

 **THREAD**

Open House

May 10 2016

THREAD GROUP | The Need for a New Wireless Network

We are entering a new era of connected products

- The INTERNET of things
- Many consumer products need a low power mesh network in addition to Wi-Fi

We wanted to use an existing wireless mesh protocol

- But none fit our requirements well enough
- None were suitable for homes and CE products

We found that many companies shared the same concerns

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

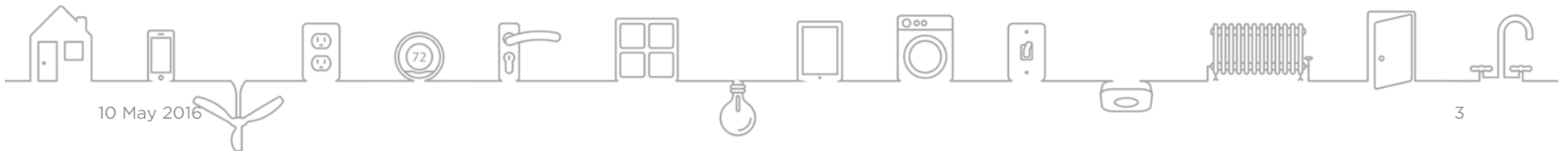
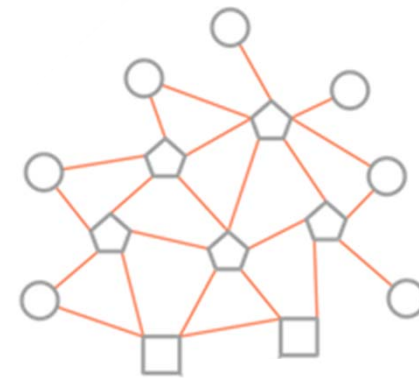
Requirements:

New wireless home network

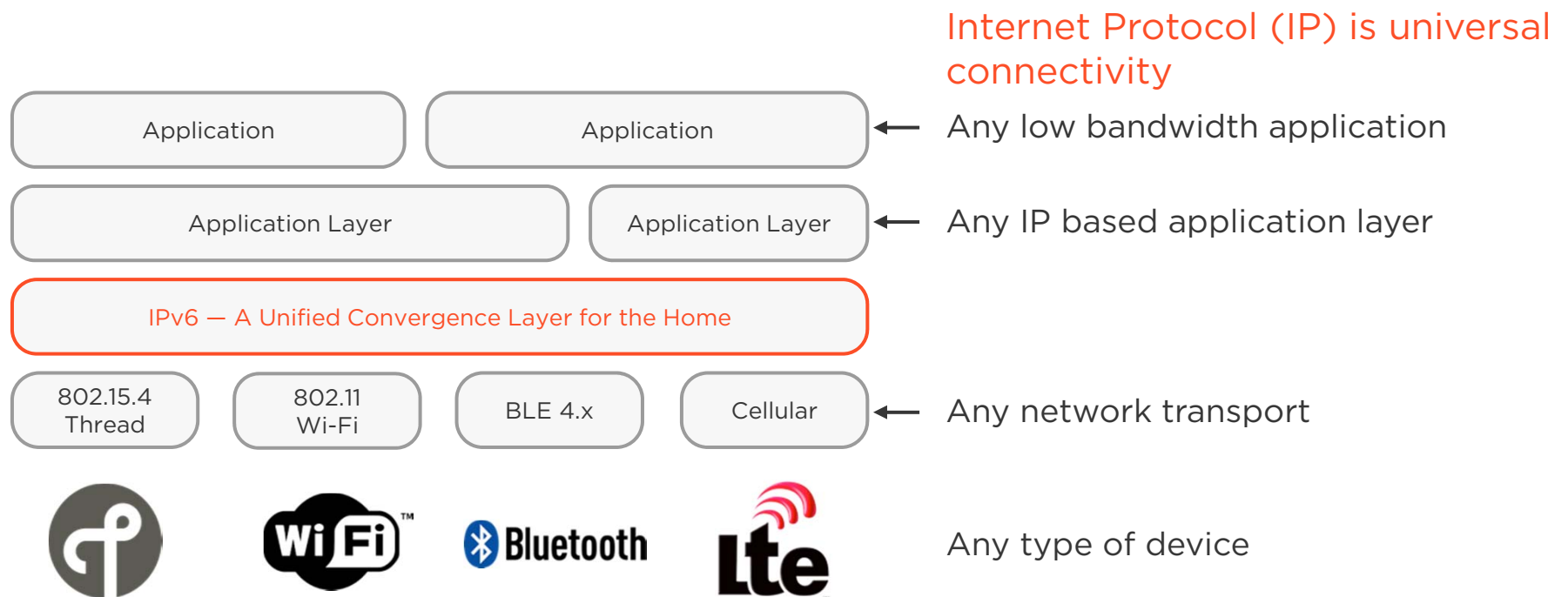
- ✓ Low power
- ✓ Resilient (mesh)
- ✓ Internet Protocol based
- ✓ Open
- ✓ Secure and user friendly
- ✓ Fast time to market
- ✓ Existing radio silicon

THREAD GROUP | Why Use Mesh?

- ✓ No single point of failure
- ✓ Self-healing, self-extending
- ✓ Interference robustness
- ✓ Support very low power nodes
- ✓ Reliable enough for critical infrastructure



THREAD GROUP | Thread is IP



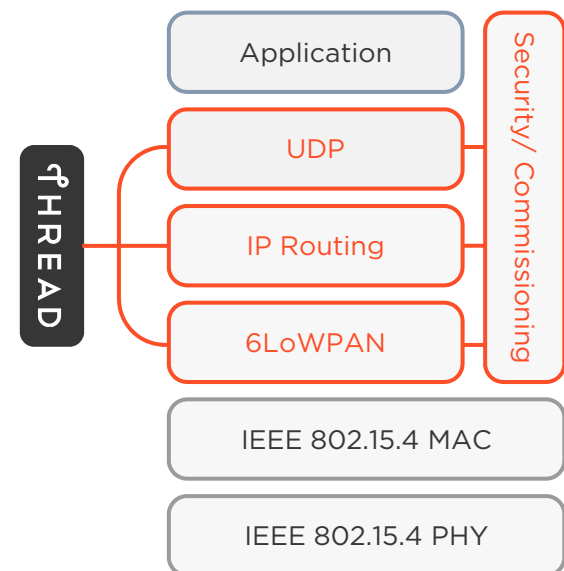
THREAD GROUP | What it Delivers

A secure wireless mesh network for connected products in your home

- Built on proven, existing technologies
- Uses IPv6 (6LoWPAN)
- Runs on existing 802.15.4 silicon from multiple providers
- Designed with a new security architecture to make it simple and secure to add and remove products
- Supports 250+ products per network
- Designed for very low power operation
- Legacy-free design

