zigbee alliance

zigbee interoperability
white paper

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Introduction

Interoperability is a key driver to ensuring the Internet of Things will be all that we hope it will be – the next chapter in wireless that delivers meaningful and enchanted interactions between humans and their devices. Interoperability is a critical requirement to take consumer embracement to the next level. We all want the freedom to pick and choose devices and not be siloed by one brand as we build our individually tailored smart environments. And, we want the assurance that when these new additions arrive home they'll play nicely (and easily) with those already in place. Manufacturers are wagering on interoperability to ensure their technology investments are future proof, and that their devices can sell into large, established markets. Application developers seek interoperability so they can imagine and design apps for the largest ecosystem of compatible devices.

Organizations guiding the IoT must lead with interoperability to solve the challenges currently hindering the connected landscape. It's truly the catalyst that will sail us all across the IoT chasm. Product manufacturers designing for this burgeoning market can achieve game-changing interoperability in several ways:

- Interoperability through unification
- Interoperability through backwards and forwards compatibility
- Interoperability through full-stack specifications
- Interoperability through over-the-air updates
- Interoperability through testing and certification
- Interoperability through commissioning

Interoperability through unification

As the Internet of Things evolves, industry leaders will sometimes need to shift strategies to continue on course and progress with the market requirements. Already, we've witnessed the growing need for new uses cases where application objects are combined in innovative ways to offer more value to the end user. The zigbee alliance is one good example of an organization that's been steering the IoT well before that moniker came along. Its legacy application profiles – ZigBee Light Link (ZLL), ZigBee Home Automation (ZHA), ZigBee Building Automation (ZBA) and ZigBee Retail Services (ZRS) – were fit for purpose to address distinct use cases within a specific market vertical, and then in 2016 the wireless standard bearer unified these profiles under its ZigBee 3.0. offering (referred to today simply as 'zigbee'). zigbee defines the widest range of device types including home automation, lighting, energy management, smart appliance, security, sensors and health care monitoring products. It provides seamless interoperability among this full range of smart devices and gives consumers and businesses access to innovative products and services that will work together seamlessly to enhance everyday life. There are no special flavors of the zigbee standard applicable in a specific market segment; there is one single specification applicable across market segments.

Interoperability through backwards and forwards compatibility

It's essential that technologies be backwards compatible with existing field deployments and older legacy systems to embrace innovation while preserving the investment made by building managers and home owners. Forwards compatibility ensures the interoperability of devices which implement newer versions of IoT wireless standards with existing devices. Both backwards and forwards compatibility are important to give manufacturers and consumers piece of mind that their investment is future proof and their installed systems are robust in these dynamic and innovative times.

By design, zigbee certified and branded products will interoperate with each other in ways meaningful to the end user, and builds on and leverages the large installed base of 100s of millions of zigbee devices already deployed across the world. Leveraging compatibility, users can upgrade and migrate their smart systems in an evolutionary and modular way to ensure

existing devices and systems are viable for future use, even when technology evolves and innovation occurs.

For example, the forwards and backwards compatibility between zigbee (formerly known as ZigBee 3.0) certified products and products certified under the legacy profiles ZigBee Light Link (ZLL) and ZigBee Home Automation (ZHA) is dependent on the type of network construction (either distributed or centralized) and the type of commissioning (classical EZ-Mode, TouchLink or install codes). In particular:

- A ZigBee Light Link device can join a distributed zigbee network using either classical EZ-Mode or TouchLink commissioning (if supported by the network).
- A ZigBee Light Link device can join a centralized zigbee network which does not require install codes.
- A ZigBee Home Automation device can join a zigbee centralized network which does not require install codes.
- A zigbee device can join either a ZigBee Light Link or a ZigBee Home Automation network using classical EZ-Mode commissioning.
- A zigbee device can join a ZigBee Light Link network using TouchLink commissioning.
- A zigbee device can join a zigbee network with any deployed security policy.
- A zigbee device cannot join a ZigBee Home Automation network using TouchLink commissioning.
- A ZigBee Home Automation device cannot join a zigbee distributed network.

