



Thread Technology Workshop

Introduction

2017-09-14

THREAD GROUP | Today's Agenda

Thread Overview

Getting Started with Thread

Lunch

Live Demonstration Session

Liaisons

Reception

Guest Speaker

Questions and Answers

THREAD GROUP | Agenda

 0:30

Why Thread?

 0:05

Who Is Thread?

 0:05

The Value of Thread

 0:15

Thread + One: Defining a Thread-based Product

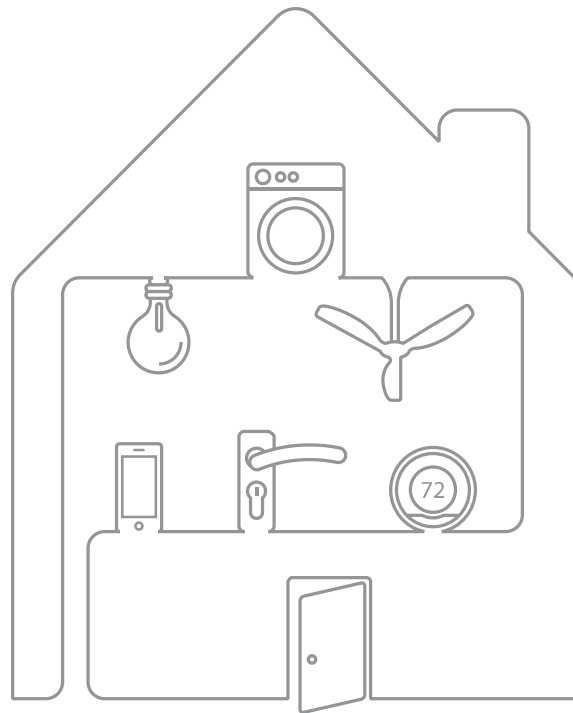
 0:05

Why Thread?

THREAD GROUP | Problem Statement

How do we **securely** and **scalably** connect an ecosystem of **low power** products to each other, to cloud services, and to consumers via their mobile devices supporting applications—including mission-critical ones—such as?

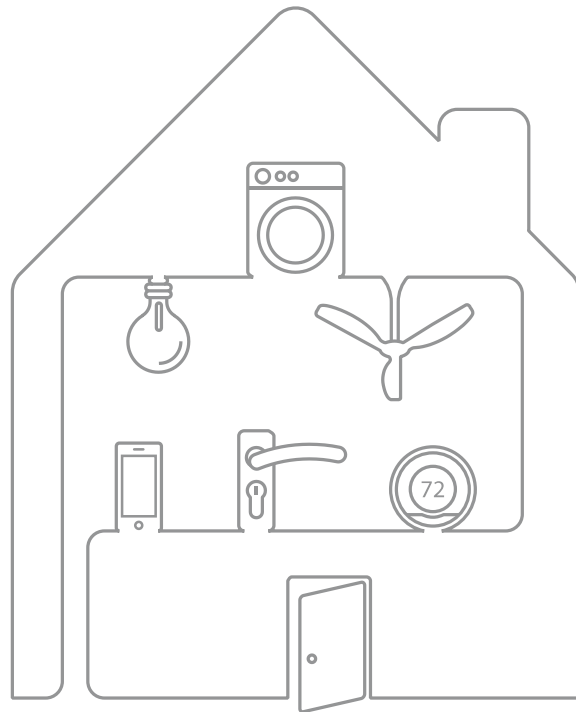
- Appliances
- Access control
- Climate control
- Energy management
- Lighting
- Safety
- Security



THREAD GROUP | The Search

We wanted to use an existing wireless mesh protocol

- None fit our requirements well enough
- None were suitable for homes and consumer electronic products



THREAD GROUP | Requirements

Requirements:

New wireless home network



Low power

THREAD GROUP | Requirements

- ✓ No single point of failure
- ✓ Self-healing
- ✓ Interference robustness
- ✓ Self-extending
- ✓ Reliable enough for critical infrastructure

Requirements:

New wireless home network

- ✓ Low power
- ✓ Resilient (mesh)
- ✓ IP-based
- ✓ Open protocol
- ✓ Secure and user friendly
- ✓ Fast time to market
- ✓ Existing radio silicon

THREAD GROUP | Establishing Thread

We found that many companies shared the same concerns

- So we created a new wireless mesh network technology
- Built on **existing standards** using established **Internet** protocols

We established Thread to be a key foundation for the **Internet of Things**

The ARM logo, consisting of the word "arm" in a lowercase, blue, sans-serif font.The Nest logo, featuring the word "nest" in a lowercase, grey, sans-serif font.

Who Is Thread?

THREAD GROUP | Who Is Thread?

Formally launched in July 2014, the Thread Group currently has more than 150 member companies

The Thread Group is:

- Not** just another standards defining organization (SDO)

- A nonprofit market education group promoting Thread's use in connected products

- Ensuring a great user experience through rigorous, meaningful product certification

Structured as a Delaware 501 (c) (6) Non-Profit Corporation for the mutual benefit of its members

- Independent, vendor-neutral and open to all — any entity can join

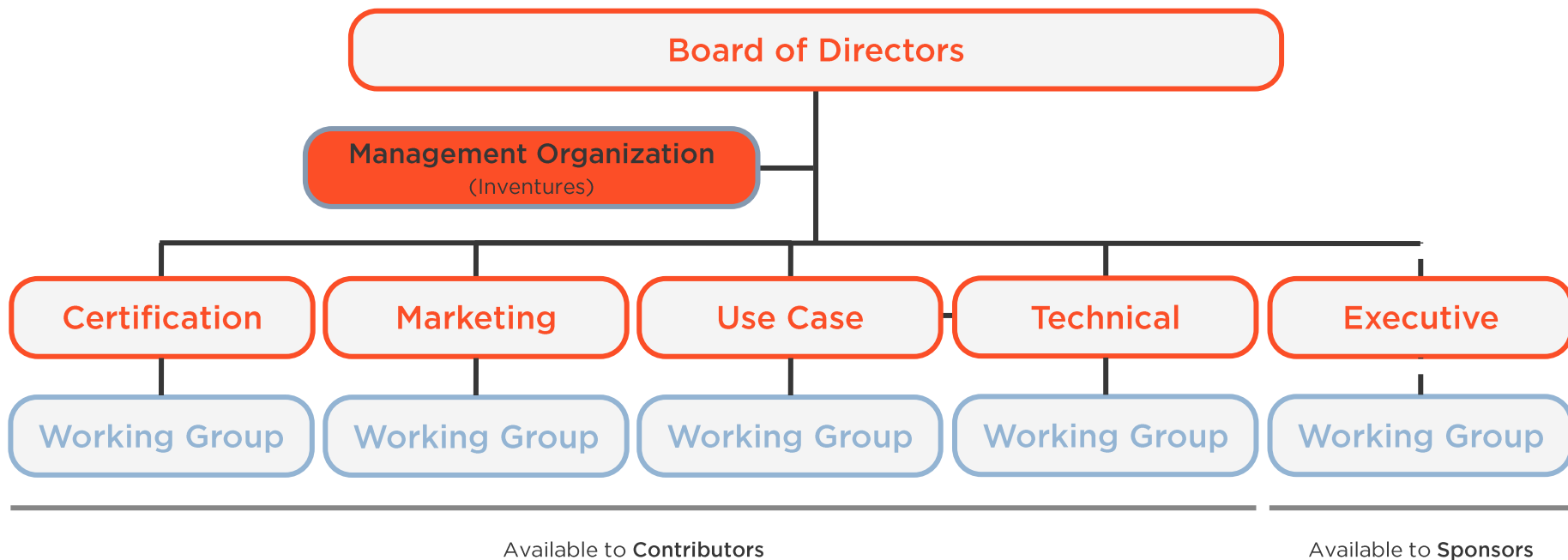
- Organizational membership only — one membership, one vote