Early versions of Thread shipping in products now

Thread can support many popular application layer protocols



A software upgrade can add Thread to some currently shipping 802.15.4 products

THREAD GROUP | Application Layers and Partners



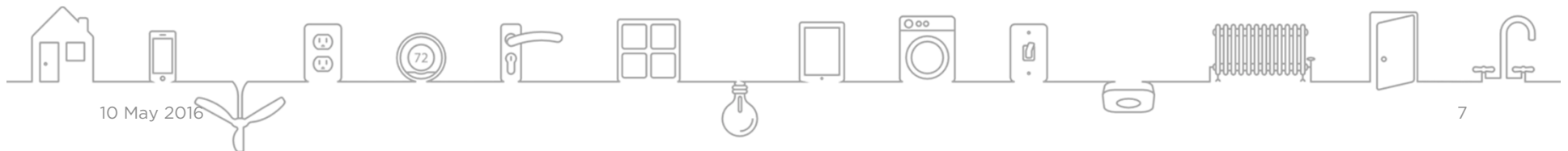
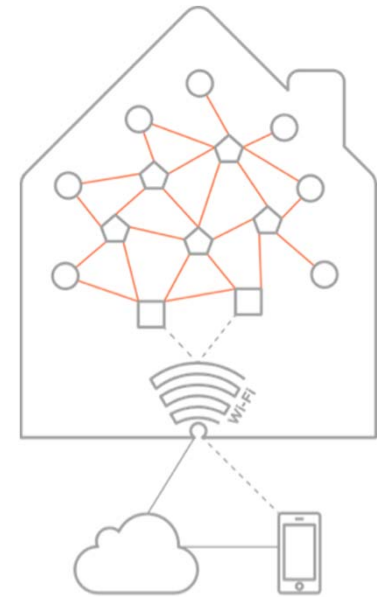
- Thread is a network and transport level stack
- Thread is “application-layer agnostic”
- Thread can support multiple application layers
 - Any low bandwidth application layer that runs over IPv6
- Multiple application layers can use the same Thread network (all Thread devices will route data through the mesh)

THREAD GROUP | Target Applications

Thread is designed for all sorts of products in the home

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

Devices working together to form a cohesive mesh network



Industry Awareness

THREAD GROUP | The Word is Out!

- [Thread Gets Real with Certification Rollout](#) — EE Times
- [Thread Group ready to start approving IoT devices that talk to each other](#) — CIO
- [This Thread Could Tie Your Smart Home Together](#) — Tom's Guide
- [Thread CEO: Homes Can't Truly Be Smart Without Security](#) — ReadWrite
- [Thread, ZigBee to Partner on Home Connectivity](#) — eWeek

<re/code>

USA TODAY



Forbes

EE Times

CIO

eWEEK

readwrite

tom's
GUIDE
TECH FOR REAL LIFE

10 May 2016



PCWorld
@pcworld

Following

ZigBee, this is Thread. Thread, meet ZigBee. We're sure you'll make the Internet of Things better together. buff.ly/1SwXIUN



ZigBee and Thread act to make their IoT smarts stack up [...]
Two pieces in the complicated puzzle of smart-home options will snap together later this year when the ZigBee Alliance starts certifying devices that use the Thread protocol for networking.
pcworld.com



Thread Group Thread's Certification Director, Tom Sciorilli, explains the unique features and milestones of Thread at CES. If you're at the show, come visit to discuss what's next for Thread in the connected home in 2016.



THREAD GROUP | Supported by Major Players in IoT

- **Silicon Labs** Simplifies IoT Connectivity with Best-in-Class Thread Solution (July 2015)
- **NXP** Introduces New Thread Connectivity Platform Running ARM mbed OS for the IoT (Nov. 2015)
- **ARM** announces availability of Thread for the mbed platform (November 2015)
- **Yale** Joins Partners at CES 2016 to Demonstrate New IoT Technologies and Products (Jan. 2016)
- **OSRAM** presents a worldwide innovation at CES in Las Vegas — Initial smart LED lamp controlled by the Thread network protocol (Jan. 2016)
- **CEL** Unveils Multiple Thread-Ready Products, Including Modules, USB Sticks, Gateways, and Award-Winning Scripting Tools (July 2015)
- **Nortek Security & Control** Showcases First Z-Wave and via Thread Smart Home Demo at CES 2016 (Jan. 2016)
- **GreenPeak** showcases ZigBee and Thread multi-channel radio chip at CES (Jan. 2016)

THREAD GROUP | Market Observations



Mareca Hatler, director of research at ON World Inc.

“Thread is poised to become one of the leading mesh networking technologies for the connected home, with many device manufacturers aligning with Thread technology this year and planning to roll out Thread-enabled products in 2016.”
source: Silicon Labs press release

WAREABLE

Dan Sung, Wareable

“There’s little debate about the direction that Thread’s been moving. It’s a clever and, now that someone else has thought of it, an obvious solution to a problem that could easily have mired the development of the kind smooth and successful smart home vision that the mass market might be willing to adopt. It has the capacity to make a difference and, while, **not as headline-grabbing as Google’s Brillo or Apple HomeKit, it’s potentially far more important.**” source: [Thread: The idea to save your connected home from Bluetooth](#)



Chris Preimesberger, eWeek

“Thread Group is maintainer of the newly developed Thread networking protocol, which **developers are flocking to in droves.**”
source: [Enterprise IoT Gets New Products, Services at CES 2016](#)



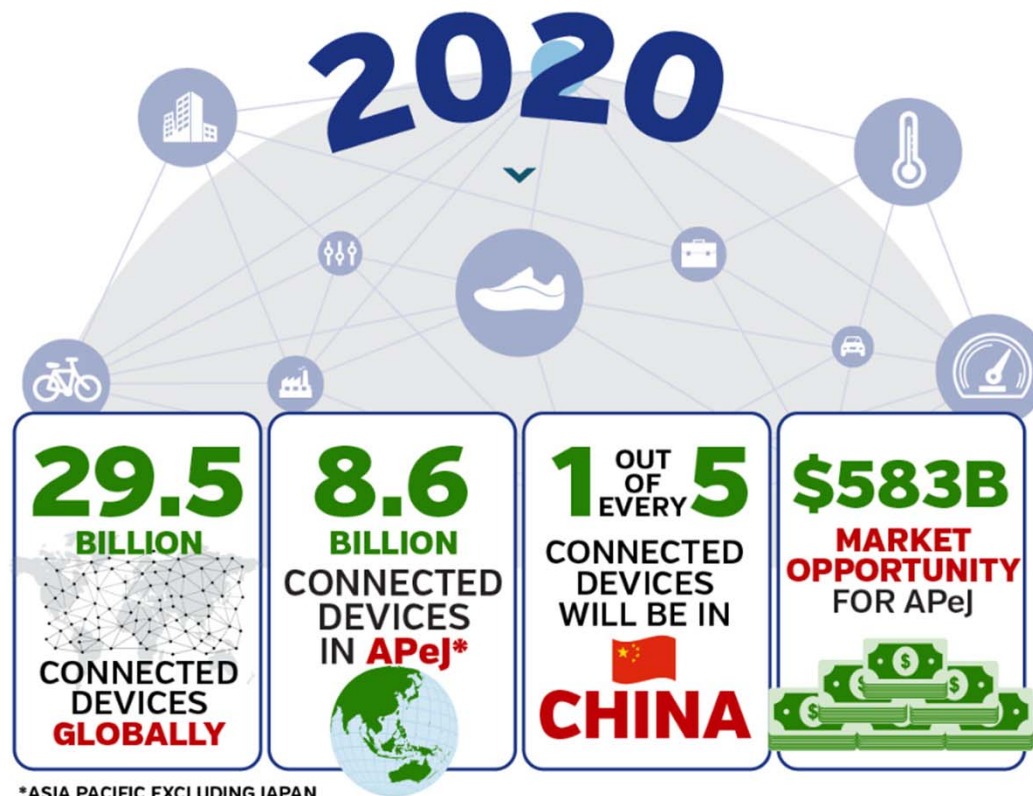
Junko Yoshida, EE Times

“Altogether, the Thread Group is gathering momentum, laying a foundation for much needed unity in IoT, and rolling out **the networking layer designed to interoperate with a broad range of IoT solutions.** Among various industry alliances jockeying for position in the fragmented IoT market, the Thread Group, with its specs in place, will shift gears to the certification of commercial Thread IoT products and market education.” source: [Unifying IoT: Thread Delivers V1.0. Gets Qualcomm](#)

