Introduction to Thread

Nordic Tech Webinar

Pär Håkansson / Product Manager, Short Range IoT

Krzysztof Loska / Technical Product Manager

14 October 2020

Today's hosts

Pär Håkansson

Krzysztof Loska

Product Manager

Technical Product Manager

Practicalities

- Duration: 50-60 mins

- Questions are encouraged!
  - Please type questions in the top of the right sidebar
  - All questions are anonymous
  - Try to keep them relevant to the topic
  - We will answer them towards the end

- The chat is not anonymous, and should not be used for questions

- Go to DevZone if you have more questions

- A recording of the webinar will be available together with the presentation at webinars.nordicsemi.com

Ask a question

Type something...

Ask Question

This is the chat

{ DevZone
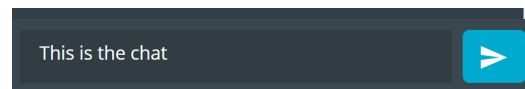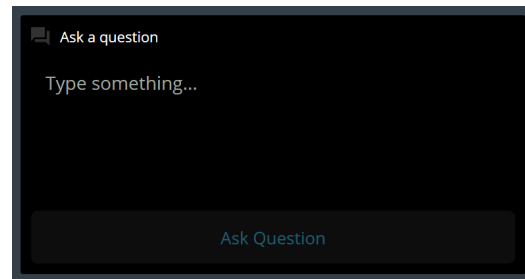
Agenda

- Thread Group intro

- Thread - What is it?

- Networking stack
  - Thread's primary features
  - Thread devices types and roles
  - OpenThread project

- Application layers

- Thread certification

- Nordic's SDK and devices supporting Thread

Introduction to Thread

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Thread Group intro

Thread Group
Mission and Vision

Mission:

The Thread Group brings the Internet to the Internet of Things through its IP-based, low power, secure and future proof mesh networking technology.

Vision:

To serve as the foundation of the Internet of Things by seamlessly connecting devices where we live and work.

Thread Group

- A standardization body for creating, maintaing and develop the Thread protocol specification

- Educate product developers and consumers on the key features and benefits of Thread.

- Ensure a great user experience through rigorous, meaningful product certification.

Membership tiers:

- Academic
- Affiliate
- Implementer
- Contributor
- Sponsor

Sponsor members:

What is Thread?

A low power, secure, future-proof mesh networking technology for IoT products

1   **Built for IoT -** Securely and reliably connect products in homes and buildings

2   **Built-In Security**- Provides security at the network layer

3   **Low energy footprint** - Based on the power-efficient IEEE 802.15.4 MAC/PHY

4   **Open IPv6 based protocol** - Device-to-device and device-to-cloud connections

5   **Seamless integration** - Extends the internet into low power end devices

6   **Market ready** - Broad selection of silicon, stacks and components available globally

Thread Specifications

v1.0   Introduced in 2014.

v1.1.1   Launched in 2017 . Specification publicly available on the Thread Group website.

v1.2   Launched in 2019. Spec is available to members.

Thread networking stack

Thread's primary features

- Built on proven technologies

- Scalability

- Security

- Reliability

- Efficiency

Thread's primary features

- **Built on proven technologies**
  - IEEE 802.15.4 - the same radio as used for Zigbee networking protocol
  - IPv6 and 6LoWPAN – Thread is an Internet Protocol version 6 (IPv6) based mesh network. 6LoWPAN defines how to sent IPv6 packets over 802.15.4
  - No application layer defined
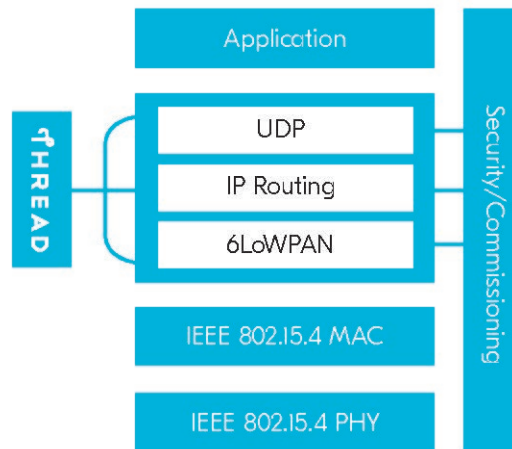
# Importance of IP (Internet Protocol)

In non-IP mesh networks:

- Network header (and network addresses) must be adapted to IP

- Payload usually re-secured at IP Gateway and may require some adaptation for IP