			Network Type							
			Pre zigbee		Z3 Distributed Without TL	Z3 Distributed With TL	Z3 Centralized (TC Policy: RKX, RIC)			
Device joining	Commissioning	Link Keys	ZLL Distributed	ZHA Centralized			RKX=F, RIC=F	RKX=T, RIC=F	RKX=F, RIC=T	RKX=T, RIC=T
ZLL	Classical	DGTC, DSG	●	●	●	●	●			
ZLL	TouchLink	TP	●			●				
ZHA	Classical	DGTC	●	●			●			
ZHA	Classical	ICDP		●			●		●	
Z3	Classical	DGTC, DSG, ICDP	●	●	●	●	●	●	●	●
Z3	TouchLink	TP	●			●				
			Backward Compatibility		Forward Compatibility					

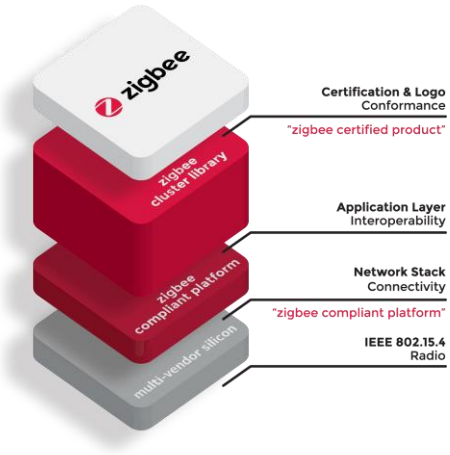
LEGEND

DGTC	Default Global Trust Center link key
DSG	Distributed Security Global link key
F	False
ICDP	Install Code Derived Preconfigured link key
RIC	"Require Install Code" TC policy
RKX	"Require Key eXchange" TC policy
T	True
TC	Trust Center
TL	TouchLink
TP	TouchLink Preconfigured link key
Z3	zigbee certified
ZHA	zigbee Home Automation 1.2.1 profile certfied
ZLL	zigbee Light Link 1.0 profile certified

Zigbee represents more than just an effort in unification of previously vertically integrated profiles. It is a definition of what a fully interoperable product looks like, from the physical layer to the network layer to the application layer.

Zigbee requires use of the widely implemented IEEE 802.15.4 Physical and MAC layer standard, allowing manufacturers to benefit from a wide variety of supply options for their integrated circuit needs. Above these layers, zigbee employs the most widely deployed Mesh Network: ZigBee PRO. Leveraging the completeness and robustness that only comes from decades of use in 100s of millions of nodes around the world, zigbee provides a solid network foundation for all products conforming to its requirements.

New in zigbee (ZigBee 3.0) is the definition of a Base Device Behavior. It is this Base Device Behavior which gives zigbee products their unique capability to identify available networks, recognize network requirements, adapt to these requirements and join them. It is this "behavior" that allows backwards and forwards compatibility of products and networks. Above the Base Device Behavior, zigbee leverages the same set of functional objects which were developed in support of the legacy profiles and used in millions of deployed products worldwide: the ZigBee Cluster Library (ZCL).



Finally, before any specification is released and before the Certification Program is opened, there is a process of validating the zigbee specification through a series of interoperability test events using multiple independent implementations.

Interoperability through over-the-air updates

Despite rigorous review and testing processes, it is always possible that an interoperability issue is discovered with devices already deployed in the market. The ability to provide a remote firmware update is very beneficial, especially because with the enormous growth of connected devices brought forth by the Internet of Things the option to bring a device into a service center for repair is not always feasible. Manufacturers should seek protocols that offer a robust means for remote over-the air (OTA) system software upgrades, using secure wireless transfer of encrypted code images. Often times, techniques can be used to enhance product functionality, operational features and most importantly provide fixes for particular interoperability issues.

