

# ARTIK Connectivity

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## Agenda

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- ARTIK Connectivity in Artik 0 modules
  - Artik 053 Wi-Fi specifics
  - Artik 020/030, ZB, Thread and BLE Overview
- Connectivity in ARTIK 530 and 710
  - A710 Wi-Fi and BT
  - A530 Wi-Fi and BT



## ARTIK Module Portfolio

ARTIK 0



Flexible  
Economical  
Tiny

Optimized for single-  
function things like door  
locks, lights and sensors

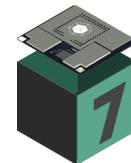
ARTIK 5



Balanced Power  
Balanced Performance

Ideal balance of computing and  
storage for gateways or smart  
devices with modest video and  
processing requirements

ARTIK 7



Powerful  
Secure  
Communicative

Great performance for high-end  
gateways with local processing  
and analytics to improve  
latency and responsiveness



Bluetooth®



CONNECTS WITH THREAD

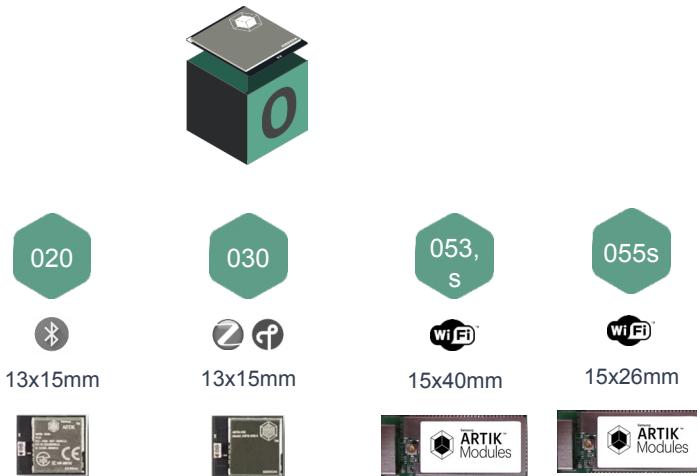


ZigBee®



## ARTIK Module Portfolio – details

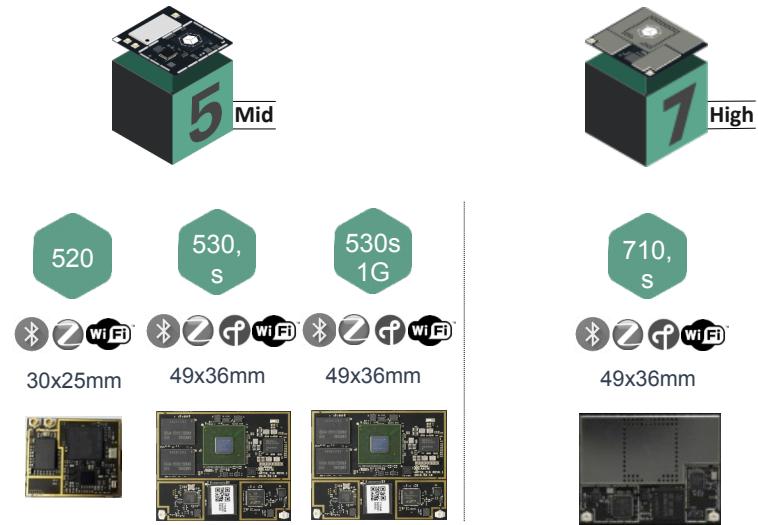
Edge Nodes, Sensors and Actuators



- Cortex-M, Cortex-R CPUs
- Single, Dual protocol radios
- Internal RAM/Flash

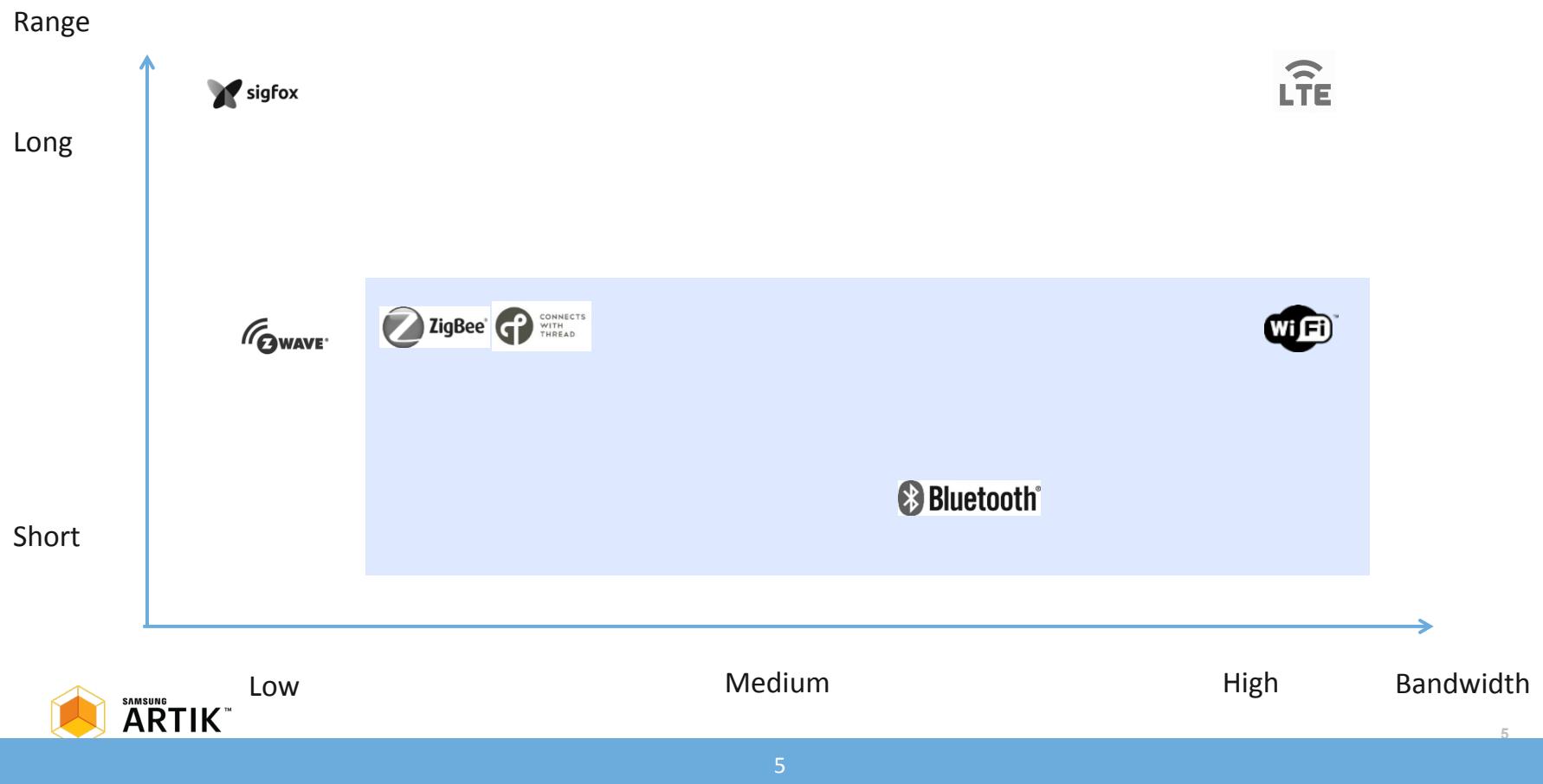


Hubs, Gateways



- Single, Dual, Quad, Octa core Cortex-A CPUs
- Multiple protocol radios
- Linux based platforms

## ARTIK Module – Radio Protocol Comparison



## ARTIK 05x Module Features

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Feature	053	055
Cores	1	1
Processors	ARM Cortex R4 @ 320 MHz and Cortex R4 @ 480MHz for Wi-Fi stack	ARM Cortex R4 @ 320 MHz and Cortex R4 @ 480MHz for Wi-Fi stack
RAM	1280 KB	1280 KB