- Proprietary translation, hampered end-to-end security
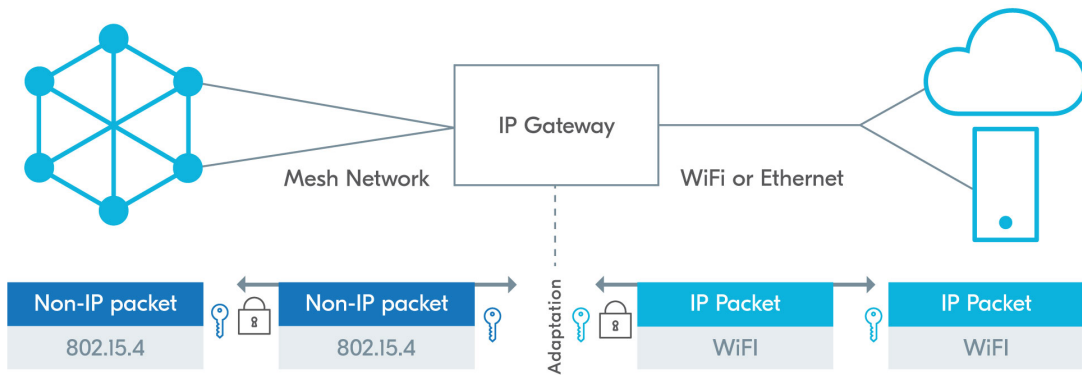
Importance of IP (Internet Protocol)

- The Internet runs on IP, a point of convergence for the IoT industry

- Thread devices seamlessly integrate with larger IP networks and don't need proprietary gateways or translators

- Developers use the same rich set of tools available for the Internet
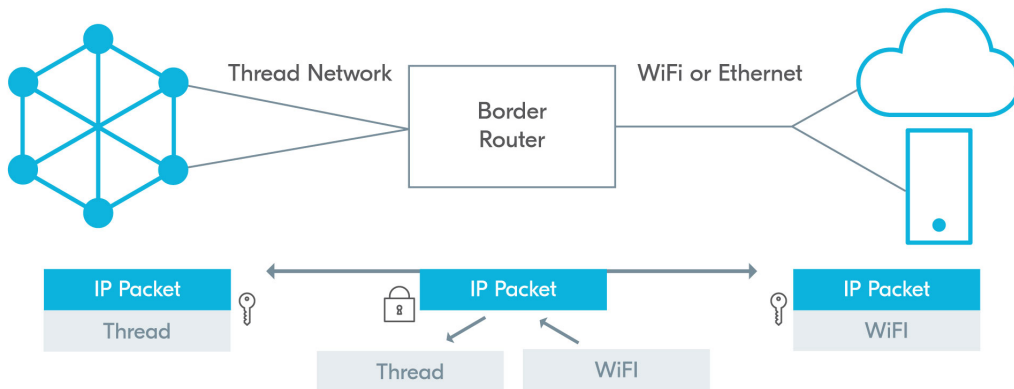
Thread device types and roles

Thread devices types

Full Thread Device (FTD)

- most versatile in the roles

- autonomous role - subscribes to the all-routers multicast address, and maintains IPv6 address mapping

- requires more HW resources e.g. memory size

- always has its radio on, so it is usually a mains-powered device

Minimal Thread Device (MTD)

- may perform certain roles

- affiliate - does not subscribe to the all-routers multicast address and forwards all messages to its Parent

- has the lowest requirements for HW resources

- may sleep to preserve energy, so it is often a battery-powered device
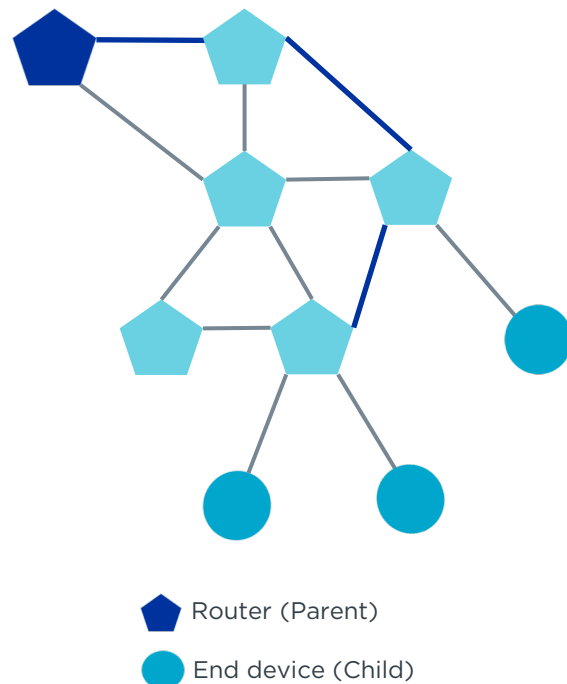
Thread devices roles