THREAD GROUP | Board of Directors and Team

President	Grant Erickson - Alphabet / Google / Nest
VP of Marketing	Sujata Neidig - NXP
VP of Technology	Skip Ashton - Silicon Laboratories
Secretary	Bill Curtis - ARM
Treasurer	Kevin Kraus - Yale
Director	Jean-Michel Orsat - Somfy
Director	Greg Hill - Johnson Controls
Director	Rolf De Vegt - Qualcomm
Director	Arnulf Rupp - OSRAM
Director	Cam Williams - Schneider Electric
Executive Director	Deepak Kamlani - Inventures
Director of Certification	Tom Sciorilli - Thread Group



THREAD GROUP | Structure



THREAD GROUP | Intellectual Property

Copyrights and Trademarks

Licensed to participants royalty free

Other Intellectual Property Policy

Policy is designed to maximize the adoption of the Thread technology and accelerate market acceptance

Policy for Thread Group membership balances interests of all stakeholders

Applies to all Thread members

Commitment to grant a RAND-RF (royalty free) license to members for patents essential to the Thread specification

THREAD GROUP | Membership Tiers

Membership Benefits	Academic	Affiliate	Contributor	Sponsor
Receive member communications	✓	✓	✓	✓
Participation in general or annual meetings	✓	✓	✓	✓
Access to members only website	✓	✓	✓	✓
Use of Alliance Member Logo	✓	✓	✓	✓
Participation in press articles & interviews	✓	✓	✓	✓
Access Final Deliverables	✓	✓	✓	✓
Access Draft Deliverables		✓	✓	✓
Chair Committees and/or Work Groups			✓	✓
Certify Compliant Products and Utilize Certification Logo			✓	✓
Participate and Vote in Work Groups			✓	✓
Participation and Vote in Committees			✓	✓
Approve Operating Budget				✓
Approve Final Deliverables				✓
Initiate Work Groups or Committees				✓
Automatic Seat on Board of Directors				✓
Annual Fee	\$0K	\$2.5K	\$15K	\$100K

THREAD | Membership Benefits

Access to the technology and spec

Reduce time for development and implementation using a proven solution

Access to the IP

Gain IP rights for the Thread technology with no royalty payments

Access to Thread Certification Program

Guarantee network interoperability with other Thread devices and broaden your ecosystem

Use of the Thread Test Harness and Commissioning App

Save time and resource investment by completing in-house testing for spec conformance and network interoperability

Participation in Marketing and PR campaigns

Leverage Thread's marketing, social media and PR tools to extend marketing efforts

Participation in Committees

Provide a voice to help influence the direction of Thread

Networking with an ecosystem of companies

Collaborate with other members to optimize investment

THREAD GROUP | Liaisons

Organization	Liaison Type
	Marketing
	App Layer
	Standards
	App Layer
	Marketing
	App Layer
	App Layer

The Value of Thread

THREAD GROUP | The Value of Thread

Thread is a low power, secure and future-proof mesh networking technology for IoT products.



BUILT FOR IoT

Low energy footprint

Secure and reliable connectivity

No single point of failure

Interoperability

Scalability

Based on proven standards

IPv6

IP-BASED

Convergence layer across all networks

Ease of Development

Application layer choices

Multiple Ecosystems

Flexibility to add or change app layers, ecosystems

Device-to-device and device-to-cloud communication



MARKET READY

Broad selection of silicon

Four certified stacks

Publicly available specification

Active certification program

Fast-ramp tools accelerating time to market

Global Solution



SEAMLESSLY INTEGRATED

Seamlessly and securely works with users' existing networks

Extends the internet into low power end devices without translators

Can easily extend to personal devices

THREAD GROUP | The Value of Thread

Thread is a low power, secure and future-proof mesh networking technology for IoT products.