Flash	SPI flash 8 MB	SPI flash 8 MB

Features	053	053s	055s
Dimensions	15mm x 40mm x 3mm	15mm x 40mm x 3mm	15mm x 26mm x 3mm
Power supply	5-12v DC	5-12v DC	3.3 v
Security	-	Secure boot, jtag protection	Secure boot, jtag protection
Antenna	Metal PIFA	Metal PIFA	Chip



## 05x Overview – Wi-Fi Performance

- Supports 802.11b/g/n (2.4GHz single band), 20 MHz channels SISO
- Wi-Fi RF has internal PA, LNA and TRx switch
- Up to MCS7, 50 Mbps UDP throughput
- No support for 5 GHz, MIMO and concurrency .

053 Wi-Fi Specification

Item	
Protocol	802.11b/g/n
Channel Bandwidth	20MHz, SISO
Operating Modes	Station or Soft-AP
Security	Open, WEP, WPA, WPA2
Wi-Fi Alliance	802.11 b/g/n

Power Consumption

	Protocol	Current (mA)	Power (W)
11n TX	053@5V	254	1.27
	055 @3.3 V	320	1.06
11n RX	053@5V	191	0.95
	055 @3.3 V	240	0.79



## ARTIK 053 – Protocols Stack

- ARTIK 05x TizenRT RTOS uses lwIP TCP/IP stack.

Network		
		Description
IPv4		IPv4 Unicast
		IPv4 Multicast
		IPv4 Broadcast
		IPv4 ARP/RARP
		IPv4 ICMP
	TCP, UDP	TCP
		UDP
		TCP flow control
BSD socket		Socket interface
xmDNS		mDNS query
		mDNS cache
DNS client		DNS client
NTP		NTP client
DHCP server/ client		DHCP client
		DHCP server

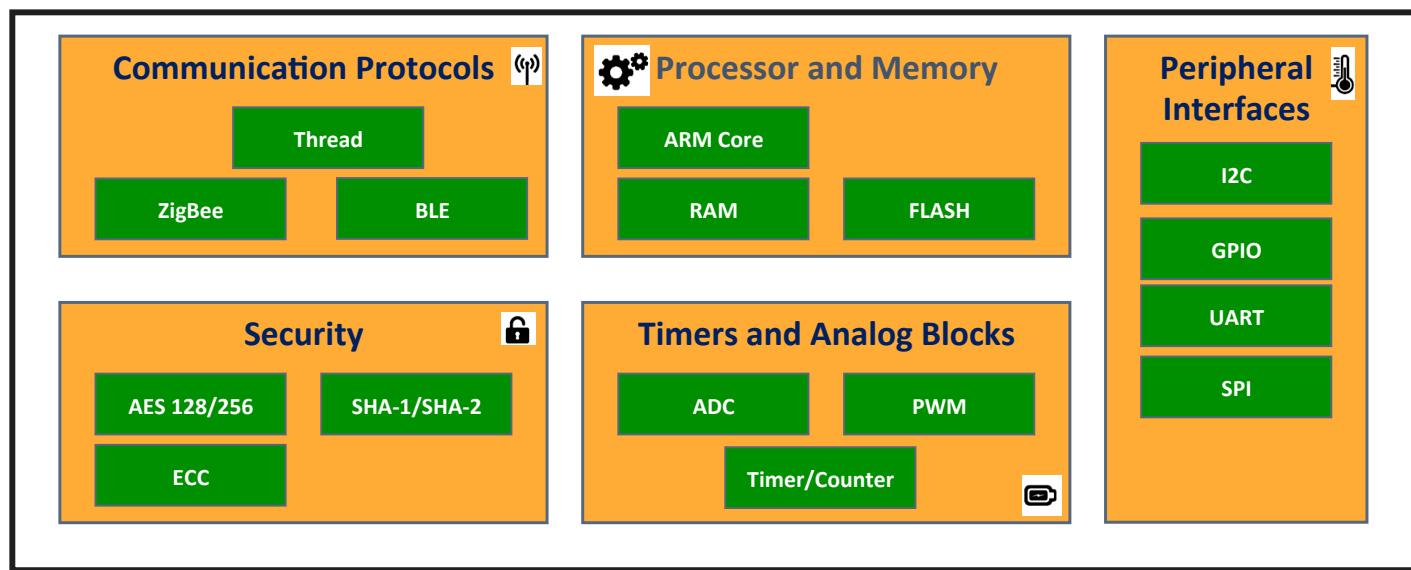
Network		
		Description
HTTP server/client		RESTful API Client
		RESTful API Server
		Webpage Server
		Support Chunked
		Support Content-Length
		HTTP server) multiple threads
MQTT		HTTP servers) mutiple instances
		MQTT Client
	IoTivity	IoTivity Server
		IoTivity Client
Wi-Fi		Service Discovery
		Authentication : WPA,WPA2,WEP
		Datagram Protection : AES , TKIP
		802.11 b/g/n (2.4Ghz) Station
		802.11 Soft-AP