Router

- forwards packets for network devices

- provides services for devices joining the network

- keeps its transceiver enabled at all times

End Device

- communicates primarily with a single router

- does not forward packets for other network devices

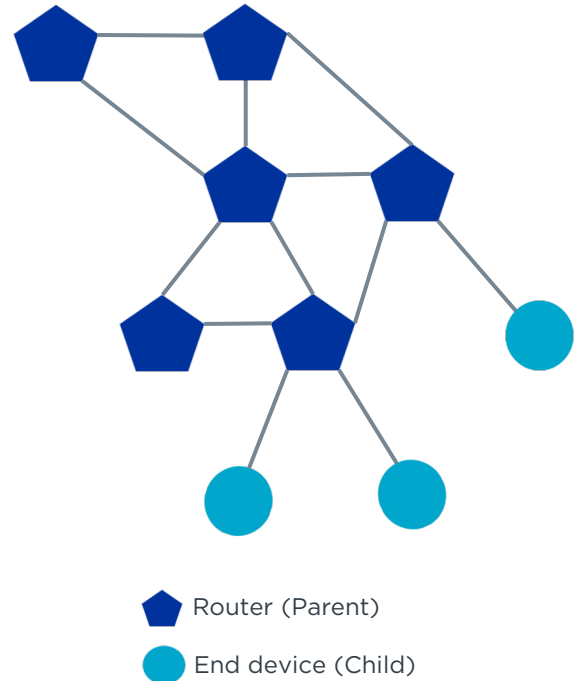- can disable its transceiver to reduce power

Router (Parent)

End device (Child)

# Thread devices types and roles - details
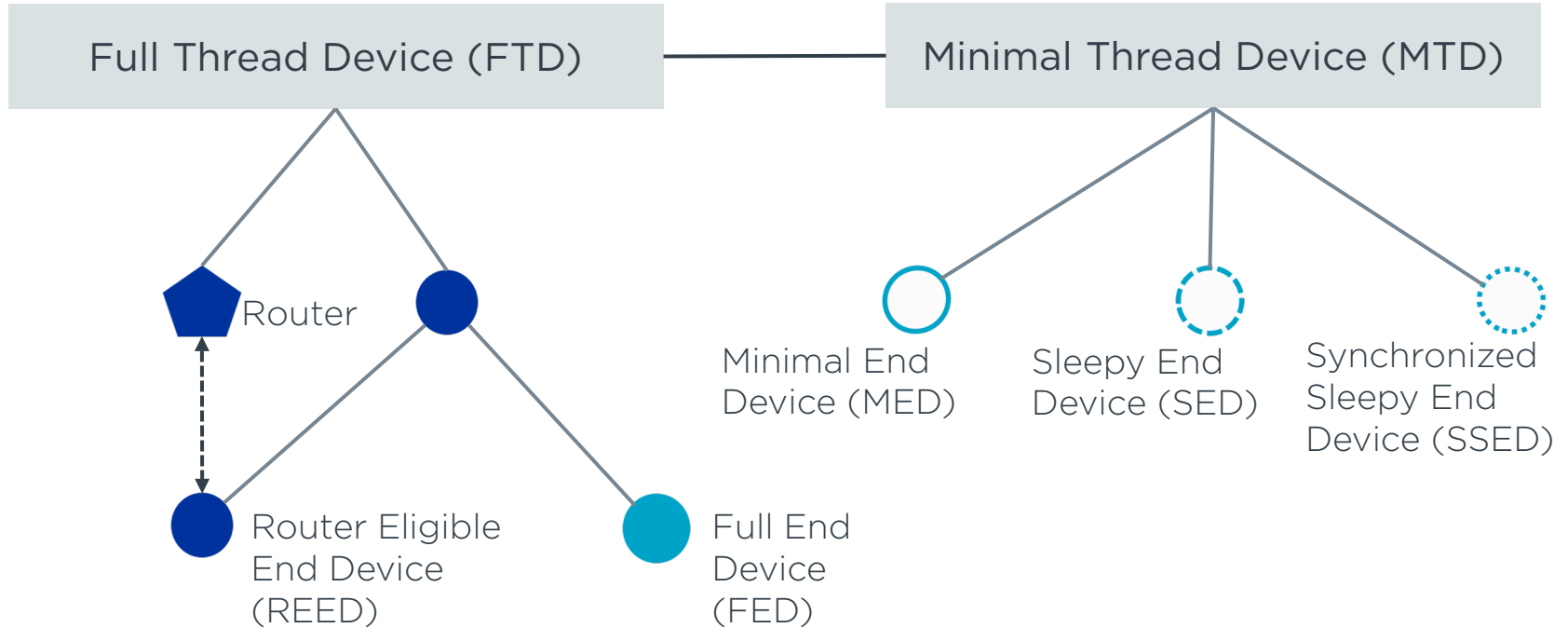
Thread's primary features

- Scalability
  - Thread 1.1 supports up to 32 routers per network and up to 511 end devices per router, what allows to scale up to hundreds of devices per network