BUILT FOR IoT

Low energy footprint

Secure and reliable connectivity

No single point of failure

Interoperability

Scalability

Based on proven standards

IPv6

IP-BASED

Convergence layer across all networks

Ease of Development

Application layer choices

Multiple Ecosystems

Flexibility to add or change app layers, ecosystems

Device-to-device and device-to-cloud communication



MARKET READY

Broad selection of silicon

Four certified stacks

Publicly available specification

Active certification program

Fast-ramp tools accelerating time to market

Global Solution



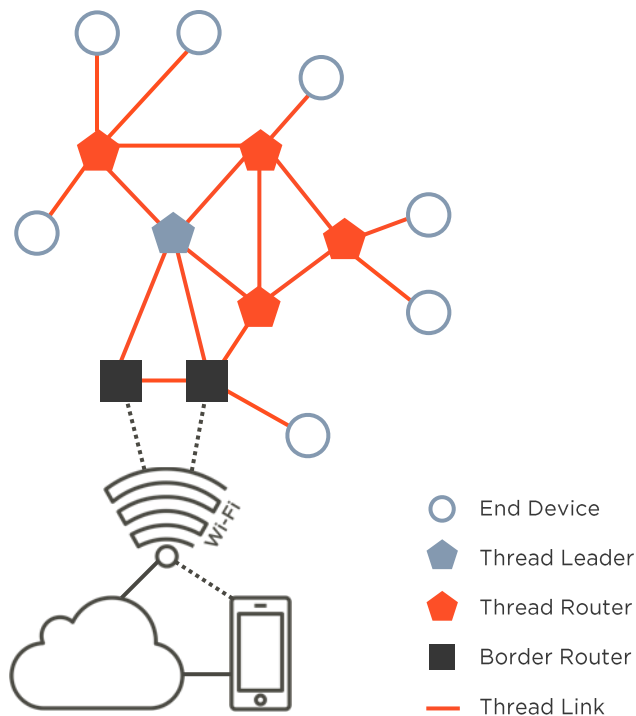
SEAMLESSLY INTEGRATED

Seamlessly and securely works with users' existing networks

Extends the internet into low power end devices without translators

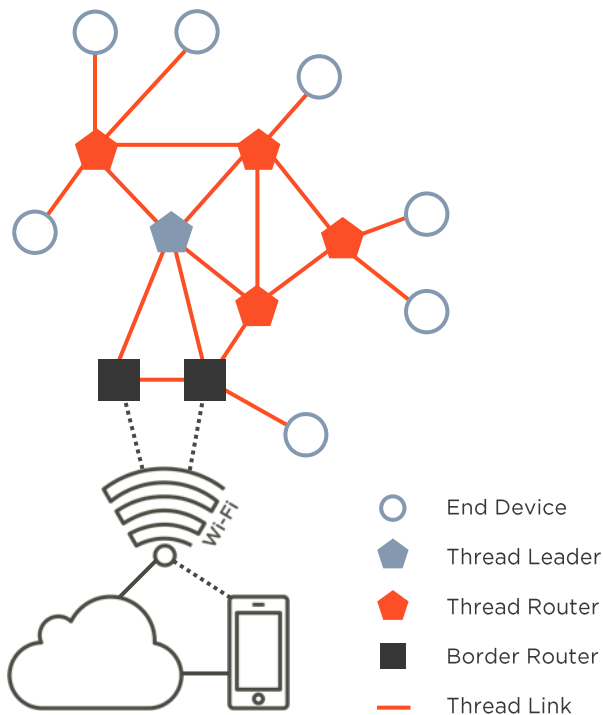
Can easily extend to personal devices

THREAD GROUP | Low Power Operation: Sleepy Devices



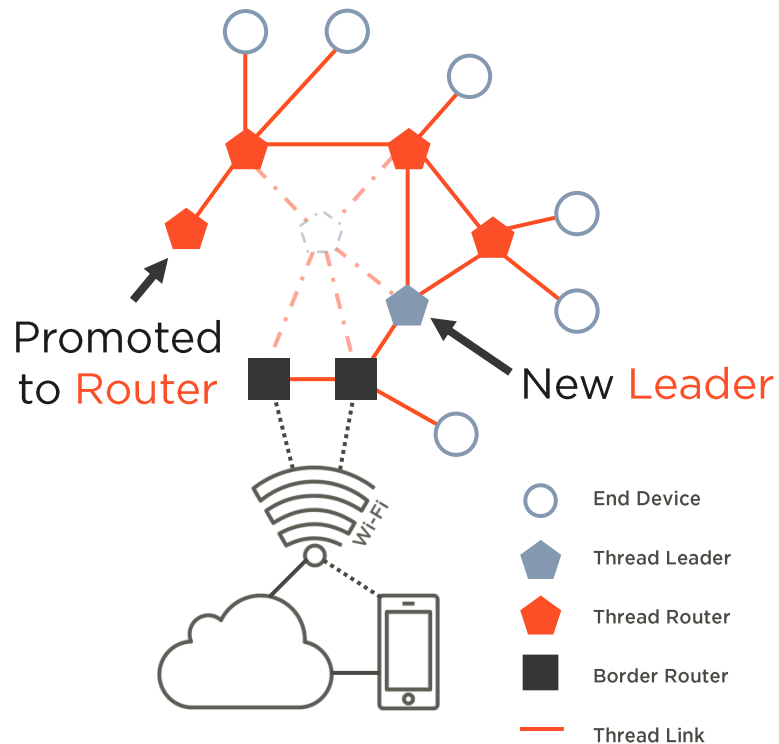
- Sleeping devices poll parents for messages (or remote device if application configured)
- Sleeping devices not required to check which allows lower power operation
- Parents hold messages for sleeping devices
- Sleeping device automatically switches parent connection is lost

THREAD GROUP | Security and Commissioning



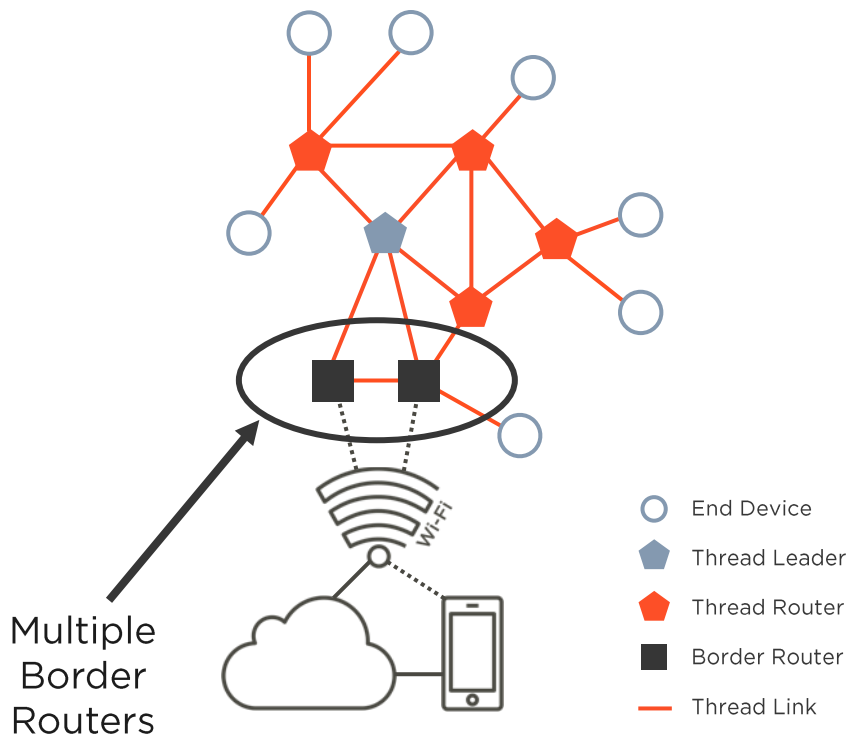
- Simple Commissioning
 - User authorizes devices onto the network using smart phone or web
 - Can be done on network if there is a device with a graphical interface
- DTLS Security session established between new device and commissioning device to authenticate and provide credentials
- Once commissioning session is done, device attaches to network
- MAC security used for all messages
- Application level security is based on end-device requirements and application layer being used