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## ARTIK 030/020 Hardware

## ARTIK 030/020 Hardware- Module Block Diagram



## ARTIK 020/030 Processor and Memory

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ARTIK 030		
ARM Processor	Number of Cores	1
	Details	ARM Cortex M4 @ 40 MHz
Memory	RAM	32 KB
	Flash	256 KB



## ARTIK 030/020 Security

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- The Crypto Accelerator is a fast and energy-efficient autonomous hardware encryption and decryption accelerator.
- It supports for AES 128/256, SHA-1, SHA-2 and ECC making Thread commissioning much faster than with other modules.

ARTIK 030/020	
AES 128/256	✓
SHA-1/SHA-2	✓
ECC	✓



## ARTIK 030/020 Module Peripherals

ARTIK 030		
Peripheral Interfaces	I2C	2
	SPI	2
	GPIO	25
	UART	2
Timers And Analog	ADC	*□▼□✓∞ *※*■■■*●▲
	PWM	✓
	Timer/Counter	✓



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## Mesh Networking Comparison

Network Technology	Wireless Mesh (ZigBee, Thread)	BLE	Wi-Fi
IEEE Standard	IEEE 802.15.4	IEEE 802.15.1 <i>(no longer maintained)</i>	IEEE 802.11
Speed and Power profile	Low-Power, Low-Data Rate	Low-Power, Mid-Data Rate	High-Power, High-Data Rate
Network topology	Mesh	P2P and Mesh	Star, Mesh*
Good for	Low power devices, needs a hub	Low power, phone connectivity	Mains powered, high data transfer, no hub required



## ARTIK 030/020 Protocol Stacks

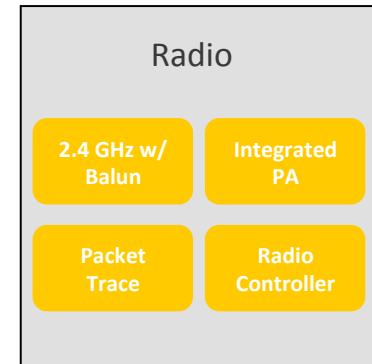
### Protocol Stacks

- ZigBee
- Thread
- BLE



### Radio Features

- Integrated high performance chip antenna
- Configurable TX Power up to +10 dBm
- RX Sensitivity (-101 dBm)
- 8.7 mA RX current
- 8.2 mA TX current @ 0 dBm output power



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## ARTIK 030/020 Characteristics

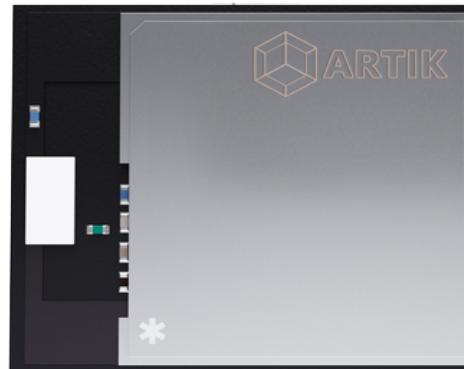
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### Environmental/Regulatory

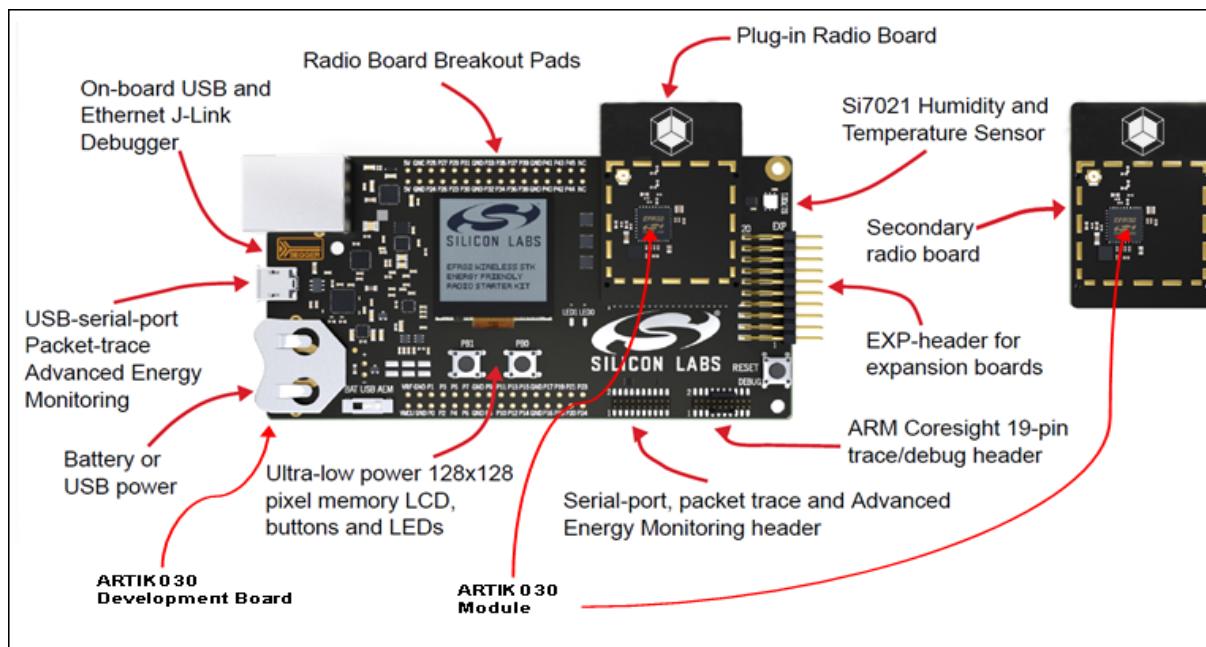
- Temperature range: -40C to +85C
- FCC, IC, CE, Korea and Japan