THREAD GROUP | IoT in Asia Pacific



THREAD GROUP | IDC Market Forecast: April 2015



THREAD GROUP | Juniper Research Study

China's Smart Home Market

- Forecast: \$22.8 billion by 2018
- Chinese consumers are ready for smart home
 - 54.9% of consumers 'very interested' in converting to smart home
 - 36.8% 'fairly interested' in smart home idea

Organization Overview

THREAD GROUP | About Us

The Thread Group was launched in July 2014

- A nonprofit market education group offering product certification
- Promoting Thread's use in connected products for the home
- Thread will offer rigorous product certification to ensure security and interoperability
- Membership in the hundreds — <http://www.threadgroup.org/ABOUT/Our-Members>



10 May 2016

THREAD GROUP | Board of Directors

7 Founding Companies, grown to 12 Sponsors

President: Grant Erickson — Nest Labs

VP of Marketing: Sujata Neidig — NXP

VP of Technology: Skip Ashton — Silicon Labs

Secretary: Bill Curtis — ARM

Treasurer: Kevin Kraus — Yale Security

Director: Landon Borders — Haiku Home

Director: Christian Federspiel — OSRAM

Director: Rolf De Vegt — Qualcomm

Director: Mark Trayer — Samsung Electronics

Director: Cam Williams — Schneider Electric

Director: Jean-Michel Orsat — Somfy

Director: Greg Blackett — Tyco



10 May 2016

THREAD GROUP | Corporate Status

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 manages the delivery of enabling solutions:
 - Specifications
 - Certification Programs
 - Website
 - Trademarks
 - Copyrights
 - Logos/Brand Marks



THREAD GROUP | **Business Benefits**

Membership to Thread comes with its benefits:

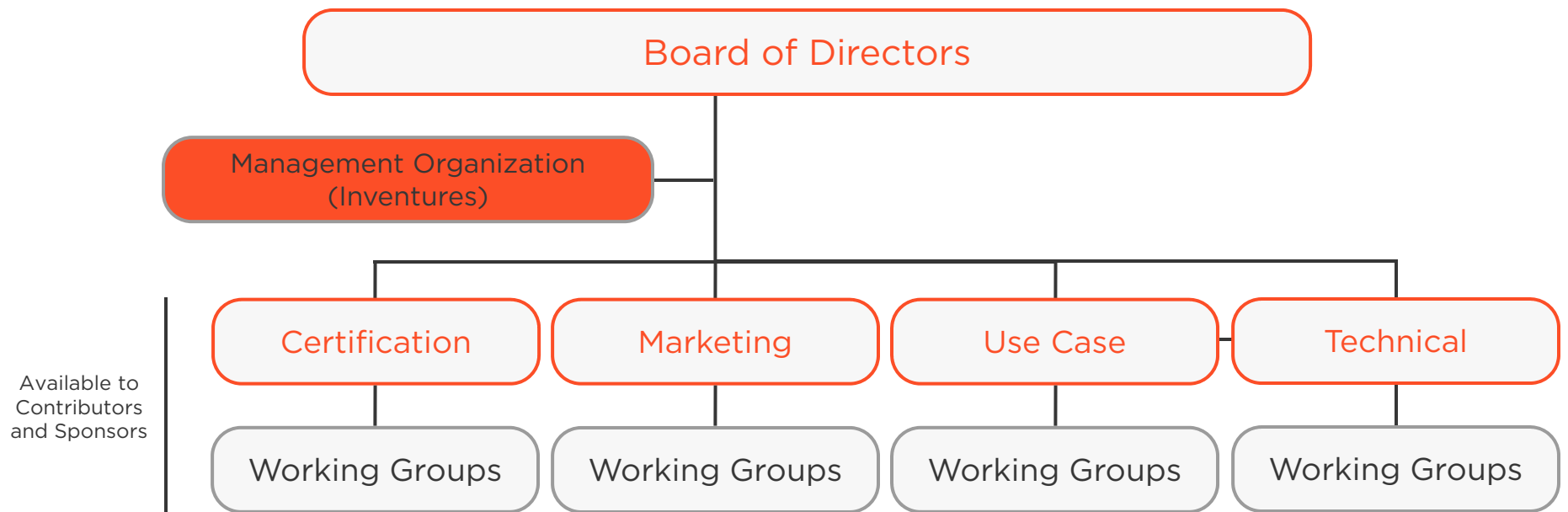
- Access to the technology and IP rights
- Access to the spec
- Access to Thread Certification Program
- Access to Thread Test Harness and Commissioning App
- Participation in Marketing and PR campaigns
- Participation in Committees to drive direction of Thread
- Networking with an ecosystem of companies building connected products for the home

THREAD GROUP | Marketing Benefits

There are great marketing benefits:

- The Thread Group will help promote your Thread-compliant products
- Engage in press activities and receive media coverage
- Participate in industry events with Thread
- Evangelize at high exposure speaking opportunities
- Use Thread Group marketing collateral and assets
- Build awareness through Thread online and social media

THREAD GROUP | Structure



THREAD GROUP | Membership Tiers

MEMBERSHIP BENEFITS	AFFILIATE	CONTRIBUTOR	SPONSOR
Receive member communications	✓	✓	✓
Participate in general or annual meetings	✓	✓	✓
Access to members only website	✓	✓	✓
Use of Alliance Member Logo	✓	✓	✓
Participate in press articles & interviews	✓	✓	✓
Access Final Deliverables	✓	✓	✓
Chair Committees and/or Work Groups		✓	✓
Certify Compliant Products and Utilize Certification Logo		✓	✓
Access Draft Deliverables		✓	✓
Participate and Vote in Work Groups		✓	✓
Participate and Vote in Committees		✓	✓
Access to Thread Reference Commissioning App		✓	✓
Ability to purchase Thread Test Bed		✓	✓
Access to Thread Test Harness		✓	✓
Approve Operating Budget			✓
Approve Final Deliverables			✓
Initiate Work Groups or Committees			✓
Automatic Seat on Board of Directors			✓
Annual Fee	\$2,500	\$15,000	\$100,000

10 May 2016

Copyright 2016 - Thread Group

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THREAD GROUP | Membership Process

You can join NOW

- Submit Application via www.threadgroup.org
- Agreements provided for legal and business review
- Membership complete once agreements signed and payment processed
- Members will be granted access to the Thread Group Members Only Portal
- The Portal will include technical documentation, certification info and marketing plans



THREAD GROUP | IPR Policy

- Our IPR policy is designed to maximize the adoption of the Thread technology
- IPR Policy for Thread Group membership balances interests of all stakeholders
- Commitment to grant a RAND-RF (royalty free) license to members for patents essential to the Thread specification
- Applies to all Thread members
- Avoids patent confusion
- Accelerates market acceptance
- Thread Group copyrights, trademarks are licensed to participants royalty free

THREAD GROUP | Development

Product companies can start developing Thread-based products today

- Compatible silicon is already available
- Many new products are in development

Pre-certified Thread stacks are available from three sources

- Please get in contact with the below companies
- There will be more silicon and stack providers over time



THREAD GROUP | Innovation Enabler Award

- We recognize that much of the innovation in the Connected Home is coming from small start-up companies who can't necessarily afford membership fees
 - We want to help these small, innovative companies launch Thread-enabled products
- To do this, we give away a free one-year Thread Group contributor membership quarterly
- Get details and apply at <http://www.threadgroup.org/join/innovation-enabler-program>
- Applicable Thread Affiliate members can apply



Rapport Network®



THREAD GROUP | Connect With Us Today!