Router (Parent)

End device (Child)

Thread's primary features

- Scalability
  - Thread 1.2 enables integration of multiple Thread networks and partitions in one Thread domain using a backbone link, what enables creating a coherent mesh consisting of several thousands of devices

Wired Network
(including other IoT Devices)

Wi-Fi
AP

Thread Network A
Partiion 1

Thread Network A
Partiion 2
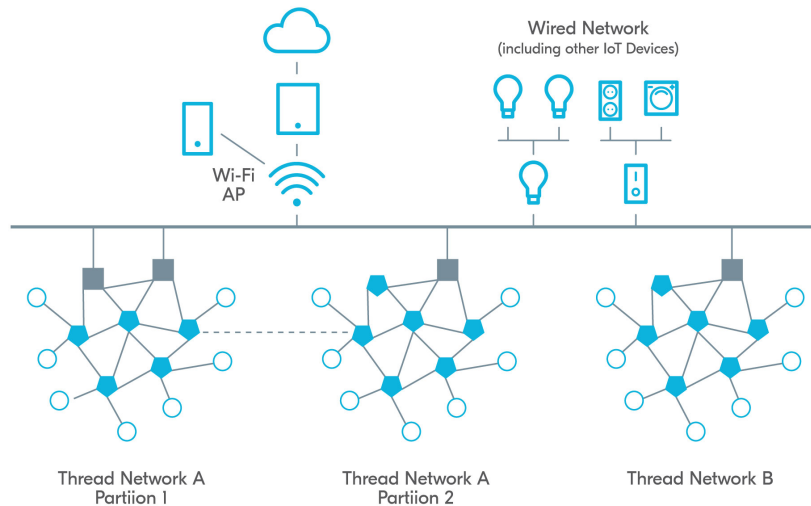
Thread Network B

Thread's primary features

- Security
  - Commissioning - all devices joining a Thread network have to be authenticated. User authorizes devices onto the network using smartphone or web
  - Data traffic protection – all Thread communications are encrypted and authenticated using 802.15.4 security mechanisms
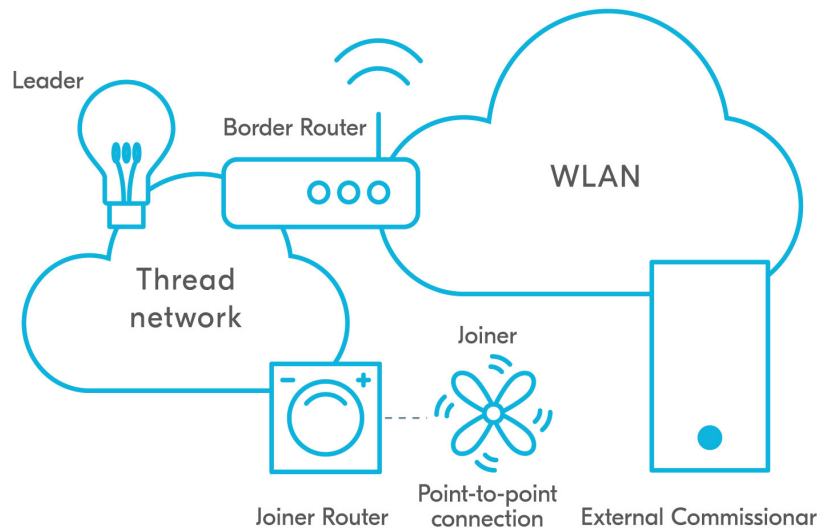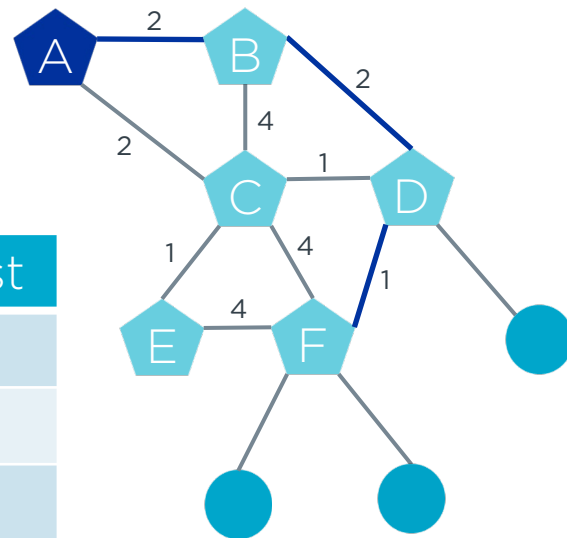
Thread's primary features

