Developing IoT Devices with Thread

June 2018
You will be defaulted to mute by organizer

Audio pane: Use the Audio pane to switch between Telephone and Mic & Speakers

Questions pane: Post your questions for panelists

Questions will be read and addressed after the presentation

Recording of this webinar will be made available on the Thread Group website
Thread Group | Today’s Speakers

Grant Erickson
President, Thread Group; Principal Software Engineer, Google / Nest

Grant Erickson is a principal engineer at Google / Nest, where he oversees the technical development of software designed to support Bluetooth Low Energy, Thread, Wi-Fi, and Nest Weave.

Sujata Neidig
Vice President of Marketing, Thread Group; Director of Marketing, NXP

Sujata Neidig has over 23 years of experience in the semiconductor industry and has served in a variety of roles ranging from product engineering to marketing and business development. She is currently the MCU & Connectivity Director of Marketing driving leadership and growth in multiple market segments.

Jonathan Hui
Vice President of Technology, Thread Group; Principal Software Engineer, Google / Nest

Jonathan Hui is a principal software engineer at Google / Nest, where he is responsible for Thread implementation in products and is maintainer of OpenThread released by Nest.
What is Thread?
What is Thread?

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

BUILT FOR IoT
Securely and reliably connect products in homes and buildings

BUILT-IN SECURITY
Provides security at the network layer

LOW ENERGY FOOTPRINT
Based on the power-efficient IEEE 802.15.4 MACPHY

OPEN IPv6 BASED PROTOCOL
Provides device-to-device and device-to-cloud connections

SEAMLESS INTEGRATION
Extends the internet into low power end devices

MARKET READY
Broad selection of silicon, stacks and components available globally
What is Thread?

A low power, secure and Internet-based mesh networking technology for IoT products.

- Built on proven, widely available and supported technologies
  - Uses IPv6 (6LoWPAN)
  - Runs on existing 802.15.4 silicon from multiple providers
- Legacy-free design with updated architecture
  - 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
Thread is

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

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

- End Device Router Eligible
- Thread Router
- Leader
- Border Router
- Thread Link
### Border Router
Forwards data to and from cloud/other networks
Provides optional Wi-Fi connectivity

### Thread Leader
Manages network parameters
Coordinates commissioners
Makes network decisions

### Thread Router
Routes traffic among devices
Form the mesh topology
Eligible to become the Leader

### End Device
Designed for low power operation
May be powered or sleepy
May be router-eligible if powered

- Many + One + Up to 32 + Up to 511 per Router
- Hundreds of Devices per Network
Securely and scalably connecting an ecosystem of low power products to each other, to cloud services, and to consumers via their mobile devices supporting applications

- Appliances
- Access control
- Climate control
- Energy management
- Lighting
- Safety
- Security
Thread Technology is ideally suited for many different devices/applications

- **Line Powered Devices**: Each powered device can be a border router making a very reliable and robust home network

- **Access Control**: Thread uses state-of-the-art security making for a very secure access control network

- **Battery Powered Devices and Sensors**: Thread is designed to support low power devices ensuring battery powered devices operate efficiently and securely
Thread is being expanded with functionality specifically designed for integration opportunities in commercial applications like office buildings, hotels, factories, universities, outdoor applications and smart city areas.

Thread addresses key requirements of Building Automation & Lighting Control (BALC) use cases.

- Thread is the only open-standard IPv6 mesh network that is available for BALC
- Cost-effective and low-power devices
- Future-proof security that supports any building automation and critical infrastructure
Thread can be integrated into an existing enterprise network.

A Thread network consists of:

- One or multiple border routers that connect the Thread network to the local IP network and the internet.
- Thread devices, all of which can act as routers to expand the mesh-network.
- Multiple end devices that can also be sleeping devices that are not required to check in and thus preserve power.
Who Is Thread?
The Thread Group is:

- Thread Group is a technology alliance focused
- Thread Group is focused on making Thread the foundation for the internet of things in homes and commercial buildings.
- The Thread Group provides a rigorous certification program to ensure device interoperability and a positive user experience.
- Thread is backed by industry-leading companies including Arm, Nest Labs, Nordic Semiconductors, NXP Semiconductors, OSRAM, Qualcomm, Schneider Electric, Siemens, Silicon Labs, Somfy and Yale Security.