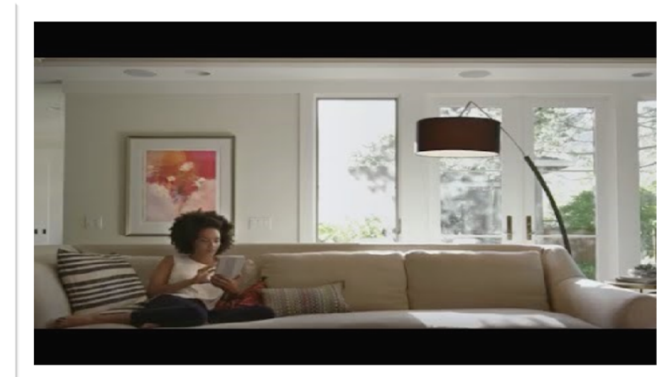
For more information, please contact us:

- help@threadgroup.org
- www.threadgroup.org
- 1-925-275-6690
- [linkedin.com/company/thread-group](https://www.linkedin.com/company/thread-group)
- @TheThreadGroup



Resources available:

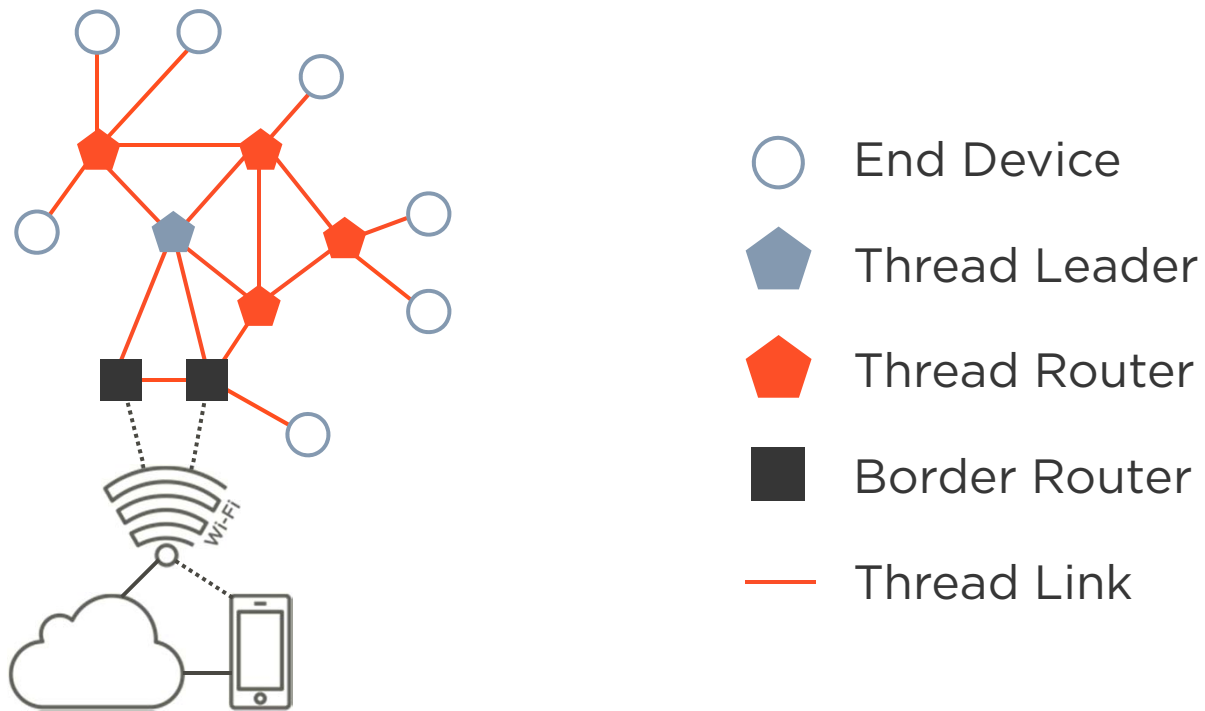
- White papers
- Presentations
- Videos
- <http://threadgroup.org/ourresources#Videos>
- Blog — <http://threadgroup.org/news-events/blog>



Built on Thread Video

Technical Overview

THREAD GROUP | Network Topology Roles



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

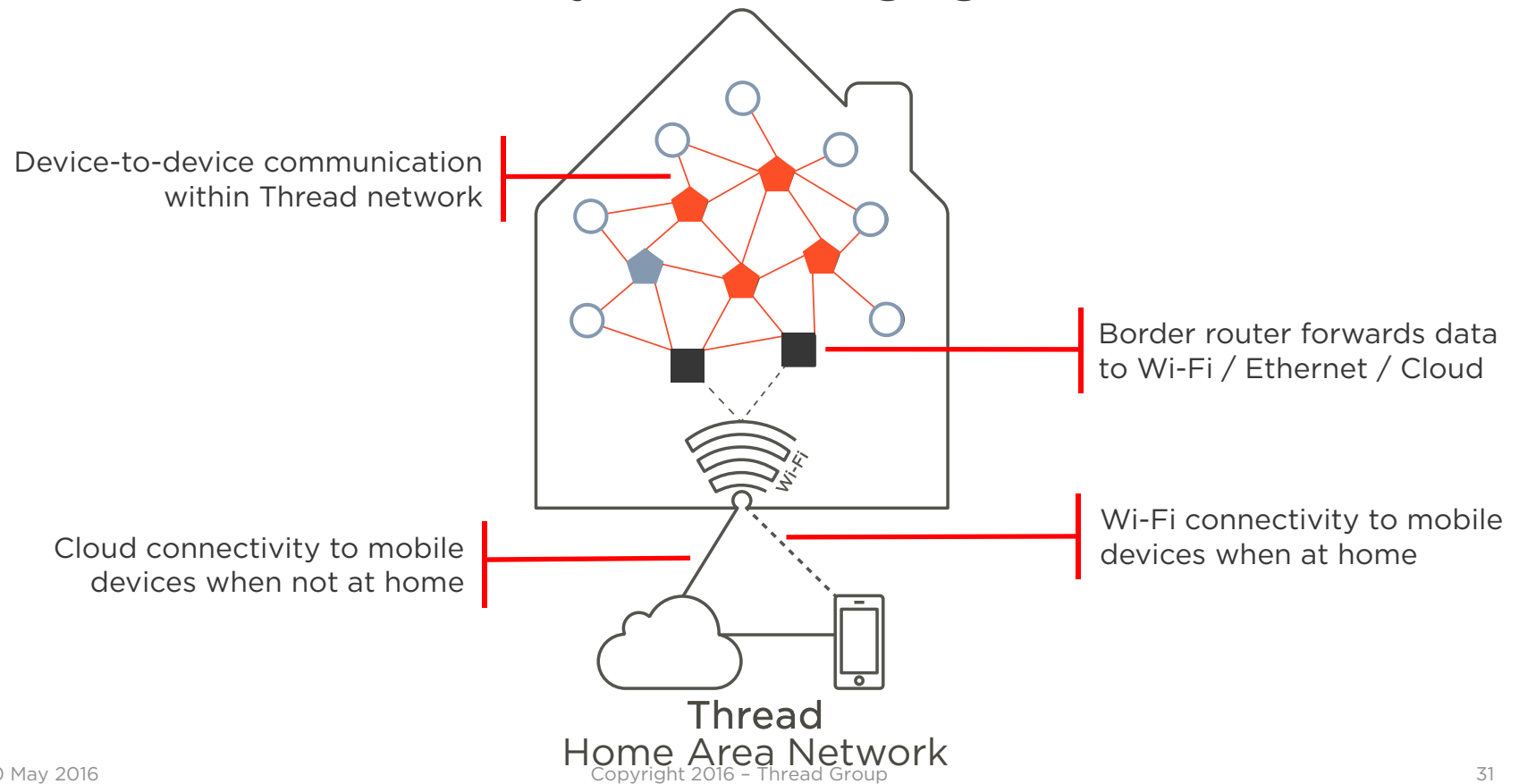
May be router-eligible if powered

Up to 64 per Router

=

Hundreds of Devices per Network

THREAD GROUP | System Messaging Model



THREAD GROUP | Key Features Overview

Thread	Standard
Application Layer	
UDP + DTLS	RFC 768, RFC 6347, RFC 4279, RFC 4492, RFC 3315, RFC 5007
Distance Vector Routing	RFC 1058, RFC 2080
IPv6	RFC 4862
6LowPAN	RFC 4944, RFC 6282, RFC 6775
IEEE 802.15.4 MAC (including MAC security)	
Physical Radio (PHY)	IEEE 802.15.4 (2006)