- Reliability
  - Self-healing mesh – by using dynamic routing Thread allows to route packets efficiently, and dynamically react to node failures or connectivity issues

| Dest	Next	Cost
B	B	2
C	C	2
D	C	3
E	C	3
F	B	5

Thread's primary features

- Reliability
  - No single point of failure:
    - **self-configuring leader** – Thread dynamically elects a leader. Thread requires that all routers are capable of performing as a leader. If the leader fails, another router assumes the role
    - **multiple border routers** - Thread supports multiple border routers operating simultaneously, providing multiple, redundant paths into and out of a network

○ End Device

⬟ Thread Leader

⬠ Thread Router

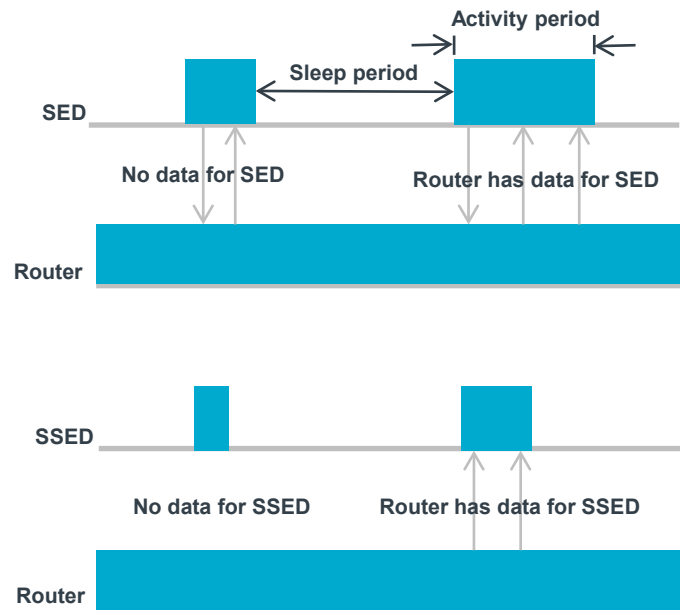■ Boarder Router

— Thread Link
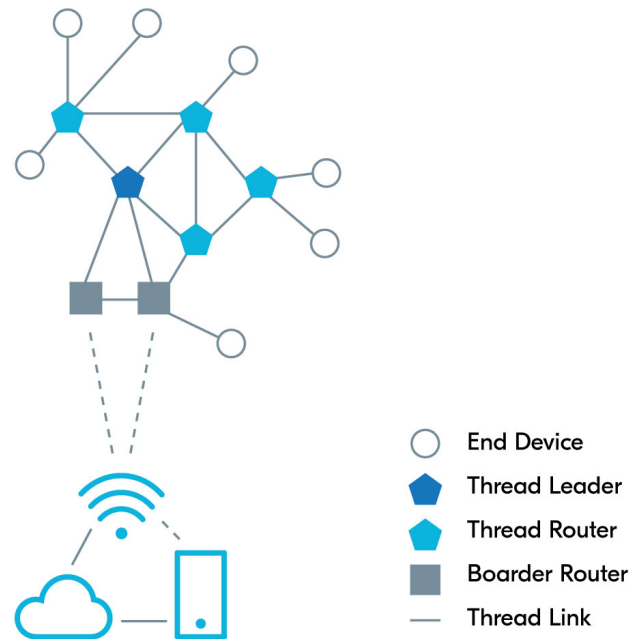
Thread's primary features

- Efficiency

  - Self-configuring routers – an REED node promote to a router to increase connectivity and range, downgrade to an end device to reduce redundant connectivity
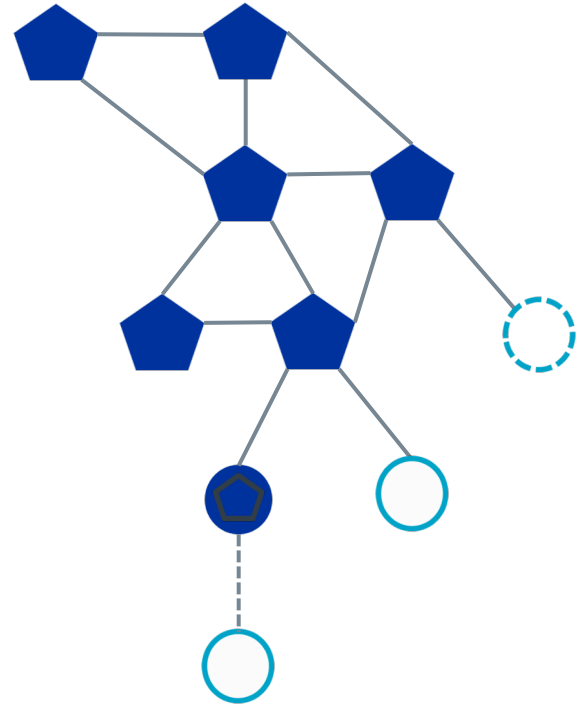
Thread's primary features

- ## Efficiency
  - Low-power – years of activity of battery-powered devices
    - **Sleepy end device (SED)** - has its radio turned off during idle periods and wakes periodically to communicate with its parent router
    - **Synchronized sleepy end device (SSED)** - introduced in Thread 1.2, It has its radio turned off during idle periods and wakes periodically to listen for messages from its parent at scheduled intervals

Activity period

Sleep period

SED

No data for SED   **Router has data for SED**

Router

SSED