THREAD GROUP | Robust: No Single Point of Failure



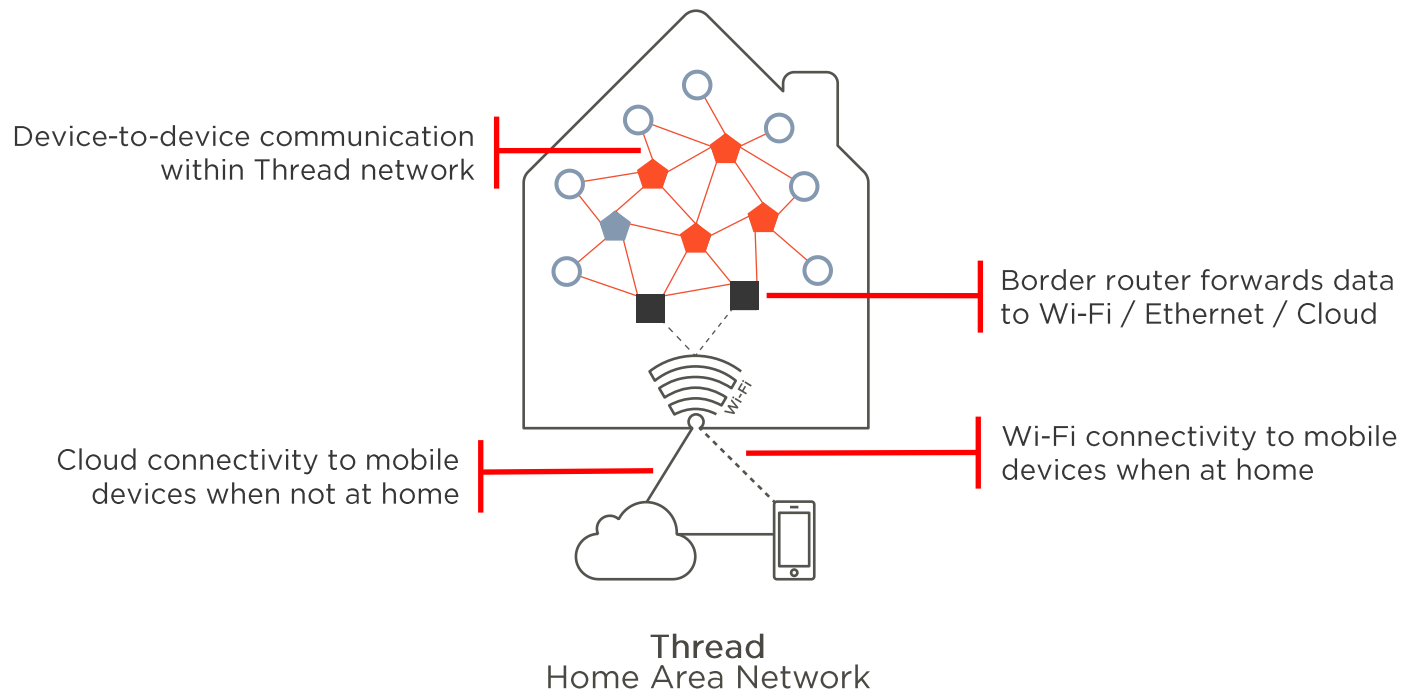
- Dynamic Leaders
 - If Leader fails, another Router will become Leader
- Router Promotion
 - Leader can promote Router Eligible devices to Routers to improve connectivity if required

THREAD GROUP | Robust: No Single Point of Failure



- Multiple Border Routers can be used for off network access
 - Devices operate without Border Router
- What can be a Border Router?
 - Anything with an 802.15.4 radio and another physical layer
 - Home Wi-Fi router
 - Set top box
 - Smart Thermostat (802.15.4 and Wi-Fi)

THREAD GROUP | Thread Home Area Network



THREAD GROUP | Network Topology Roles



Border Router

Forwards data to and from cloud/other networks

Provides optional Wi-Fi connectivity

Many

+



Thread Leader

Manages network parameters

Coordinates commissioners

Makes network decisions

One

+



Thread Router

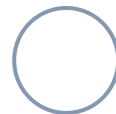
Routes traffic among devices

Form the mesh topology

Eligible to become the Leader

Up to 32

+



End Device

Designed for low power operation

May be powered or sleepy

May be router-eligible if powered

Up to 511 per Router



Hundreds of Devices per Network

THREAD GROUP | The Value of Thread

Thread is a low power, secure and future-proof mesh networking technology for IoT products.



BUILT FOR IoT

- Low energy footprint
- Secure and reliable connectivity
- No single point of failure
- Interoperability
- Scalability
- Based on proven standards

IPv6

IP-BASED

- Convergence layer across all networks
- Ease of Development
- Application layer choices
- Multiple Ecosystems
- Flexibility to add or change app layers, ecosystems
- Device-to-device and device-to-cloud communication



MARKET READY

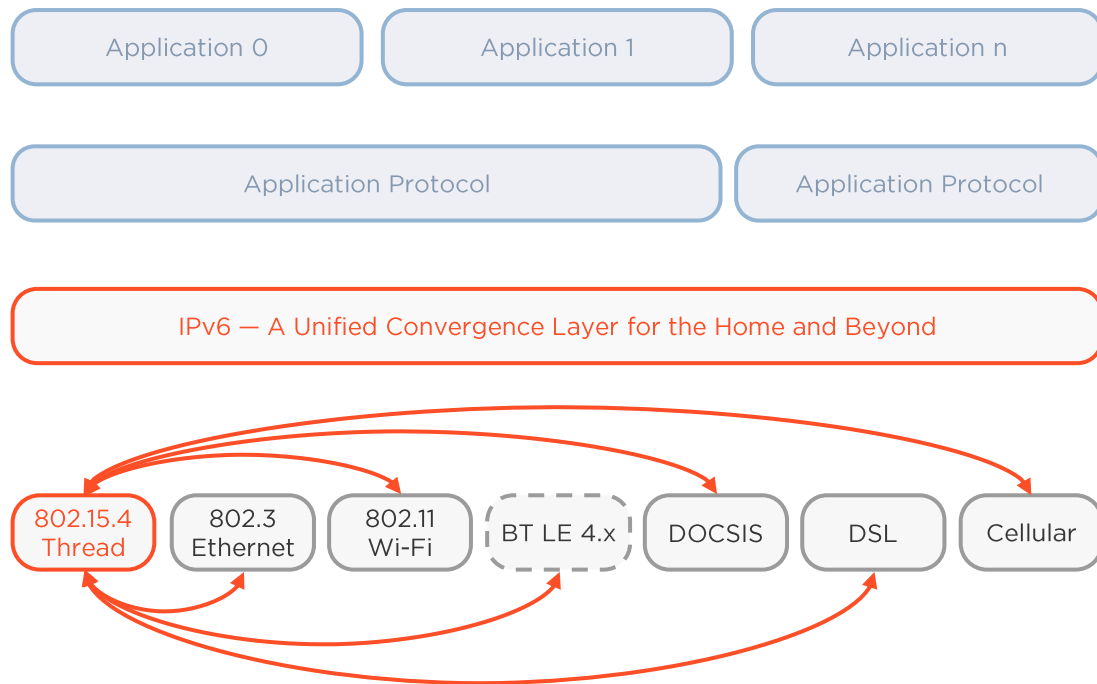
- Broad selection of silicon
- Four certified stacks
- Publicly available specification
- Active certification program
- Fast-ramp tools accelerating time to market
- Global Solution