IP-based

- Simple bridging to other IP networks

Flexible Network

- Not tied to specific device types

Robust

- No single point of failure

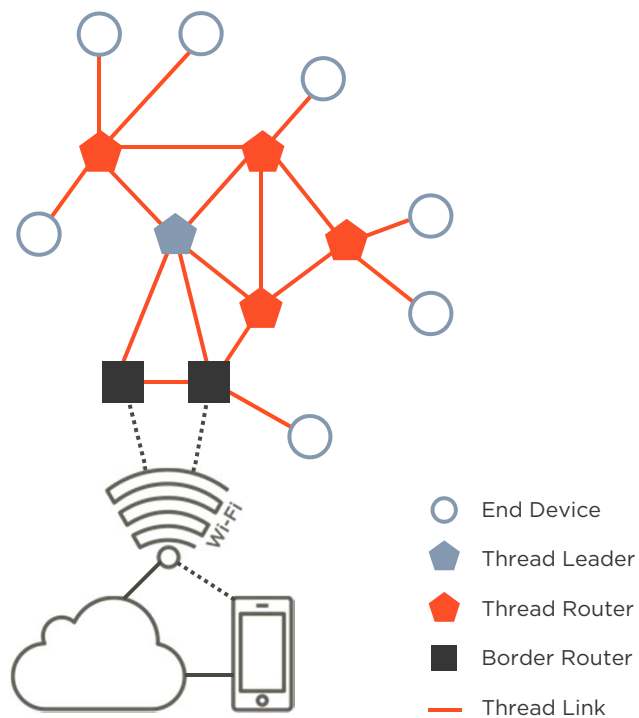
Secure

- Robust security, simple commissioning

Low Power devices

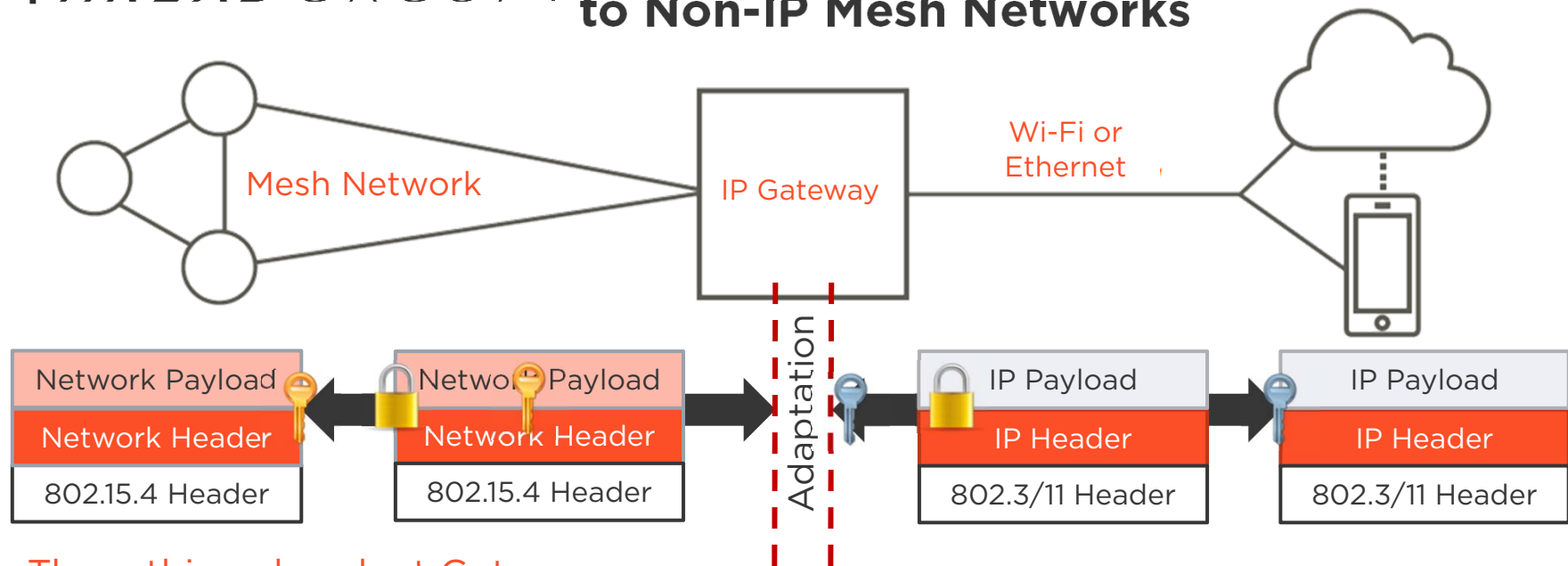
- Support for battery powered devices

THREAD GROUP | IP-based: Direct Addressability



- All devices have IPv6 address plus short address on HAN
- Devices for Unique Local Address (ULA) locally or Global Unicast Address (GUA) if IPv6 prefix available
- Home Network can directly address devices through Border Routers
- Cloud Services can address devices from the Internet
- Devices use IP to address any connected node — HAN, LAN, or WAN

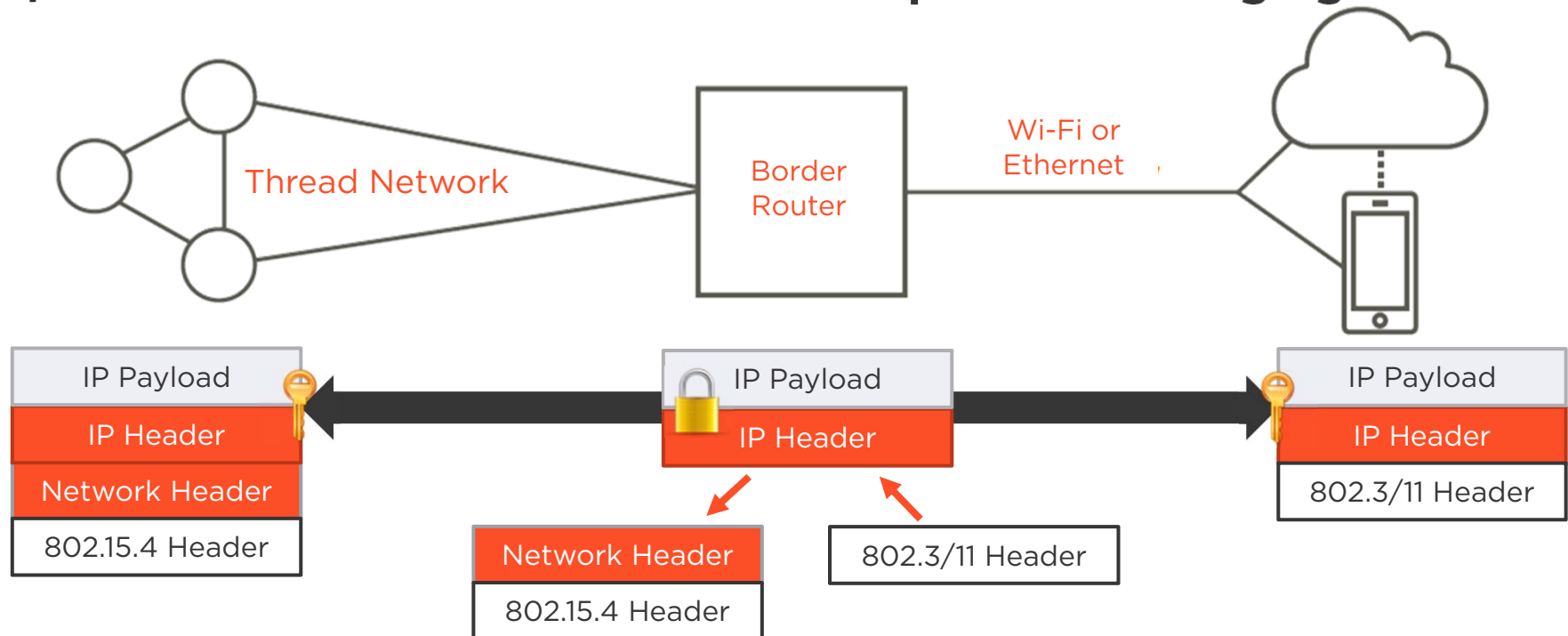
THREAD GROUP | IP-based: Comparison to Non-IP Mesh Networks