### Dimensions

- W x L x H: 12.9 mm x 15.0 mm x 2.2 mm

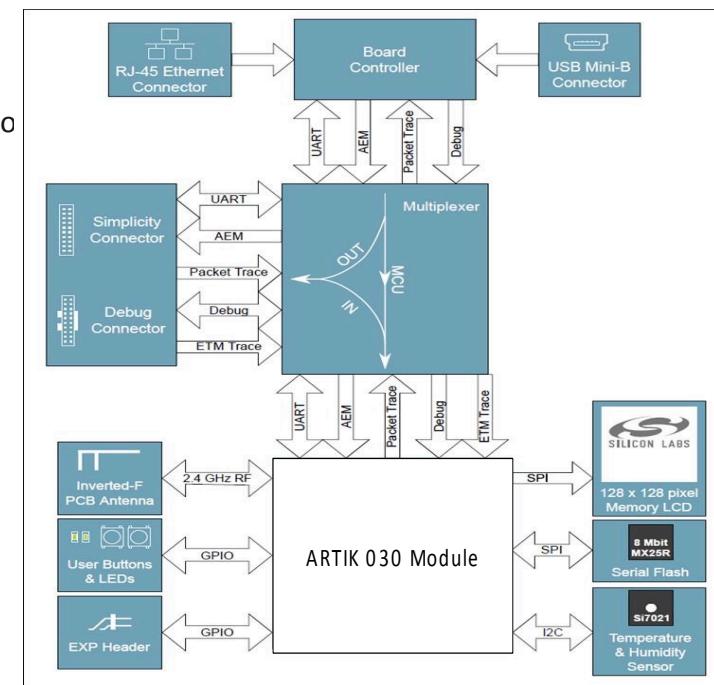


## ARTIK 030/020 Development Board



## ARTIK 030/020 Development Board

- The core is the Wireless Starter Kit Mainboard which features:
  - On-board Segger J-Link debugger
  - Advanced Energy Monitor for real-time current and voltage monitor
  - Virtual COM port interface
  - Access to the Packet Trace Interface (PTI).
  - Ultra low power 128x128 pixel Memory LCD
  - Temperature and humidity sensors
  - Power sources includes USB, CR2032 and AA batteries.
  - 20-pin 2.54 mm header for expansion boards
  - Breakout pads for direct access to all radio I/O pins



## ARTIK 030/020 Summary

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- ARTIK 030 mesh networking module provides a complete, pre-certified plug-and-play solution.
- It solves one of the major customer roadblocks for fast time-to-market as it integrates
  - Pre-certified with integrated antenna
  - Stacks and RF certifications.
  - Industry-leading ZigBee/Thread stacks and tools.
  - Saving months of engineering effort and testing.
  - ARTIK 030 can be used in a wide variety of applications:
    - Connected Home/ Lighting
    - Building/Industrial Automation



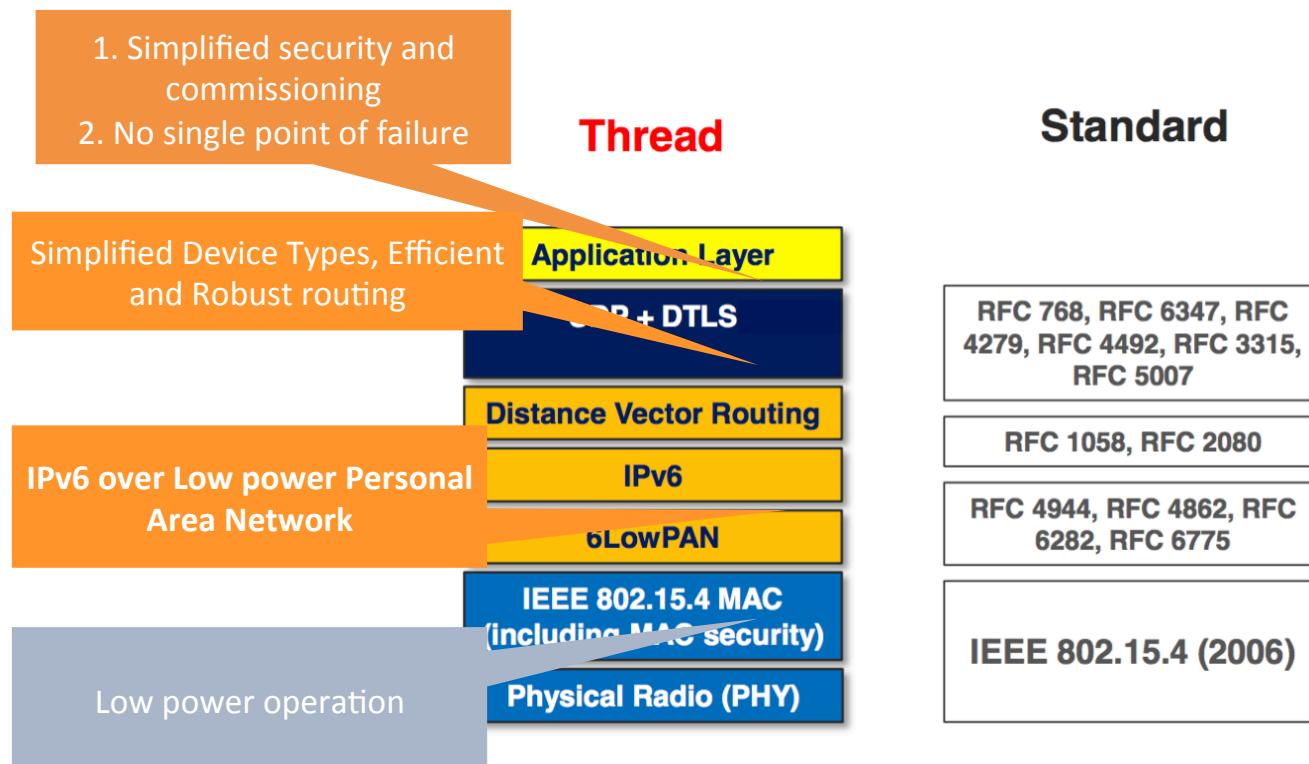
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## Thread fundamentals