SEAMLESSLY INTEGRATED

- Seamlessly and securely works with users' existing networks
- Extends the internet into low power end devices without translators
- Can easily extend to personal devices

THREAD GROUP | Thread is IP



Unified convergence layer across all networks in the home and beyond

- Reuse software stacks

Enables direct device-to-device, device-to-mobile, and device-to-cloud, and one-to-many communication

- Nodes can communicate directly with each other and with multiple apps or backend services

Support for many application layers

- Any low bandwidth application layer that can run over IPv6 can run over Thread

THREAD GROUP | Many Wireless IoT Standards

Category 1: Connectivity layer

- Provide wireless connectivity
- Examples: Thread, Wi-Fi/HaLow, ZigBee PRO

Category 2: Application layer

- Provides interoperability with other devices or the cloud. Some can be run over multiple connectivity methods, or at different layers.
- Examples: AllSeen, IPSO, OCF (IoTivity), IIC, zigbee dotdot, many vertical-industry alliances

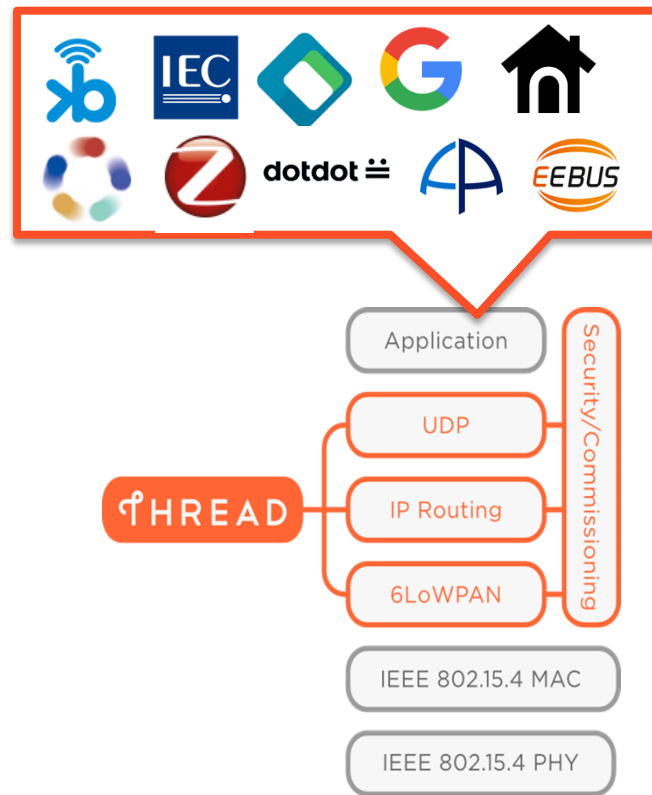
Category 3: Full-stack technologies – connectivity layer + application layer

- Examples: Bluetooth, zigbee 3.0, Z-Wave, ULE

THREAD GROUP | Application Layer Diversity

Thread is an IP network & transport layer specification

- Application Layer – A protocol running over an IP network layer
- Network layers – Ethernet, WiFi, cellular ... and Thread
- Application layers can use multiple IP networks – i.e. Thread and Wi-Fi
- Thread can support multiple application layers
- Thread **does not** favor one application layer over another
- App layers typically interoperate via services through public interfaces



THREAD | What Internet Protocols Could Thread Use?

The Internet: Today, mostly “large” devices

	Large devices Mains powered Fast networks 
Applications	Internet / Web applications
Web Transfer	HTTP
Transport	TCP
Security	TLS
Addressing	IPv6 / IPv4

THREAD | What Internet Protocols Could Thread Use?

The Internet: Now available in “small!”

	Large devices Mains powered Fast networks 	Small devices Battery powered Constrained networks 
Applications	Internet / Web applications can work with large or small devices	
Web Transfer	HTTP	CoAP
Transport	TCP	UDP
Security	TLS	DTLS
Addressing	IPv6 / IPv4	6LoWPAN

THREAD GROUP | The Value of Thread

Thread is a low power, secure and future-proof mesh networking technology for IoT products.



BUILT FOR IoT

- Low energy footprint
- Secure and reliable connectivity
- No single point of failure
- Interoperability
- Scalability
- Based on proven standards



IP-BASED

- Convergence layer across all networks
- Ease of Development
- Application layer choices
- Multiple Ecosystems
- Flexibility to add or change app layers, ecosystems
- Device-to-device and device-to-cloud communication



MARKET READY

- Broad selection of silicon
- Four certified stacks
- Publicly available specification
- Active certification program
- Fast-ramp tools accelerating time to market
- Global Solution



SEAMLESSLY INTEGRATED

- Seamlessly and securely works with users' existing networks
- Extends the internet into low power end devices without translators
- Can easily extend to personal devices

THREAD GROUP | Available Now

We set the bar high

True **multi-vendor interoperability** between ≥ 3 stacks, not just a golden node

We held 13 discrete in-depth interop sessions to validate 1.0 and 1.1

We opened certification and announced 4 certified stacks

We provide fast ramp tools



THREAD GROUP | Certification Fast Ramp Tools

Thread Commissioning App

- Speeds prototyping / implementation of the Thread device commissioning process for end users.
- First beta release of compiled app now available via the Google Play Store; iOS version to follow shortly.

Thread Test Harness

- Inexpensive test bed, plus software replicates the test environment used for certification.
- Provides debug & pre-validation of Thread implementations internally, vs. lab time at 3rd party test facility.

Thread Test Harness Extensions

- Automates Thread test execution for devices-under-test (DUTs) and integrates Thread testing into an existing automated regression environment.
- Functionality can be extended to control the testing of other technologies to create a comprehensive regression environment.