Three things break at Gateway:

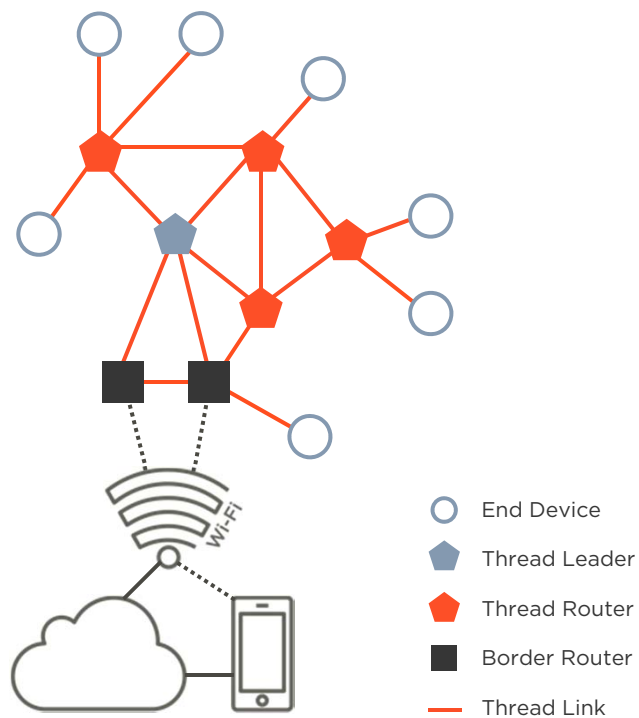
1. Network header (and network addresses) must be adapted to IP
2. Security must be adapted to IP
3. Application layer adapted to IP

THREAD GROUP | IP-based: Simplified IP Bridging



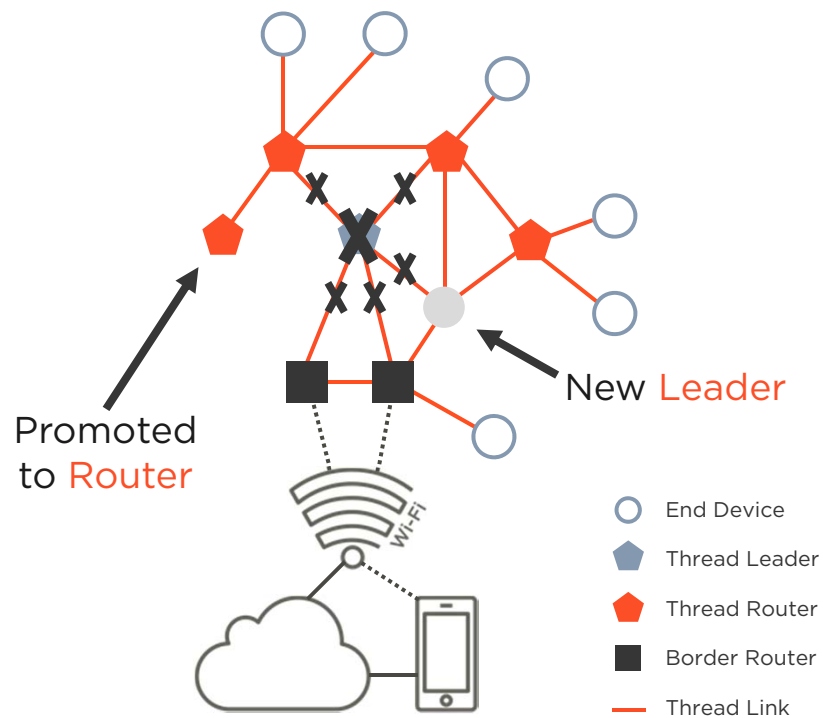
- Simplified bridging between mesh network and Internet
- Enables end-to-end IP security

THREAD GROUP | Flexible: Simplified Device Types



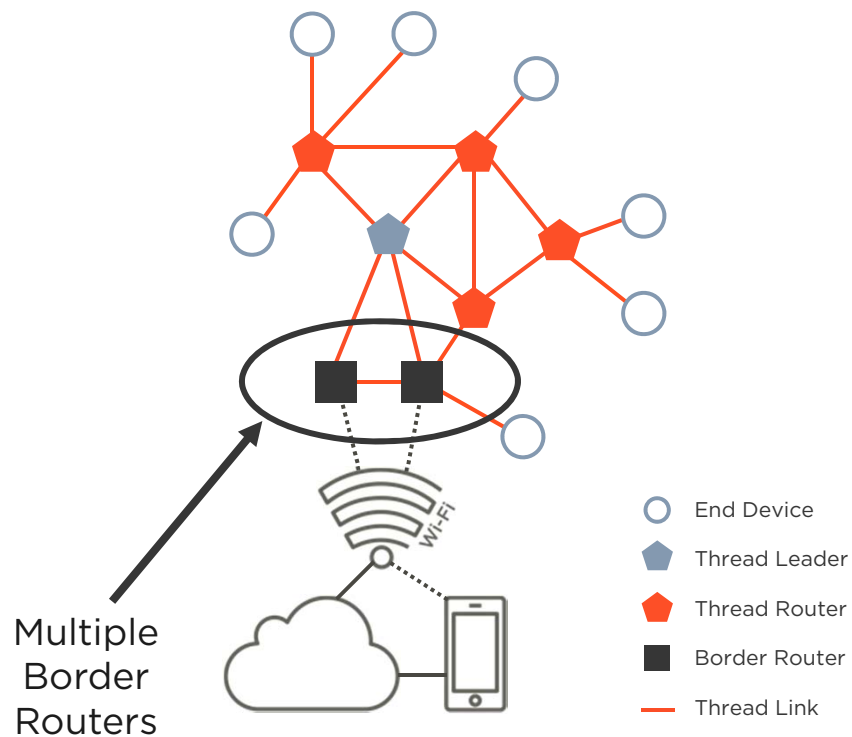
- Devices join as Router Eligible or End Device
- Router Eligible: Can become Routers if needed
 - First router on network becomes Leader
 - Leader: Makes decisions within network
- End Devices: Route through parent
 - Can be “sleepy” to reduce power consumption