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

President
Grant Erickson – Google / Nest

VP of Marketing
Sujata Neidig – NXP

VP of Technology
Jonathan Hui – Google / Nest

Secretary
Bill Curtis – ARM

Treasurer
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Director
Rolf De Vegt – Qualcomm

Director
Cam Williams – Schneider Electric

Director
Klaus Waechter – Siemens

Director
Skip Ashton – Silicon Labs

Director
Jean-Michel Orsat – Somfy
Structure

Management Organization
(Inventures)

Board of Directors

Certification
Working Group

Marketing
Working Group

Use Case
Working Group

Technical
Working Group

Executive
Working Group

Available to Contributors

Available to Sponsors
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
<table>
<thead>
<tr>
<th>Membership Benefits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to the technology and spec</td>
<td>Reduce time for development and implementation using a proven solution</td>
</tr>
<tr>
<td>Access to the IP</td>
<td>Gain IP rights for the Thread technology with no royalty payments</td>
</tr>
<tr>
<td>Access to Thread Certification Program</td>
<td>Guarantee network interoperability with other Thread devices and broaden your ecosystem</td>
</tr>
<tr>
<td>Use of the Thread Test Harness and Commissioning App</td>
<td>Save time and resource investment by completing in-house testing for spec conformance and network interoperability</td>
</tr>
<tr>
<td>Participation in Marketing and PR campaigns</td>
<td>Leverage Thread’s marketing, social media and PR tools to extend marketing efforts</td>
</tr>
<tr>
<td>Participation in Committees</td>
<td>Provide a voice to help influence the direction of Thread</td>
</tr>
<tr>
<td>Networking with an ecosystem of companies</td>
<td>Collaborate with other members to optimize investment</td>
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</table>
## Membership Tiers

<table>
<thead>
<tr>
<th>Membership Benefits</th>
<th>Academic</th>
<th>Affiliate</th>
<th>Contributor</th>
<th>Sponsor</th>
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<tbody>
<tr>
<td>Receive member communications</td>
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<tr>
<td>Participation in general or annual meetings</td>
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<tr>
<td>Access to members only website</td>
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<tr>
<td>Use of Alliance Member Logo</td>
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<tr>
<td>Participation in press articles &amp; interviews</td>
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<td>Access Final Deliverables</td>
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<td>Access Draft Deliverables</td>
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<tr>
<td>Chair Committees and/or Work Groups</td>
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<td>Certify Compliant Products and Utilize Certification Logo</td>
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<td>Participate and Vote in Work Groups</td>
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<td>Participation and Vote in Committees</td>
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<td>Approve Operating Budget</td>
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<td>Approve Final Deliverables</td>
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<td>Initiate Work Groups or Committees</td>
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<td>Automatic Seat on Board of Directors</td>
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<td>CABA</td>
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<td>EEBus</td>
<td>App Layer</td>
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<td>Fairhair Alliance</td>
<td>Standards</td>
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<td>OCF</td>
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<tr>
<td>Zigbee Alliance</td>
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</table>
“By 2023, 4.5 billion cumulative 802.15.4 mesh devices will be sold worldwide. The majority of these will use smart home protocols such as Zigbee and Thread”

Source: ON World
Thread Group | Dotdot + Thread

The first open, interoperable device language running over an Internet (IP) based network.

Open, universal protocols like HTTP over IP unlocked and accelerated innovation on the Internet.

Dotdot’s common device language over Thread’s IP network brings this foundation for innovation to the Internet of Things.
Benefits 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

**Seamlessly Integrated**
- Seamlessly and securely works with users’ existing networks
- Extends the internet into low power end devices without translators
- Easily extends to personal devices

**Market Ready**
- Broad selection of silicon
- Four certified stacks
- Publicly available specification
- Active certification program
- Fast-ramp tools accelerating time to market
- Global Solution
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• 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
**Security and Commissioning**

- **Simple Commissioning**
  - User authorizes devices onto the network using a smart phone or web.
  - Can be done on the network if there is a device with a graphical interface.

- DTLS Security session established between a new device and the commissioning device to authenticate and provide credentials.

- Once the commissioning session is done, the device attaches to the network.

- MAC security used for all messages.