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## Thread fundamentals

## Thread layers



## PHY and MAC Layers

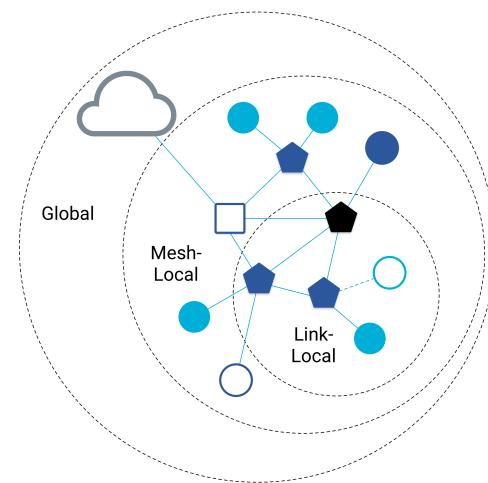
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- The MAC and PHY layers are defined by the IEEE 802.15.4 standard
- This standard was developed by the IEEE 802 standards committee and was initially released in 2003 and another amendment in 2006 (the one used by Thread)
- The MAC is responsible for:
  - Implementing CSMA-CA to share the channel
  - MAC ACK
  - Short (16-bit) Addressing
  - MAC layer security

## IPV6

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- There are three scopes in a Thread network for unicast addressing:
  - Link-Local — all interfaces reachable by a single radio transmission
  - Mesh-Local — all interfaces reachable within the same Thread network
  - Global — all interfaces reachable from outside a Thread network
- The first two scopes correspond to prefixes designated by a Thread network.
- Link-Local have prefixes of fe80::/16, while Mesh-Local have prefixes offd00::/8.



## Application Layer

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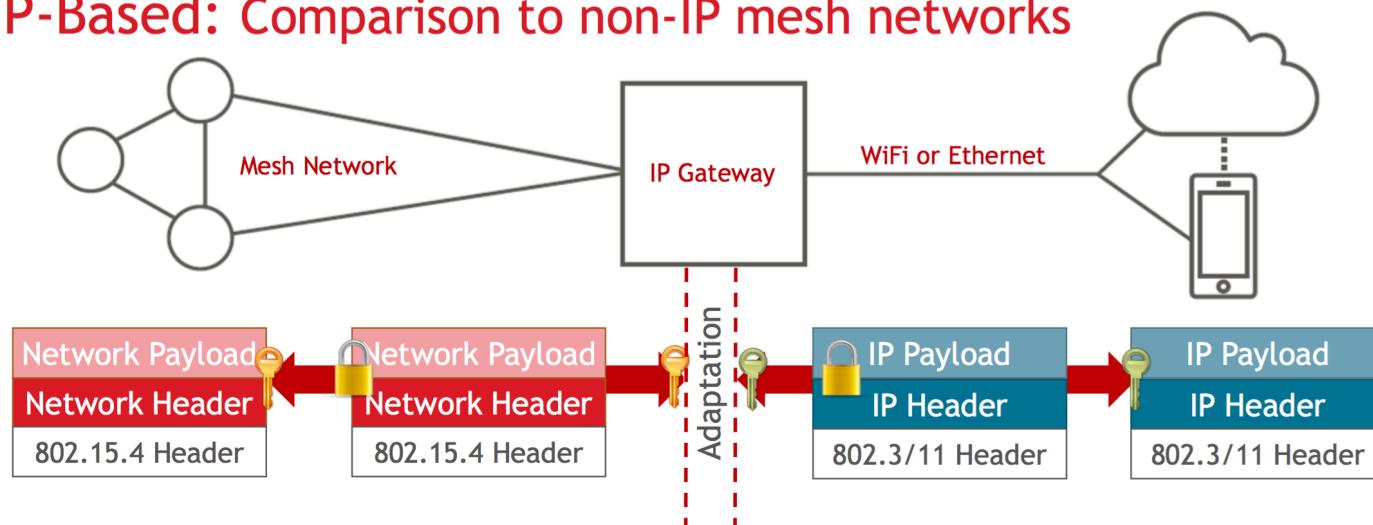
Thread just defines how data is sent in network but not how to interpret it at the application layer

However, presence of IP stack enables multiple options to interpret it, currently Thread Group is collaborating with other standards groups to like:

- ZigBee Cluster Library (Dot Dot)
- OCF (Iotivity)
- Nest Weave
- LWM2M

## Network Layer– IP to non-IP mesh network Bridging

### IP-Based: Comparison to non-IP mesh networks



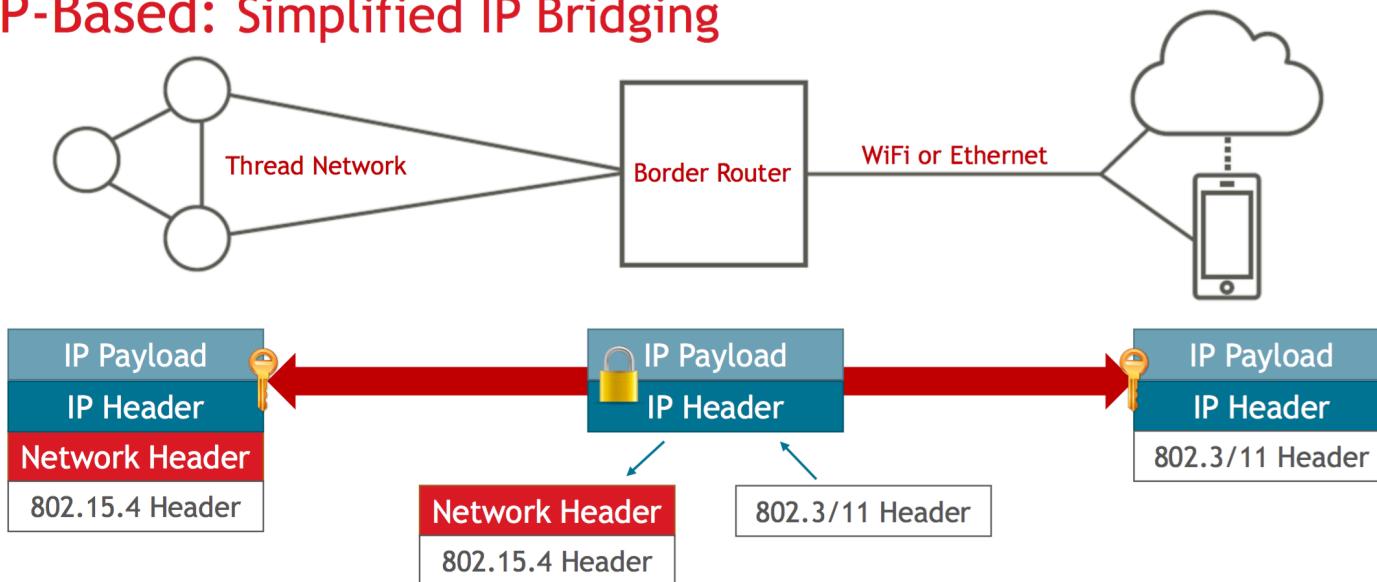
- Network header and network address must be adapted to IP
- Payload re-secured at IP Gateway and may require some adaptation for IP

Courtesy: [www.threadgroup.org](http://www.threadgroup.org)

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## Network Layer– Simplified IP bridging

### IP-Based: Simplified IP Bridging



- Simplified bridging between mesh network and internet – Reduced processing burden on Router
- Enables end-to-end IP security

Courtesy: [www.threadgroup.org](http://www.threadgroup.org)

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## Comparison to Alternatives

	WiFi	ZigBee PRO	ZigBee IP - SE 2.0	Z-Wave	Silicon Labs Thread*
Low Power Consumption	✗	↑	✗	↑	↑
Mesh network support	✗	↑	↑	✗ limited	↑
No single point of failure	✗	✗	✗	✗	↑
Support for IPv6	↑	✗	↑	✗	↑
Interoperability	↑	↑	Not Clear	Some Products	↑
Open Standards	↑	↑	↑	✗	↑
Simple gateway software	NA	✗	↑	✗	↑
Summary	Great standard for hub and spoke high bandwidth uses. Not suitable for battery operated device	Widespread use but not internet connectivity friendly. Some profile separations	Limited scalability, inefficient routing. Design for utilities and not in wide use	Single vendor standard with one source of silicon and limited roadmap. Not internet connectivity friendly.	A new technology that dispenses with legacy drawbacks. Built on Internet technologies.

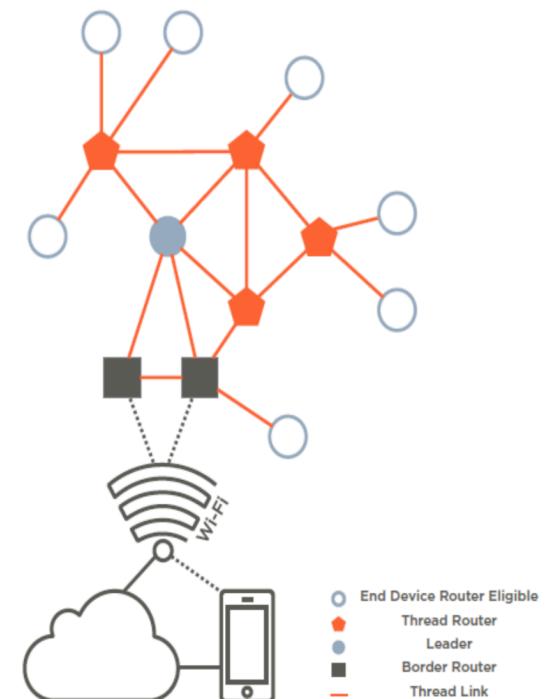


Courtesy: Silicon Labs

## Node Roles

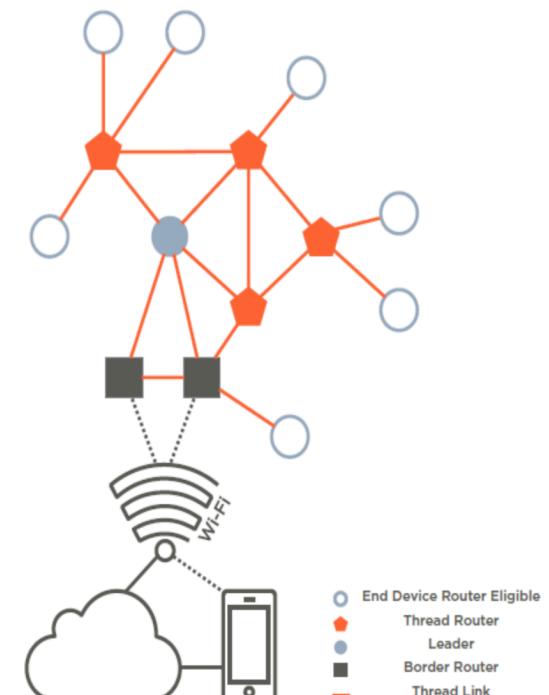
In a Thread network, nodes are split into two forwarding roles:

- A Router is a node that:
  - forwards packets for network devices
  - provides secure commissioning services for devices trying to join the network
  - keeps its transceiver enabled at all times
- An End Device (ED) is a node that:
  - communicates primarily with a single Router
  - does not forward packets for other network devices
  - can disable its transceiver to reduce power