Interoperability through testing and certification

Of course, writing down standards detailing the requirements for implementing products is only as valuable as the programs put in place to ensure that these requirements are being met and that products interoperate as expected. One example of a robust certification program is the zigbee Certified program, which was put in place more than 10 years ago to provide zigbee alliance members and the market in general with a defined, repeatable and independent set of methods by which a product's implementation of alliance standards could be validated to be compliant with the standards it purported to support. The zigbee Certified program provides two major levels of certification:

- zigbee Compliant Platform
  - This certification level validates a member's implementation of the IEEE 802.1.54 PHY/MAC and the applicable zigbee alliance Network Specification (e.g., ZigBee PRO)
- zigbee Certified Product
  - Required to be built on top of a zigbee Compliant Platform, this certification level validates that the application level standards implemented in the product conform to the stated requirements
  - Application level interoperability is validated as part of this program.

Zigbee is supported under the zigbee Certified certification programs. zigbee certified products have had their underlying platforms, Base Device Behavior and application level objects (from the ZCL) tested and validated to conform to the requirements of the various standard documents. Products carrying the zigbee certified product mark carry with them the confidence that all required behaviors (along with any implemented optional behavior) have been properly vetted and thus can interoperate with other products carrying the same mark.

Interoperability through commissioning

Commissioning is the process of configuring devices onto the network so they can communicate with each other. A new device needs to be able to securely join the network and establish control relationships with other devices on the same network. In order for a device to be commissioned, it must pass the necessary security credentials to the network where they are checked for validity, thus permitting the device to be authorized to operate on the network.

The zigbee standard defines fundamental techniques for commissioning so that all zigbee devices can join a network and establish control relationships in a consistent and interoperable way. The standard defines how a device can join a network and exchange its initial security credentials with unique and secure Trust Center link keys. The initial security credentials of a device can be incorporated into the network through out-of-band mechanisms such as QR codes or an NFC tag (not defined in the standard). In addition, other commissioning mechanisms – such as the use of a commissioning tool with a rich user interface – can also be used, giving manufacturers more flexibility if required by the market need.

Interoperability demonstrated

Many organizations are collaborating to demonstrate real-world product interoperability available today. From CES 2017, a product display of nearly 100 devices from 33 companies operated seamlessly in a single demo within the zigbee booth. This provided a perfect example of product interoperability between an extensive range of devices from different manufacturers, leveraging current and legacy protocols. The display was split into two main areas – Residential and Commercial – to further demonstrate penetration and presence in both markets.

This massive, interactive in-booth IoT display demonstrated how open IoT standards can enable a large interoperable ecosystem of products offered by companies near and far. Devices from global innovators included: Bega, Bosch, Centralite, Danalock, Develco, DSR, Eastfield, Feibit, Heiman, Kroger, Kwikset, Ledvance, LEEDARSON, Legrand, Meazon, Megaman, Midea, Nortek, Oblo Living, Owon, OSRAM, Qorvo, Philips, QMotion, Schneider Electric, Silicon Labs, Systech, ubisys, UMEInfo, V-Mark, Wulian, Yifang and ZEN.

Designing for today and tomorrow

It's not enough for smart devices to connect. They must speak the same universal language and do so seamlessly to access the potential waiting in the wings around all thing IoT. Interoperability is paramount, and critical factors tied to this requirement include backwards and forward compatibility, rigorous testing and certification programs to provide validation and build trust around brands, the ability to remotely resolve incidents and developing products around a full stack solution based on widely deployed and battle-hardened (and proven) standards.

Consumers deserve the freedom to pick and choose the devices they like, and expect when they bring their latest purchase home it works with the devices they already own. Manufacturers deserve to have the confidence that their technology investments are future proof, and that their devices can sell into large, established markets. Application developers deserve access to the largest possible ecosystem of compatible devices for their applications. Through the efforts of hundreds of forward-thinking companies and more than a decade of developing best practices around open and complete IoT solutions, all this is absolutely possible – today.