneath it sit Working Groups (WGs) responsible for specific technical areas.

WG 31, where this standard was discussed, defines its scope as "Multimedia home systems and applications for end-user networks."

WG 31's predecessor, TA 18, produced many international standards for technologies used in everyday life. The flagship example is USB. The USB specification itself is a consortium standard developed by the USB-IF (USB Implementers

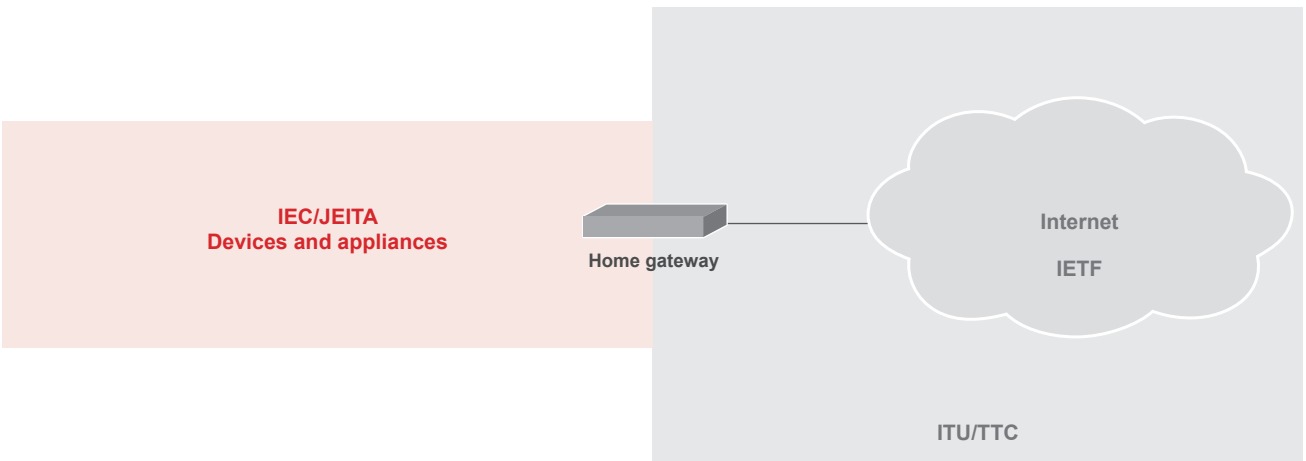

Figure 1: Domains of Standardization and Where This Standard Fits

Forum), but TA 18 turned it into an international standard, which it manages as the IEC 62680 series.

Recently, as part of its SDG-driven push to cut electronic waste, the European Union issued an amendment to the Radio Equipment Directive (Directive (EU) 2022/2380) unifying the charging port for certain electronic devices on USB-C. This mandates the USB-C charging interface for certain portable electronic devices. So instead of keeping a different charger and cable for every gadget, people can reuse the USB-C gear they already have. The technical reference standards cited are the IEC 62680 series of international standards.

IEC 62608 was also developed as an international standard for the logical management of home networks, with this kind of end-user connectivity in mind.

1.5 IEC 62608: Configuration Management for Multimedia Home Networks

IEC 62608 defines a "basic reference model" for managing a home network made up of diverse devices as one integrated system.

In this series, Part 1 (System Model) was published in 2014, and Part 2 (Operational Model) in 2017. But much time has passed since those first editions, and the world around home networks has changed dramatically with the rise of cloud services, the spread of wireless LAN, and so on.

As such, work to revise Part 1 began in 2021, and the latest edition, IEC 62608-1 Ed. 2.0:2025, was published in 2025. This section outlines the basic reference model, the background to the revision, and the technical features.

As Figure 2 shows, the standard's system model separates functions on the network into two logical entities: the side that manages, and the side that is managed.

- Configurator: The entity that keeps track of configuration information for the entire network, issues configuration instructions to, and checks the status of, each device. In Ed. 2.0, it is envisioned that this Configurator role will cover not only the home gateway but also cloud servers, smartphones, etc.
- Agent: Software that runs on a device, answers Configurator requests with the device's own attribute information, and changes its configuration as needed. Agents are intended to run on individual multimedia devices such as TVs, audio equipment, and white goods.