No data for SSED   **Router has data for SSED**

Router

OpenThread Project

OpenThread project

- OpenThread released by Google is an open-source implementation of Thread networking protocol and other necessary components

- Key components:
    - Core stack – implementation of Thread specification
    - Border router – implementation of Thread Border Router
    - Commissioner – implementation of Thread Commissioner
    - Network Simulator – simulate large scale Thread networks

- Licensed under 3-clause BSD

- Open, community-based project, hosted on github: https://github.com/openthread/

OPENTHREAD
released by Google

OpenThread and Nordic

- Nordic joined OpenThread project from the beginning of its public existence in 2016

- Nordic provides full support for its SoCs within OpenThread and actively participates in the development of OpenThread by co-authoring some core modules

- To provide complete SW development experience Nordic incorporates OpenThread in its development environments: nRF Connect SDK and nRF5 SDK for Thread and Zigbee

- More information about OpenThread and Thread available at https://openthread.io

OPENTHREAD
released by Google

Application layers

An application layer

- Thread protocol is application layer agnostic and does not define an application layer

- Thread can simultaneously support multiple application protocols on the same network

- Application layer and cloud services can be changed over time

Application	
Transport	Thread networking stack
Network	
MAC	IEEE 802.15.4 PHY/MAC
PHY	
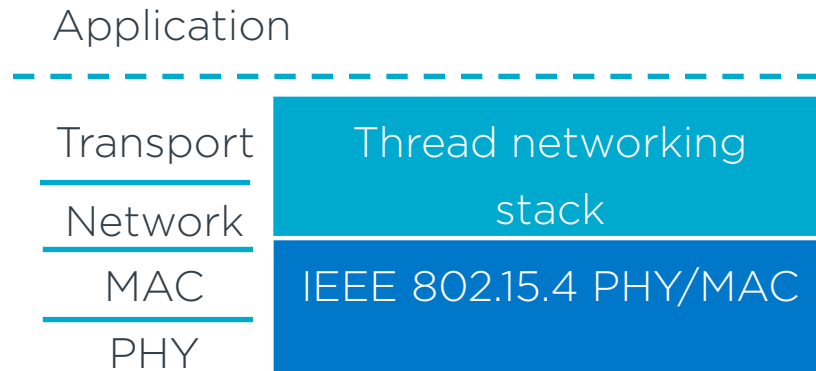
An application layer