THREAD GROUP | Robust: No Single Point of Failure



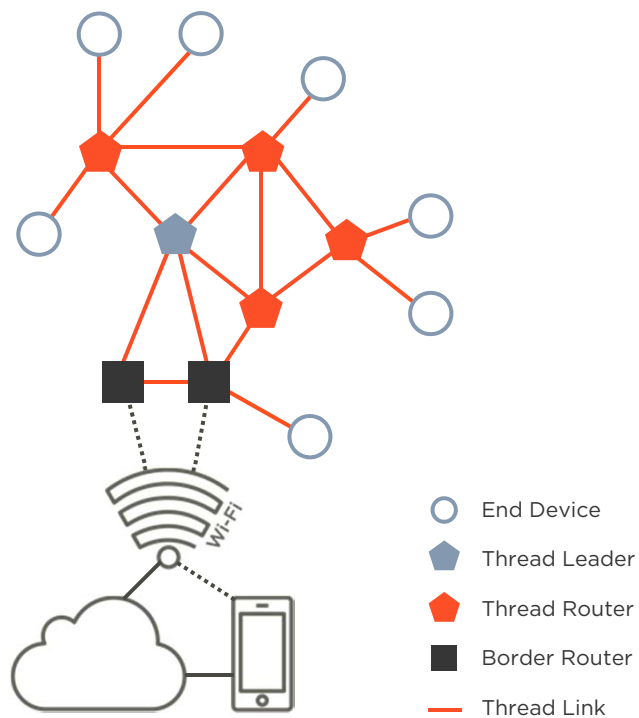
- Dynamic Leaders
 - If Leader fails, another Router will become Leader
- Router Promotion
 - Leader can promote Router Eligible devices to Routers to improve connectivity if required

THREAD GROUP | Robust: No Single Point of Failure



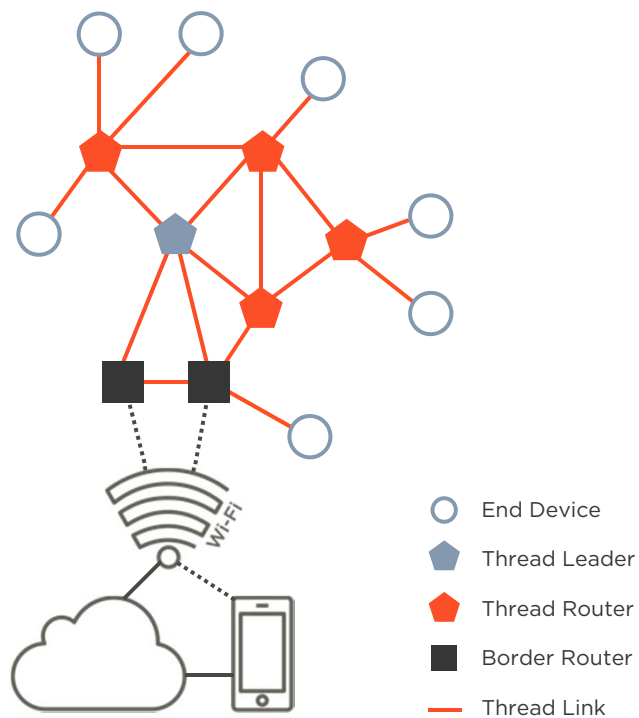
- Multiple Border Routers can be used for off network access
 - Devices operate without Border Router
- What can be a Border Router?
 - Anything with an 802.15.4 radio and another physical layer
 - Home Wi-Fi router
 - Set top box
 - Smart Thermostat (802.15.4 and Wi-Fi)

THREAD GROUP | Secure: 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 (GUI)
- 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

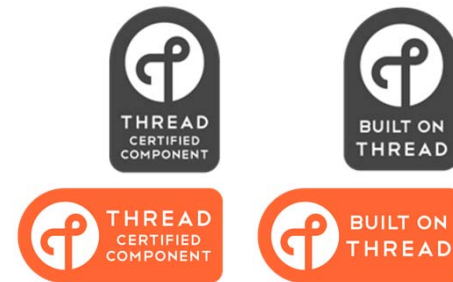
THREAD GROUP | Low Power Operation: Sleepy Devices



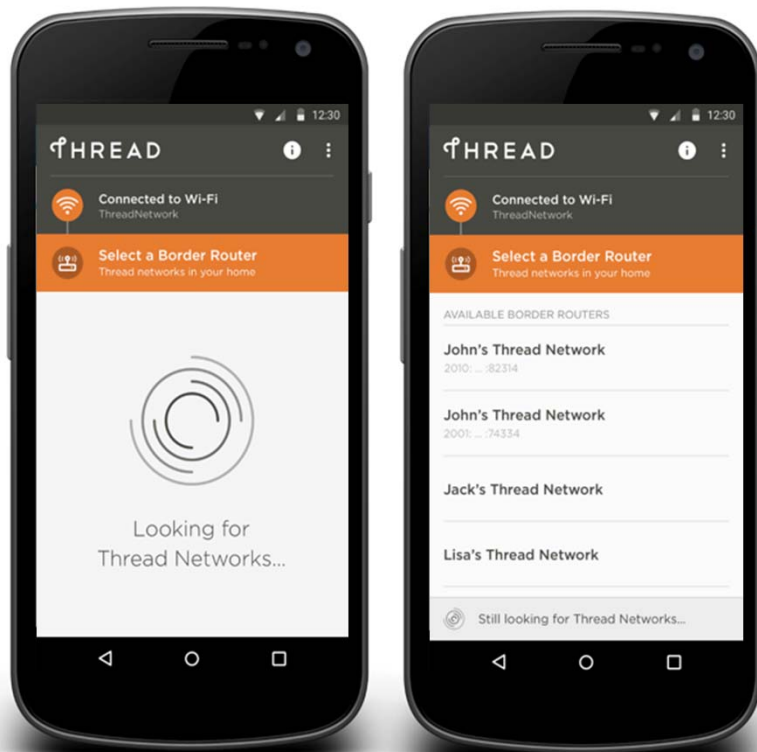
- Sleeping devices poll parents for messages (or remote device if application configured)
- Sleeping devices not required to check which allows lower power operation
- Parents hold messages for sleeping devices
- Sleeping device automatically switches parent connection is lost

THREAD GROUP | Thread Certification

- Commercial products must be certified in order to receive the Thread logo
- Validation of device behavior
 - Commissioning
 - Network functionality and interoperability
 - Device operation in network
- The certification program addresses components and end products
- Sponsor and Contributor Members have access to a standard test harness and sample commissioning app
- Certification uses a 3rd party test lab



THREAD GROUP | Thread Commissioning Application



- Enables users to effortlessly add devices on the Thread Network and manage settings
- Designed as a reference app with source code for all Sponsor and Contributor level members
- Communication via Thread Group's MeshCoP Protocol and CoAP
- Communication library written in C and C++, leveraging code that is extendable across iOS and Android

Test Harness Overview

[GRL Presentation](#)

FAQ

THREAD GROUP | Frequently Asked Questions

Agenda

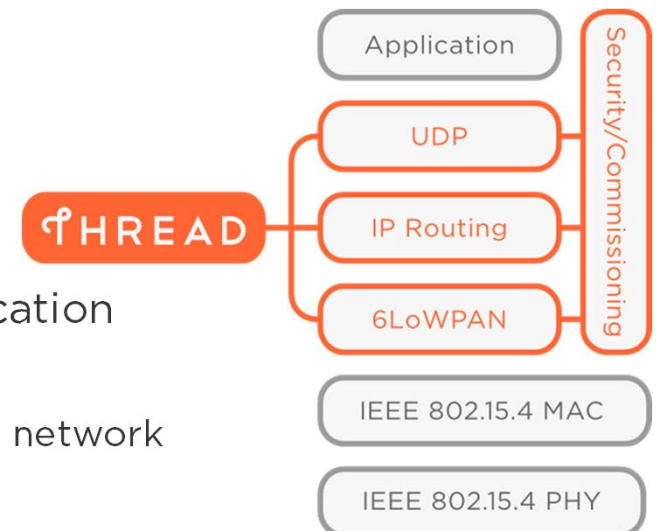
1. Top 10 questions
2. Interactive Q&A

THREAD GROUP | Q&A – Question 1 – Application layers

Q: Thread does not have an application layer.
Why? Which ones will be supported?