- Application level security is based on end-device requirements and the application layer being used.
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
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)
Device-to-device communication within Thread network

Border router forwards data to Wi-Fi / Ethernet / Cloud

Cloud connectivity to mobile devices when away

Wi-Fi connectivity to mobile devices when in the building
Thread is a low power, secure and future-proof mesh networking technology for IoT products.

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The Internet: Today, mostly “large” devices

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<tbody>
<tr>
<td>Web Transfer</td>
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</tr>
<tr>
<td>Transport</td>
<td>TCP</td>
</tr>
<tr>
<td>Security</td>
<td>TLS</td>
</tr>
<tr>
<td>Addressing</td>
<td>IPv6 / IPv4</td>
</tr>
</tbody>
</table>
**THREAD | What Internet Protocols Does Thread Use?**

The Internet: Now available in “small!”

<table>
<thead>
<tr>
<th>Applications</th>
<th>Large devices</th>
<th>Small devices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mains powered</td>
<td>Battery powered</td>
</tr>
<tr>
<td></td>
<td>Fast networks</td>
<td>Constrained networks</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Applications</th>
<th>Internet / Web applications can work with large or small devices</th>
</tr>
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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
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: 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 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
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THREAD | 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?
With Thread and IP you are not forced to choose a single link technology to the exclusion of all others.
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
THREAT | Thread + Many
THREAD | Thread + WiFi
Thread + Ethernet
Thread + Internet & Telecommunications
THREAD | Thread + Bluetooth
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- Global Solution
We set the bar high

True multi-vendor interoperability between $\geq 3$ stacks, not just a golden node

We held 13 discrete in-depth interop sessions to validate the spec

We have many certified stacks

We provide fast ramp tools
THREAD | Available Now

ARM mbed OS (NXP FRDM-K64F + Atmel ATZB-RF-233)
ARM mbed OS is an open source embedded operating system designed specifically to facilitate the creation of commercial, standards-based IoT solutions at scale. mbed OS features full support for Thread to simplify development of secure IoT applications in the home and to ease Thread product certification. [Product Link]

Express Logic X-WARE IoT PLATFORM
An industrial-grade IoT platform for Thread devices that is based on the SIL-4 safety certified ThreadX RTOS and NetX Duo IPv6/IPv4 TCP/IP solutions. This platform contains no open source X-WARE IoT PLATFORM for Thread is highly portable and currently available for most leading semiconductor solutions. Designed to be small, fast, and easy to use, X-WARE IoT PLATFORM greatly eases Thread development and subsequent deployment. [Product Link]

Kirale Technologies - KINOS Thread Stack
Kirale Real-Time Networking System is a high-performance, secure, robust, and scalable Thread Certified Stack that is tailored for wireless low-power IP-enabled embedded devices and suitable for all Thread roles from ultra-low-power End Devices to powerful Border Routers. Full-featured and easy to use from scratch to optimize footprint and performance. Designed to be small, simple, and easy-to-use and with a very portable source code structure that facilitates its customization. [Product Link]

Kirale Technologies - KTWM102 RF Module
Complete Thread Certified Solution with world’s smallest PCB footprint. Surface-mount component, integrating a SoC which combines a powerful and ultra-efficient ARM Cortex-M32-based 32-bit microcontroller and IEEE 802.15.4-compliant 2.4 GHz RF transceiver. It can be easily handled by host processors through USB and UART interfaces and it is FCC/IC/CE certified allowing faster time to market and lower development costs. [Product Link]

Nordic Semiconductor nRF52840 (OpenThread)
The nRF52840 is a multi-protocol SoC supporting Bluetooth 5.1/ANT (802.15.4) 2.4 GHz proprietary, with a 32-bit ARM Cortex-M4F CPU with 1MB flash and 256KB RAM on chip. The nRF52840 and the uRF5 SDK for Thread, which is based on the OpenThread stack makes a powerful solution for battery powered Thread devices. [Product Link]

NXP Kinetis Thread Stack (KW41Z/21Z)
Kinetis Thread Stack is a complete, robust, and scalable certified stack, architected and tested to meet the most demanding product requirements including very low power end nodes, large vehicle networks and gateway solutions. The stack is available across multiple NXP microcontrollers and easily connects to host processors to create Thread Border Router solutions. [Product Link]