THREAD GROUP | The Value of Thread

Thread is a low power, secure and future-proof mesh networking technology for IoT products.



BUILT FOR IoT

- Low energy footprint
- Secure and reliable connectivity
- No single point of failure
- Interoperability
- Scalability
- Based on proven standards



IP-BASED

- Convergence layer across all networks
- Ease of Development
- Application layer choices
- Multiple Ecosystems
- Flexibility to add or change app layers, ecosystems
- Device-to-device and device-to-cloud communication



MARKET READY

- Broad selection of silicon
- Four certified stacks
- Publicly available specification
- Active certification program
- Fast-ramp tools accelerating time to market
- Global Solution



SEAMLESSLY INTEGRATED

- Seamlessly and securely works with users' existing networks
- Extends the internet into low power end devices without translators
- Can easily extend to personal devices

Thread + One

Defining a Thread-based Product

THREAD GROUP | Defining the IoT Product

What is the environment?

- Home, Commercial, Professional, Personal?
- Number of devices to support?

Is it standalone or part of an ecosystem?

- A proprietary ecosystem?
- Established industry ecosystem or ecosystems?
- Is it a single product or a system?

What is this product connecting to?

THREAD GROUP | Choosing Link Technologies

With Thread and IP you are not forced to choose a single link technology to the exclusion of all others.

Network Links

Choose One

- ☒ Thread
- ☐ WiFi
- ☐ Ethernet
- ☐ Bluetooth
- ☐ Cellular
- ☐ DOCSIS
- ☐ DSL

THREAD GROUP | Choosing Link Technologies

Choose the right link technologies for your product and customer

Choose the right application layers appropriate for the:

Resources of your product

Ecosystems your customers want to access

Network Links

Choose Any



Thread



WiFi



Ethernet



Bluetooth



Cellular

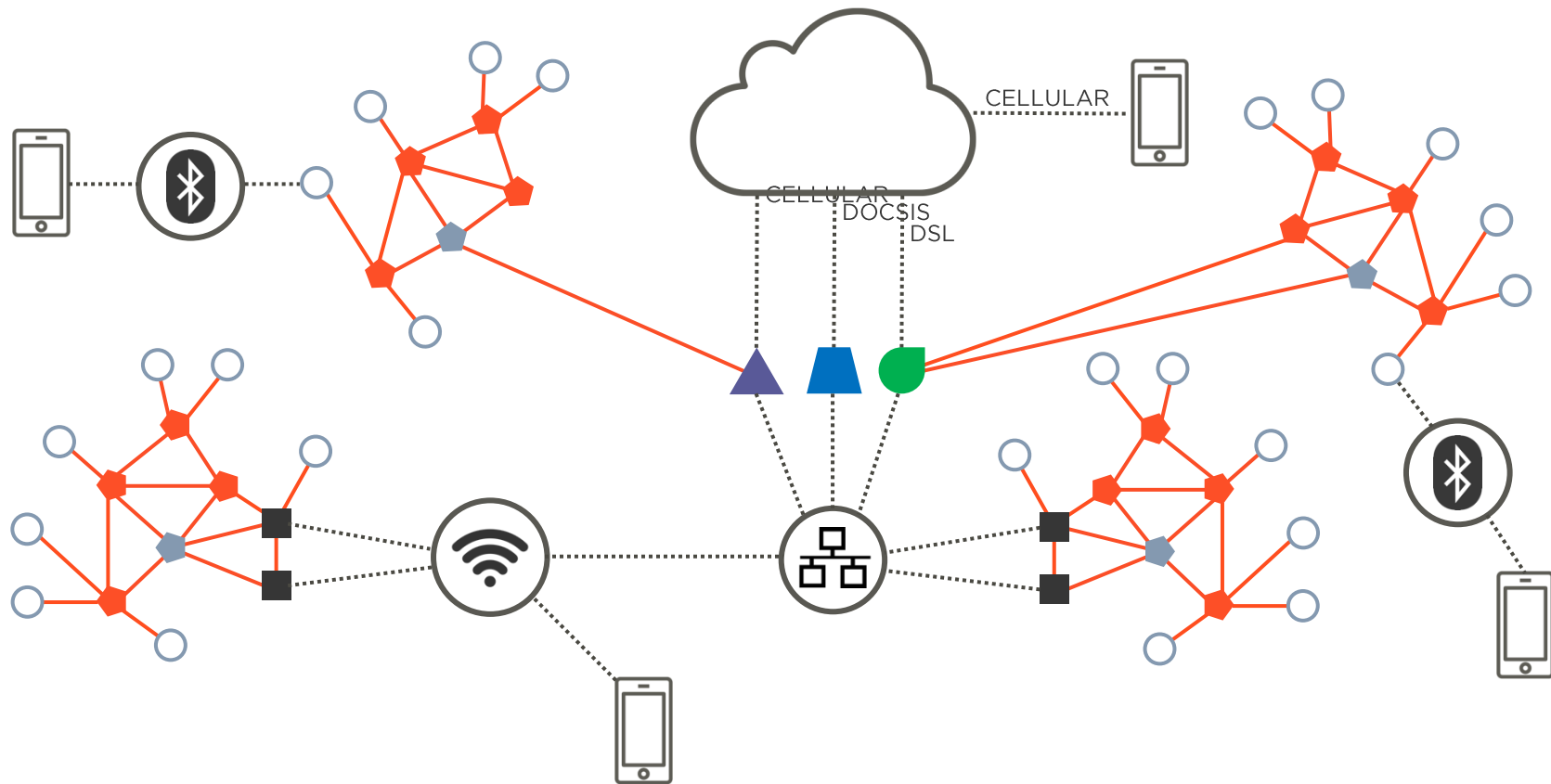


DOCSIS

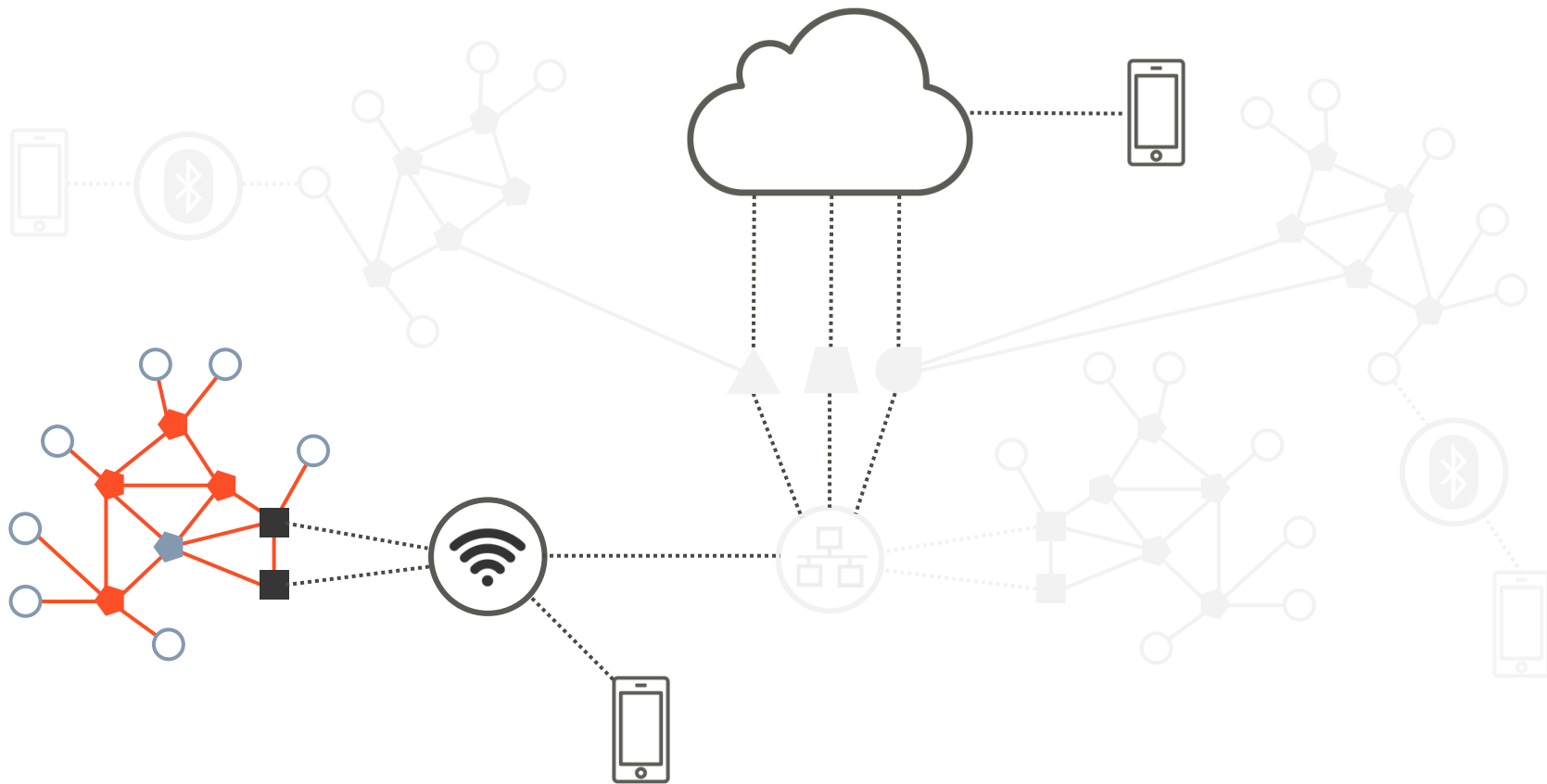


DSL

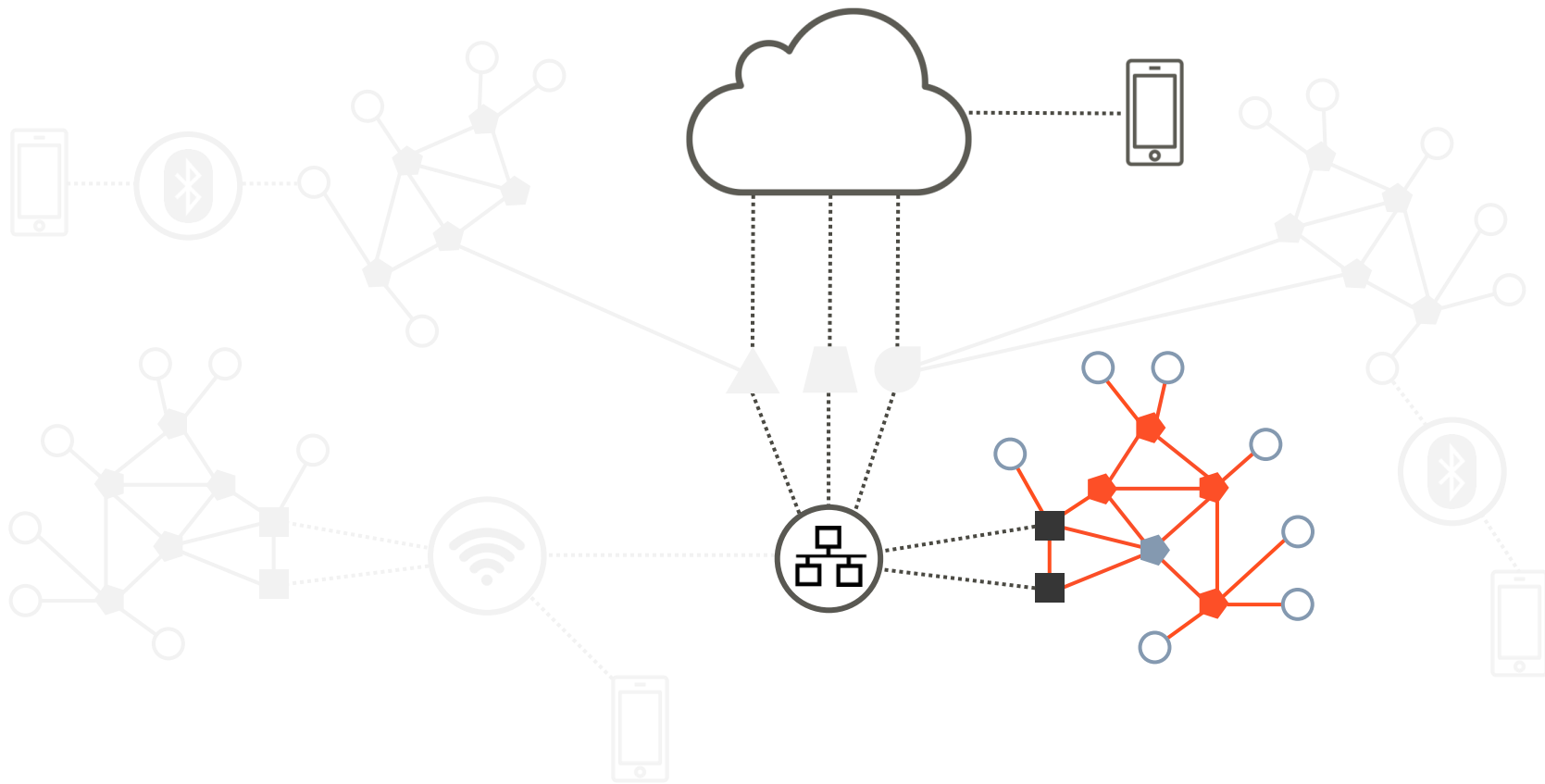
🌀 THREAD GROUP | Thread + One



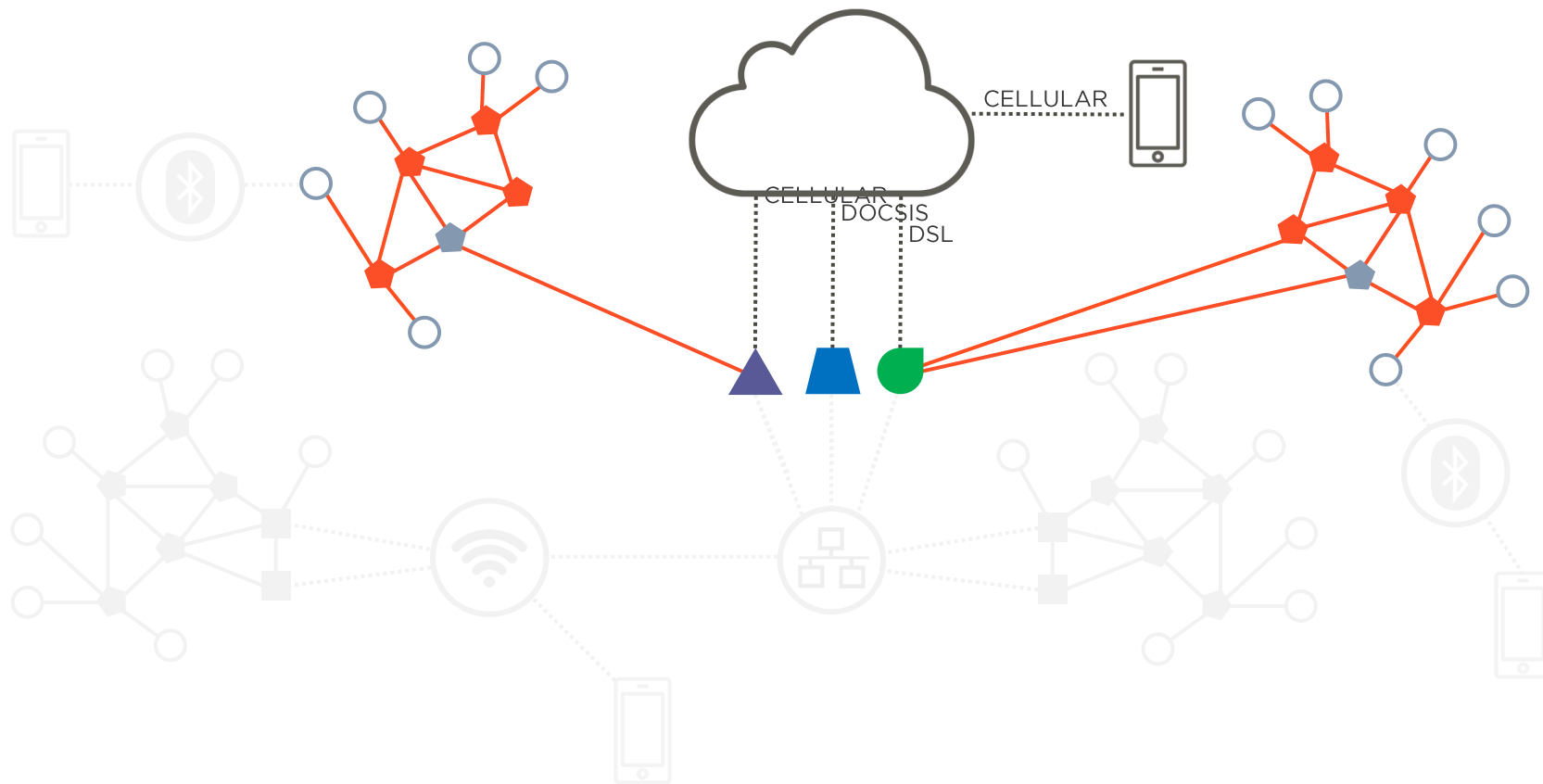
THREAD GROUP | Thread + WiFi



THREAD GROUP | Thread + Ethernet



THREAD GROUP | Thread + Internet & Telecommunications



THREAD GROUP | Which ONES do you choose?

	Wi-Fi 802.11 a/ac/b/g/n	Wi-Fi 802.11 ah (HaLow)	BLE 5	Bluetooth Mesh	Zigbee 3.0	Z-Wave Plus	ULE	Thread
Range	Medium	Long	Variable	Short	Short	Short	Short	Short
Topology	Star	Star	Star	Flood	Mesh	Mesh	Star	Mesh
Bandwidth	High Mb/s	Medium Kb/s	Variable Kb/s	Low Kb/s	Medium Kb/s	Low Kb/s	Low Kb/s	Medium Kb/s
Band(s)	2.4 GHz 5.0 GHz	Sub-GHz	2.4 GHz	2.4 GHz	Sub-GHz 2.4 GHz	Sub-GHz	1.9 GHz	2.4 GHz
Frequency Hopping	No	No	Yes	Yes	No	No	Yes	No
Power Requirements	High	Low	Low	Low	Low	Low	Low	Low
Open Standard	✓	✓	✓	✓	✓	✗	✓	✓
Support for IPv6	✓	✓	Future	✗	✗	✗	Planned	✓
Application Layer	Multiple Concurrent	Multiple Concurrent	Native Singular	Native Singular	Native Singular	Native Singular	Multiple Concurrent	Multiple Concurrent
Use Cases	A/V equipment, mains-powered devices	Connected home products, mains- and battery-powered devices, A/V	One-to-one connections for portable devices or automotive speaker systems	Data, IoT devices built for the home.	Mission critical devices, such as security, on their own network	Security	Telephony, Physical Security, Home Automation (based on DECT)	Mission critical IoT devices built for the home and beyond
Benefits	Used almost universally in commercial and residential spaces	A more power-conservative, longer-range, sub-gig version of Wi-Fi	A power-conservative, user-friendly solution for control of devices tethered to your phone	A mesh version of BLE designed for collections of products	A purpose-built, device-to-device connectivity solution	A secure and closed device-to-device solution for connected products	Long-range, secure, low-latency, audio-capable	IP-addressable, low-bandwidth, secure mesh network designed to support today's connected devices
Silicon Availability	Broad	None	Broad	Broad	Broad	Single	Broad	Broad



Backup