A: Thread is a network and transport layer specification

- Thread is like “Wi-Fi for devices”
- Application Layer – a protocol running over a Thread network
- Thread can support multiple application layers
- Application layers can use multiple networks – i.e. Thread and Wi-Fi
- Thread does not favor one application layer alliance over another
- We have liaison agreements with several ... and more are on the way!



THREAD GROUP | Q&A – Question 2 – Liaison agreements

Q: What is Thread Group's strategy for liaisons with other alliances like the ones that are in place with ZigBee and OCF?

A: Thread can support multiple application layers

- We want broad market adoption for application layers that align with Thread member interests
- Liaison agreements with application layer alliances accelerate adoption and integration
- Nothing prevents any IP based application layer from using Thread

Thread Liaison Agreements May 2016



THREAD GROUP | Q&A – Question 3 – Other wireless options

Q: How does Thread differ from other “competing” technologies like ZigBee, Z-Wave, Bluetooth, AllSeen, OIC, HaLow?

A: These technologies fall into three categories

- Category 1: Connectivity layer
 - Provide wireless connectivity
 - Examples: Thread, Wi-Fi, HaLow, ZigBee IP
- Category 2: Application layer
 - Provide application APIs. Some can support multiple connectivity methods.
 - Examples: AllSeen, IPSO, OCF / OIC / IoTivity, IIC, many vertical-industry alliances
- Category 3: Full-stack technologies – connectivity layer combined with application layer
 - Examples: Bluetooth, ZigBee, Z-Wave, ULE

THREAD GROUP | Q&A – Question 4 – Internet Protocol


Q: Why is IP connectivity so important?

A: Because we're building the INTERNET of Things

- Historically, “constrained” embedded devices have used specialized communication protocols
 - Low power, low bandwidth, fit-for-purpose app layer
- The Internet and WWW are built on a layered stack of open standards
 - Each layer is independent and NOT tied to a specific application
 - This is why the Internet is so flexible and pervasive
- Now, we have the technology to use Internet standards with constrained embedded devices
 - Devices and applications can be developed independently
 - Applications can run anywhere – cloud, controller, router, or endpoint device

THREAD GROUP | Q&A - Question 4 - Internet Protocol

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 GROUP | Q&A - Question 4 - Internet Protocol

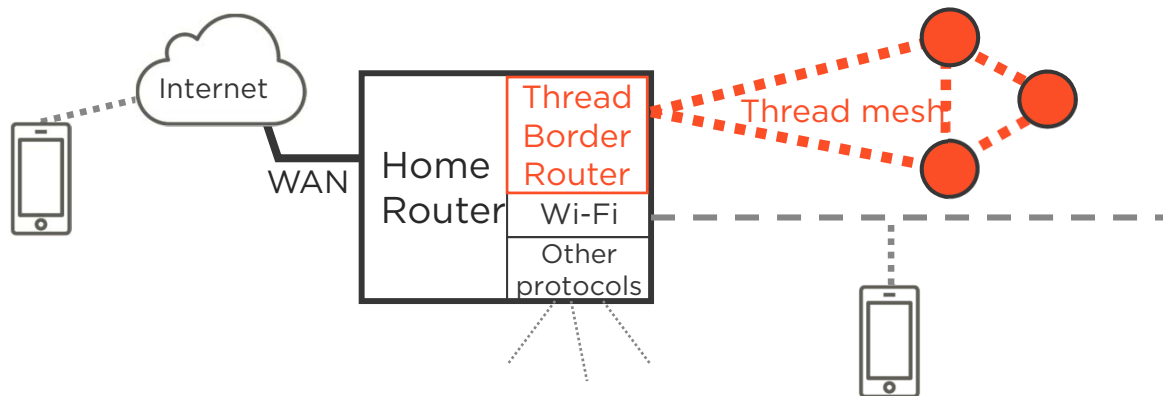
The Internet: Now available in “small!”

	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 | Q&A - Question 5 - Border Router in gateways

Q: How do I enable Thread in a gateway product?

A: Add Thread “border router” functionality to your platform



- Border Router stacks are available from Thread stack suppliers
 - ARM, NXP, Silicon Labs. Others later this year
- Border Router stack may run on router or external device WiFi, Ethernet, USB, ...
- Thread is an IPv6 network. Router must be v6 enabled

THREAD GROUP | Q&A - Question 6 - Using the logo

Q: How will companies use the “Connects with Thread” logo?
Will Thread Group invest in consumer facing brand awareness?
Will there be co-branding with application layer alliances?



CONNECTS
WITH
THREAD

A: The Thread logo assures consumers of Thread connectivity

- Logo indicates network-layer conformance for products
- Thread is an ingredient brand. Our policy is to focus on ecosystem partners, not consumers
- But we are definitely open to co-branding with application layers

THREAD GROUP | Q&A – Question 7 – Range

Q: What is the Range of Thread devices?

A: Thread uses the 802.15.4 personal area network

- Actual range depends on many factors
 - Device's 802.15.4 radio and antenna
 - Installation environment (Example: Walls, device location, enclosures, etc.)
 - Radio channel interference
- The Thread mesh network extends the range over long distances
Whole-home coverage, even for very low power endpoints
- Product certification includes RF testing to ensure “reasonable” RF design

THREAD GROUP | Q&A – Question 8 – Power

Q: What is the power consumption (savings) of Thread?

A: Thread is designed for power efficiency

- 802.15.4 is optimized for low bandwidth, low power operation
- Some low power 802.15.4 radio subsystems are very efficient ... <10 mW
- Thread network supports “sleepy” end-nodes that wake infrequently for very short periods of time
- “Coin cell for years” is feasible for simple sensor endpoints
- Actual power consumption depends on application and platform

THREAD GROUP | Q&A – Question 9 – Dev kits

Q: How do I obtain Thread development kits?

A: Today, Thread stacks and development platforms are available from ARM, NXP, and Silicon Labs

- Each of these companies has a developer access program
- Procedures are in place for members to obtain the same hardware used for Thread interoperability testing
- More options for stacks and development kits will open up this year

THREAD GROUP | Q&A - Question 10 - Licensing Thread

Q: How do I license Thread?

A: Become a member

- Contributor and sponsor members can use the logo and are covered by the IPR policy
- Membership forms are all available online

THREAD GROUP | Interactive Q&A

Skip Ashton, Silicon Labs

Bill Curtis, ARM

Thank you!

More questions?
bill.curtis@arm.com

THREAD GROUP | Antitrust Statement

The established policy of The Thread Group to comply with all laws including all anti-trust laws. Because our alliance contains members that are or may be competitors, we must be careful to confine both our formal and informal discussions to the topics described in the agenda.

In order to comply with our policy, we will not discuss issues relating to prices, discounts, terms or conditions of sale or licensing, pricing methods, profits, profit margins or cost data, production plans, market shares, sales territories or markets, allocation of territories or customers, any limitation on the timing, cost or volume of research, production, strategic business, marketing or product development plans or any other topic which cannot be lawfully be discussed among competitors.

Each participant in the meeting today acknowledges that he or she has read, understood and agrees to be bound by the Thread Group Antitrust Policy which contains additional detail and can be found on the Thread Group website.

If you have any question or concerns about these matters as we proceed today, please raise them immediately.

THREAD GROUP

Thank You