## Node Roles

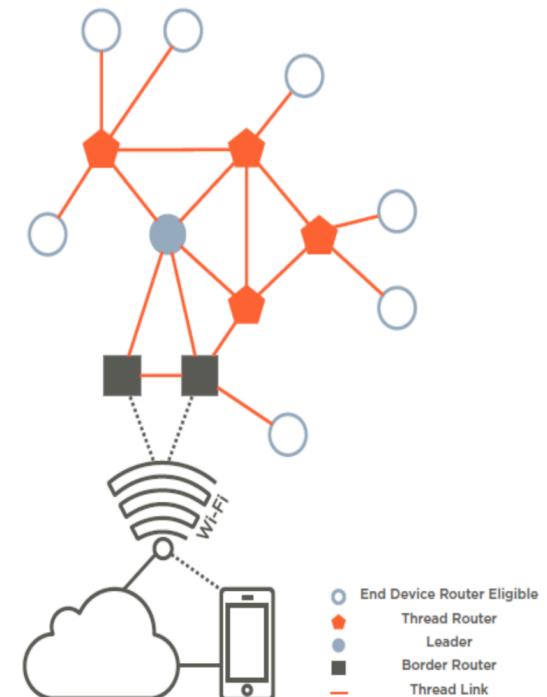
- The Thread Leader is a Router that is responsible for managing the set of Routers in a Thread network.
  - It is dynamically self-elected for fault tolerance, and aggregates and distributes network-wide configuration information.
- A Border Router is a device that can forward information between a Thread network and a non-Thread network (for example, Wi-Fi or ethernet).
  - It also configures a Thread network for external connectivity.



## Device Types

A Full Thread Device (FTD) always has its radio on, subscribes to the all-routers IPv6 address mappings. There are three types of FTDs:

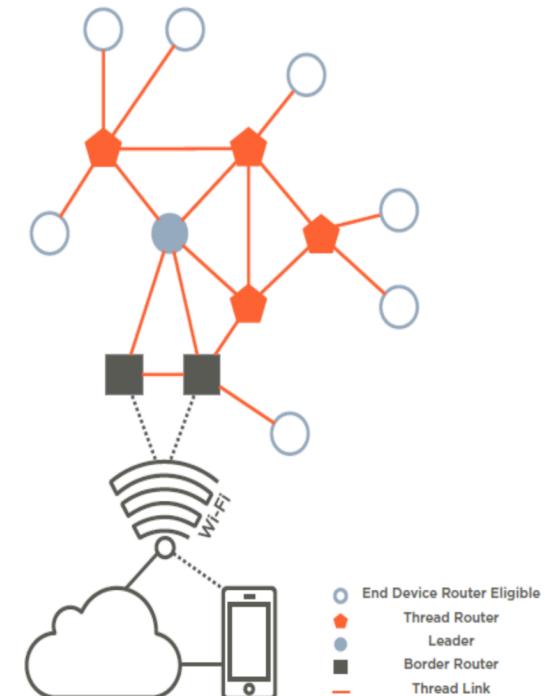
- Router
- Router Eligible End Device (REED) — can be promoted to a Router
- Full End Device (FED) — cannot be promoted to a Router
- An FTD can operate as a Router (Parent) or an End Device (Child).



## Device Types

A Minimal Thread Device does not subscribe to multicast traffic and forwards a two types of MTDs:

- Minimal End Device (MED) — transceiver always on, does not need to poll for messages from its parent
- Sleepy End Device (SED) — normally disabled, wakes on occasion to poll for messages from its parent
- An MTD can only operate as an End Device (Child).



## Summary

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Thread is:

- Reliable.
- Secure (DTLS - ECC-JPAKE)
- Scalable (Up to 250 nodes)
- Battery Friendly Operation.
- IP-based Mesh Networking.
- With a certification process to ensure interoperability.
- Runs on existing 802.15.4 radios.



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## ZigBee Concepts: Node Types

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ZigBee Types	Notes
ZigBee Coordinator (ZC)	Special router that forms the network; exactly 1 per network
ZigBee Router (ZR)	Relays packets for other nodes, “parent” to end Nodes
ZigBee End Device (ZED)	Cannot route packets, may be sleepy, must connect as a “child” to a ZR or ZC

## ZigBee Concepts: PANs

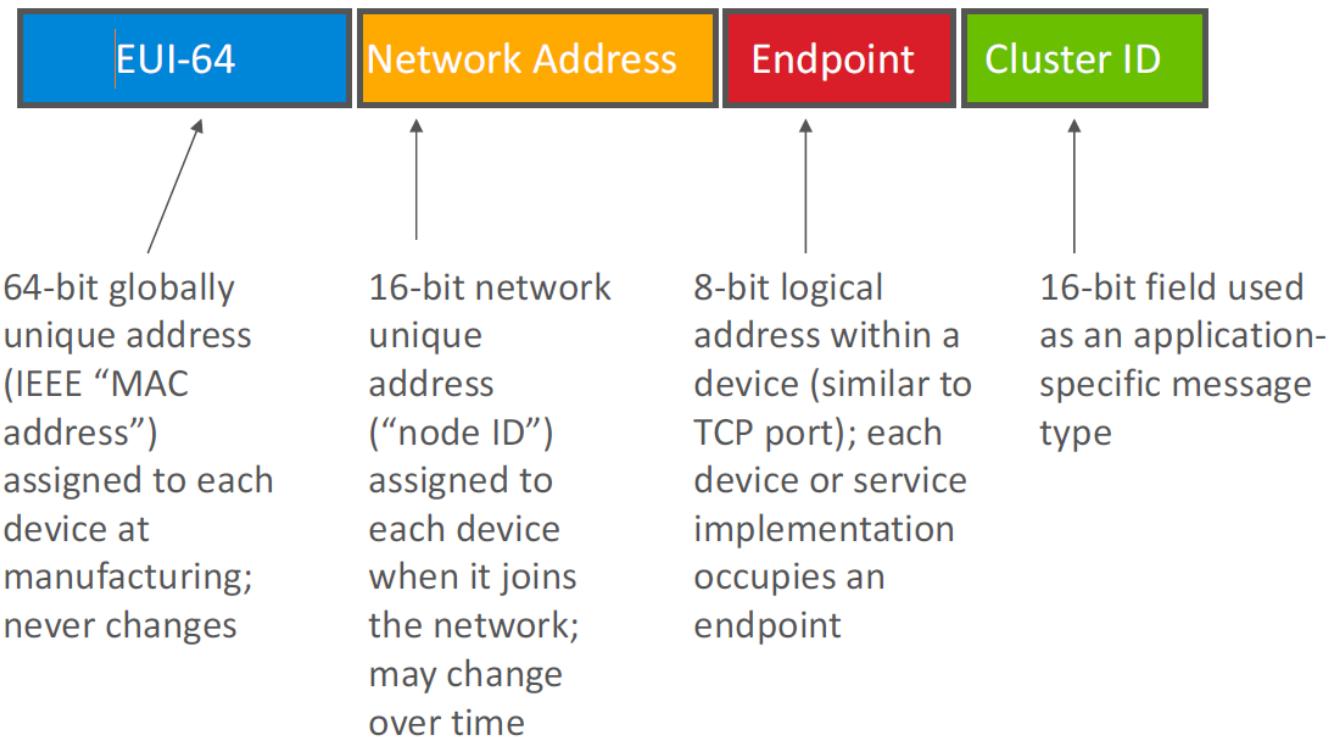
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- PAN ID
  - 16-bit identifier shared by all nodes in PAN (Personal Area Network)
  - Used in MAC header to filter out traffic not pertaining to own network
  - ZC picks value upon forming network
  - Should be random to ensure uniqueness
- Extended PAN ID
  - 64-bit extended PAN ID (EPID) known to all nodes in PAN
  - Chosen by ZC at time of network formation
  - Only sent over-the-air in response to Active Scan
  - Intended to enhance selection of eligible networks during scan/join
  - Enables recognition of network after PAN ID change (due to previous conflict)