Note that in this standard, Configurator and Agent do not refer to specific devices or products. They are defined purely as roles. So a single device can take on multiple

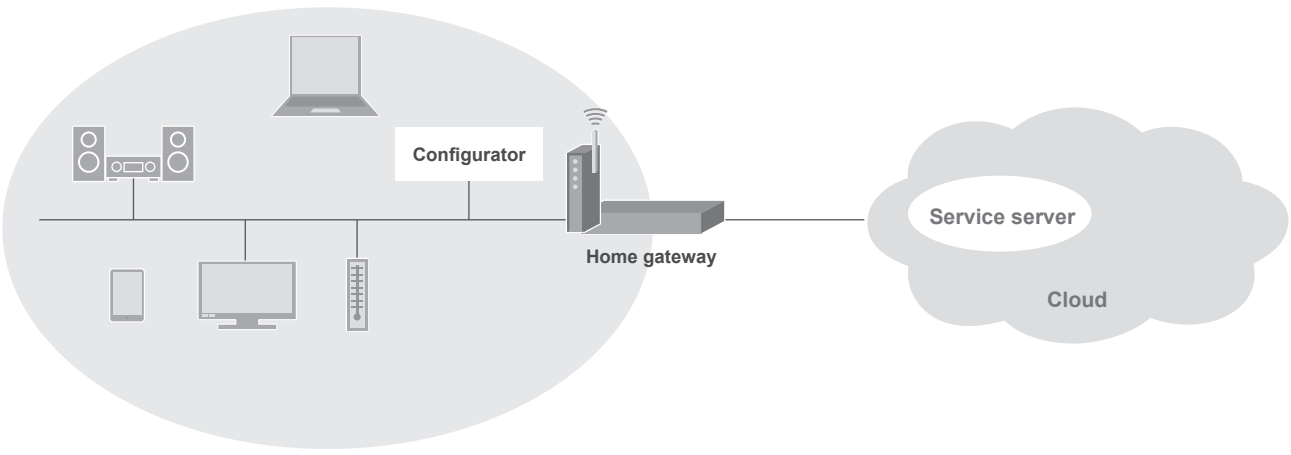

Figure 2: The IEC 62608 Reference Model

roles, and the delegation of roles can shift depending on how the system is used. This approach is intended to accommodate changes in devices, network environments, and usage patterns.

Now, when the first edition was published, wireless LAN was not all that widespread, so the standard covered wired networks only. Cloud-based data sharing was not commonplace either, so it went unmentioned. In those days, sharing data across home networks meant finding some way to connect into the home network itself.

The revision brings the standard in line with reality, with wireless LAN now in scope, and it introduces the concept of service servers designed for cloud use. Configuration management is thus no longer confined to the in-home network. Relationships with externally located functions can be covered too. The revision also addresses an issue in device–network relationships whereby it was easy to conflate the physical entity (the device) with the function (what it accomplishes); it does this by introducing a layered structure that makes the roles clear.

To illustrate specific applications, use cases were also added as an annex. Figure 3 shows an example of using the IEC 62608 reference model for automatic configuration of audio equipment in a studio. This provides a unique perspective that could only come from WG 31 (formerly TA 18) as a collection of multimedia and audio equipment experts and was created with ideas and advice from the group members.

1.6 Background to Formulation of IEC 62608 and What's Next

The idea behind IEC 62608 actually goes back to around 2002. At the time, XMLCONF (now NETCONF), a protocol for remotely configuring network devices, had been proposed at the IETF, the Internet standards body. When this was shared with the members of TC 100, the idea was put forward that home networks would surely need the same thing at some point.

But back then, when individual devices were each configured by hand, it was hard to convince people even within the IETF that XMLCONF was necessary, which made standardization slow going. It wasn't common for home appliances to connect to the network at the time either, and people generally didn't see why they would need to, so this was a time when adding networking features could actually hurt a product's sales. So while a handful of forward-looking members kept working on it, understanding was slow to develop on the TC 100 side as well.