- Many app-layer options are available and can be adapted to run over Thread

- The Thread Group partners works with other standards organizations and alliances:
  - Zigbee Alliance – Project CHIP
  - Google – Weave
  - DiiA – DALI
  - KNX – KNX IoT
  - Open Connectivity Foundation – OCF
  - OMA Lightweight M2M and others
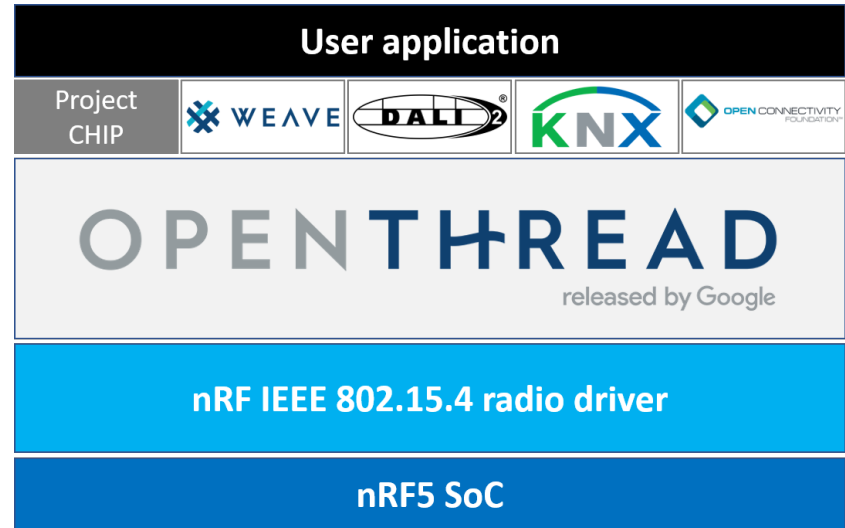
Project Connected Home over IP – the unifier

Project Connected Home over IP is a new Working Group within the Zigbee Alliance. This Working Group plans to develop and promote the adoption of a new, royalty-free connectivity standard to increase compatibility among smart home products, with security as a fundamental design tenet.
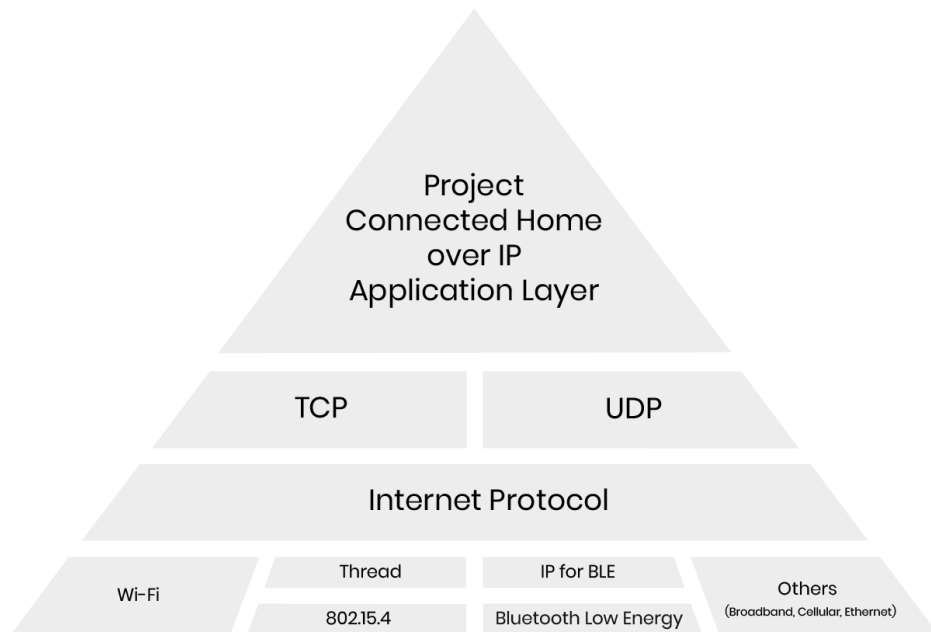
A few founding partners:

Project Connected Home over IP (Project CHIP)

- Enable communication across smart home devices, mobile apps, and cloud services

- The Project builds upon Internet Protocol (IP)

- Version 1.0 targets WiFi and Thread as main connectivity protocols. BLE will be used for device onboarding

- Reuse contributions from market-proven technologies from Amazon, Apple, Google, Zigbee Alliance, and others

- https://www.connectedhomeip.com/

Project Connected Home over IP Application Layer

| TCP | UDP |

Internet Protocol

| Wi-Fi | Thread | IP for BLE | Others |
| | 802.15.4 | Bluetooth Low Energy | (Broadband, Cellular, Ethernet) |

# Certification

Thread Certification – Why?

- Validation of conformance to the spec and interoperabillity

- Product license for intellectual property rights (IPR) to Thread technology

- Right to use Thread logos

- Co-marketing with Thread Group

  - Listed on Thread website

  - Thread Group PR and socialmedia

Logos

- **Components:** "Thread Certified Component" – software stacks, modules, etc. that can be used by companies to build an end user product.

- **Products:** "Built on Thread" – Used on packaging and collateral materials for customer-facing end user products.

- The Logos may only be used only on certified components and products.