OpenThread (TI CC2538)
OpenThread, released by Nest and supported by Google, is an open-source implementation of the Thread networking protocol. It is a highly portable library that is OS and platform agnostic with a radio abstraction layer that is supported on multiple platforms. [Product Link]

Qorvo GP712 System-on-Chip
The Qorvo GP712 System-on-Chip is an IEEE 802.15.4 multi-stack multi-channel communications controller for integration into a Zigbee or Thread/OpenThread node. It is compliant with the IEEE Standard 802.15.4, providing robust spread spectrum data communication with a secure encryption data flow, and supports multiple ZigBee 3.0 and Thread protocol stacks in the host processor. [Product Link]

Qualcomm Atheros Inc., (QCA 4020/4024/4025)
802.15.4 / Wi-Fi / BLE application processor with Thread stack. [Product Link]

Silicon Labs Mighty Gecko Module MGM12P
Silicon Labs’ Mighty Gecko MGM12P module integrates our EFR32MG12 SoC into a small form factor module supporting Thread, Zigbee and Bluetooth protocols. With 1024 kB of Flash and 256 kB of RAM, this module is ideal for applications requiring multi-protocol support. The MGM12P integrates all necessary system components including crystals, RF passive and antenna and also has worldwide regulatory compliance including FCC/IC/CE certifications. [Product Link]

Silicon Labs Mighty Gecko SoC (EFR32MG1x)
The Mighty Gecko SoC is a highly integrated wireless SoC featuring an ARM Cortex-M4 core and multi-protocol, multi-band radio supporting IEEE 802.15.4 (Thread/Zigbee), Bluetooth low energy and proprietary RF protocols. This family supports up to 1 MB flash and 256 MB RAM. Additional features include a -20 dBm PA and Silicon Labs’ unique Packet Trace Interface (PTI). [Product Link]

TI OpenThread (CC2652)
TI’s OpenThread is the Thread implementation from TI using the open source OpenThread stack as networking core, and integrated in the TI SimpleLink™ MCU environment, a SW framework including support for RTOS, drivers and tools common across all TI embedded devices. TI OpenThread runs on CC2652 silicon, a 2.4 GHz multi-protocol (BLE, Zigbee, Thread, Proprietary 2.4 GHz) low power wireless MCU which can be used to build all applications atop any Thread device type. TI OpenThread is supported on the low-cost LaunchPad™ development kit. [Product Link]
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.
Getting Started Now
THREAD DEVELOPMENT ECOSYSTEM

Ready to get started? Many members offer a variety of products & services to help you build your Thread solutions.
Development Partners

RF Module Suppliers

- FCC and Thread Certified RF hardware modules to plug into your design
- A number of vendors also offer certified turnkey hardware solutions to complement your design (e.g., border routers)
- Some also offer software and/or design services

Service Suppliers

- Software stack providers or developers
- Software system integrators - integration of all networking and application layer technologies
- Manufacturing
- Hardware design
- Network testing
**Connect with Thread Members**

Navigate the Thread Ecosystem through the Member page on threadgroup.org

**OUR MEMBERS**

*Industry*: All
*Segment*: All
*Region*: All
*Membership Level*: All

**THREAD IS BUILT FOR IoT**

*Since Thread is an IP-based technology it's very flexible when it comes to application layers. This is a huge benefit for us & means that devices can interoperate across different networking standards. MMB Networks*

*We joined Thread because it addresses the need for a wireless, IP-based, low power protocol which allows many connected devices to co-exist on one network across multiple applications. OSRAM*

*Thread can support all sorts of devices simultaneously on the same network. And that means the customer has the opportunity for greater interoperability & less concern about devices not talking to each other. eero*

**THREAD SOLVES PROBLEMS**

*We joined Thread Group because we believe Thread is a viable solution not only for the connected home, but also for commercial & industrial applications such as commercial lighting & building automation. centergic*

*Thread is interesting to MMB as a low power, mesh & IP-based technology which opens up a lot of new markets and use cases for us & our customers. MMB Networks*

*Siemens joined Thread because we are looking for a low-cost, wireless solution for constrained devices based on IP-8 this is only available through Thread. SIEMENS*
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Thank You!

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For more information, please connect with us:

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