More than 20 years later, both the Internet and the environment around home networks have been massively transformed. The Internet now has NETCONF standardization and automated operations management, while home networks have gained widespread wireless LAN, the arrival of the cloud, ubiquitous smartphones, and networked appliances. The landscape is utterly different. My sense is that we're now entering the phase in which home network management will be truly needed.

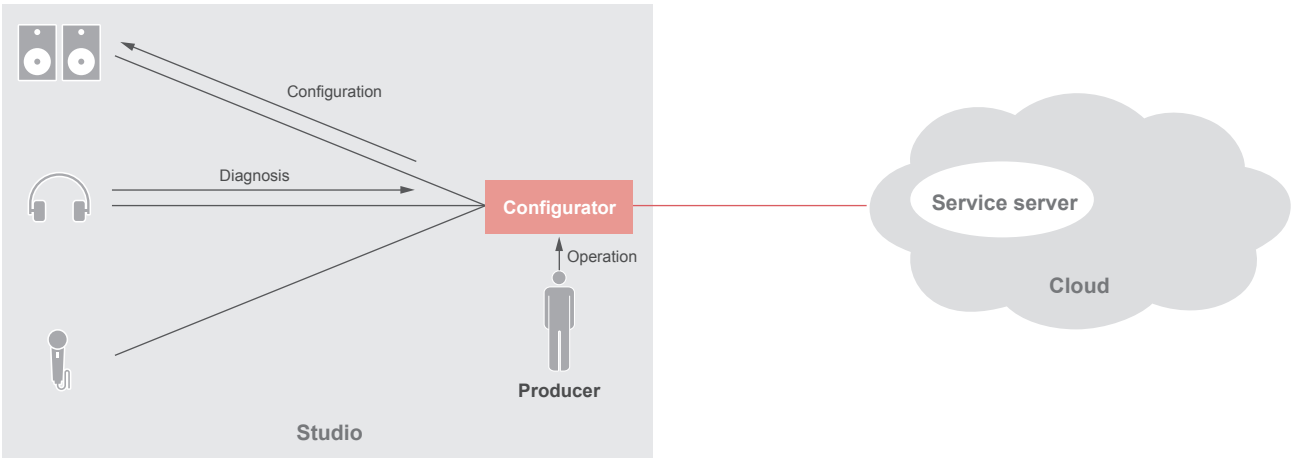

Figure 3: Studio Configuration Use Case

The revision of Part 1 of IEC 62608 is complete, but Part 2 (Operational Model) has also fallen behind the times and needs revising. Part 2 defines procedures for gathering information and applying configuration for home network management, and it corresponds closely to TTC TR-1062, "Customer support use cases for home network services."

So revising Part 2 creates the need to revise TR-1062 at the same time. Once again we'll be coordinating across two fields, but we share the same motivation, which is to make operations management easier. With the many people involved working together, I am confident we can move forward.

A new standard called Matter has recently appeared in the smart home world. It has brought a great variety of appliances, sensors, and even door locks onto the home network. Matter's connection procedures and applications are polished and intuitive, making it simple to operate appliances and view sensor data. Users may no longer even give a thought to the network at all.

Yet the more such devices can be connected without any thought for the network being needed, the harder it becomes to troubleshoot and respond in the absence of information when, inevitably, something won't connect or won't work. Network trouble, in particular, is rarely confined to a single device since it often arises from a confluence of multiple causes spanning software, configuration, and other factors. Having configuration information based on IEC 62608 available in such instances would no doubt aid in diagnosis and recovery. I believe this standard will serve as an unsung hero, quietly underpinning the reliability of home networks.

Finally, a word about international standardization. Companies that develop innovative technologies in-house while also leading the push to standardize them have been emerging of late. Standardizing can confer a market advantage in some situations. I feel that tracking standardization activity will be key when surveying new technology trends ahead.

Standards bodies differ not only in terms of creating de jure versus de facto standards. The way you are expected to participate in each also differs, and they each have their own procedures and culture. Looking beyond those differences, they also build cooperative relationships with one another through liaisons. We intend to keep working on this standard in cooperation with partners on many fronts.

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Aiming to realize a human-friendly Internet, Dr. Atarashi is engaged in research & development and standardization activities related to automated infrastructure designed to be easy for everyone to use.