The Path to Thread certification
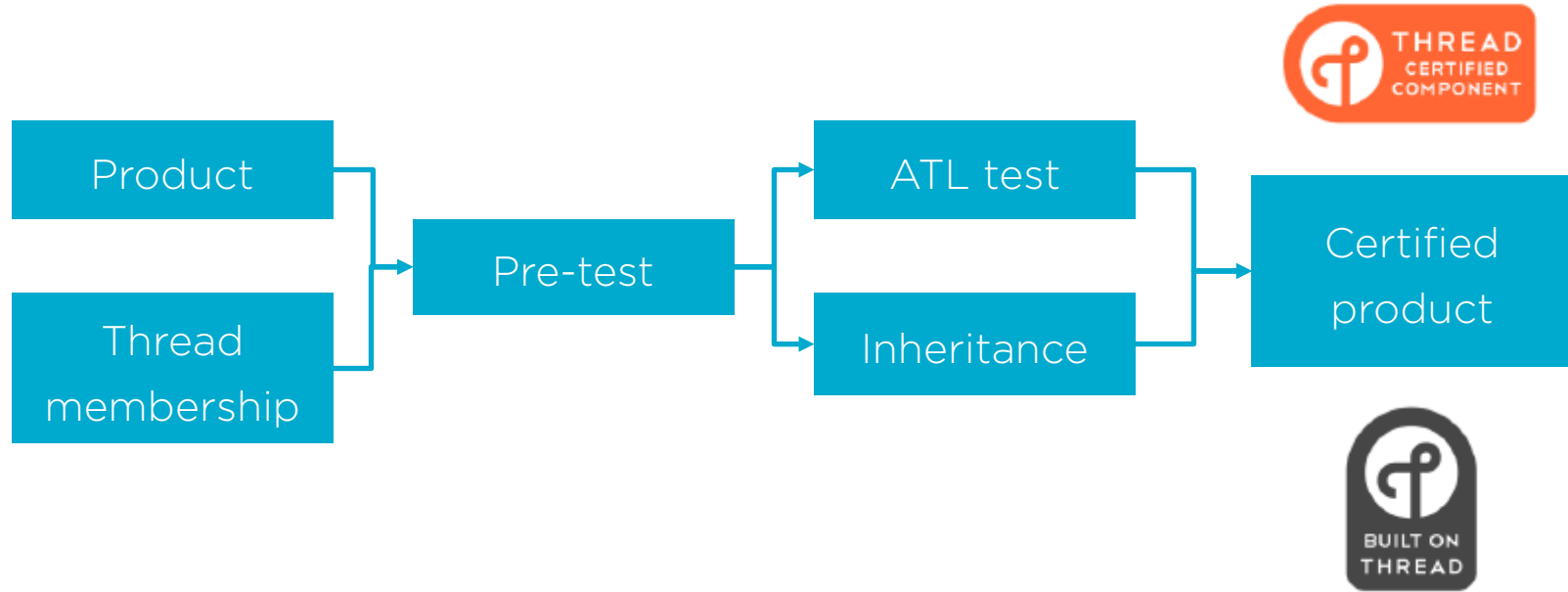
Nordic SDKs and Devices

With support for Thread

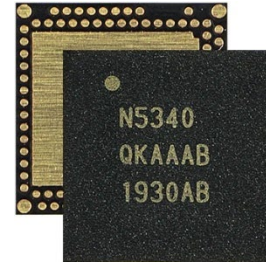# Nordics Thead offering – Hardware

nRF52 Series

192kB-1MB Flash

24-256 kB RAM

Cortex M4F

Multiprotocol

nRF53 Series

1280kB Flash / 576kB RAM

Dual core Cortex M33

Improved security

Multiprotocol

Nordics Thead offering – Software

nRF5 SDK for Thread & Zigbee

Comprehensive SDK

Market proven

Supports upto Thread 1.1.1

nRF Connect SDK

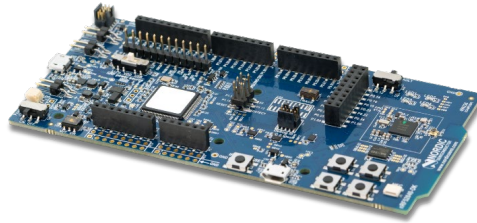New SDK from Nordic

Modern tools

Thread 1.2 and beyond

Nordics Thead offering – Tools

IDE	Development tools	Topology Monitor & Sniffer

Segger embedded Nordic edition

nRF Connect SDK

nRF52840 DK

nRF5340 DK

Debug the datatraffic

Visualize the Thread Network
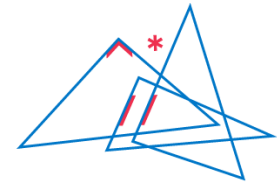
Questions?

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