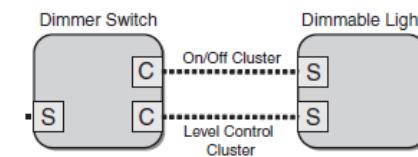
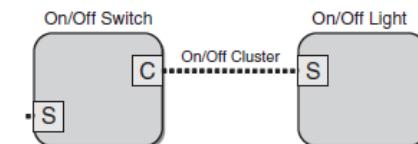
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## ZigBee Concepts: Addresses



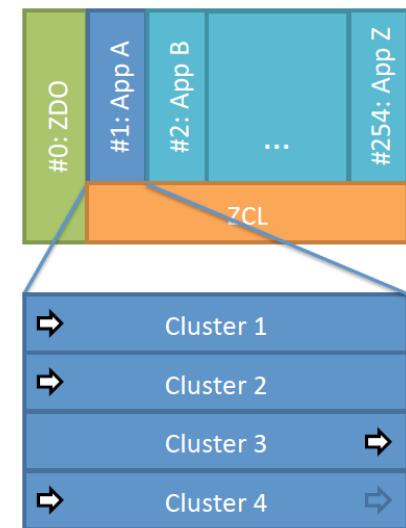
## ZigBee Concepts: Profiles and Clusters

- ZigBee profiles specify applications domains.
- Each profile defines device descriptions for each required device.
  - Home Automation (HA)
  - Commercial Building Automation (CBA)
  - ZigBee Light Link (ZLL)
- The ZigBee Cluster Library (ZCL) is a set of clusters and cross-cluster commands used in the public profiles
  - A “cluster” defines a set of commands and attributes
  - Defines clusters for use in the device types
  - “client” and “server” model of communication



## ZigBee Concepts: Endpoints

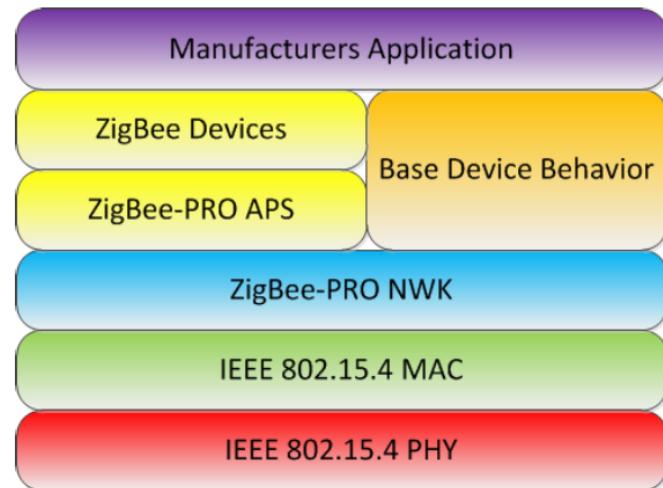
- An endpoint is a service point within a ZigBee node
  - Endpoint 0: ZigBee Device Object [ZDO]; used for network configuration
  - Endpoint 255: Broadcast endpoint
- Each endpoint implements a single device type from a single application profile, for ex, on/off light from HA profile
- Different endpoints on a single node may represent devices from different application profiles
- Each Endpoint has a descriptor and a cluster list



## ZigBee 3.0

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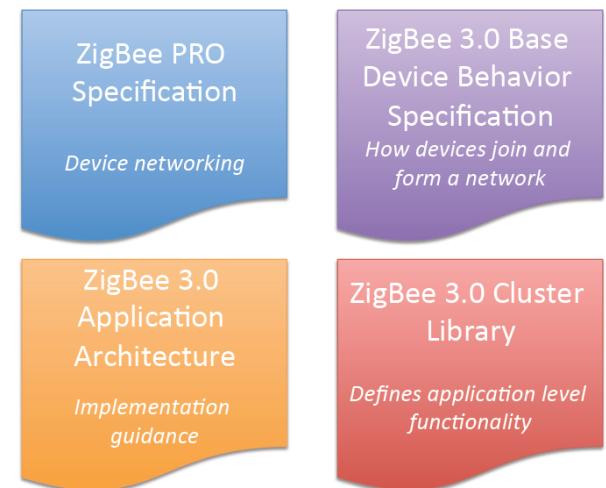
- Announced December 2014 and ratified March 2016
- Primarily it is a Unification of the ZigBee Application Profiles, ZigBee is now just “ZigBee”, no more HA or ZLL
- All previous application profiles are combined. Except Smart Energy and RF4CE
- One “ZigBee Certified” logo for products that meet certification
- No major changes to the networking protocol, is the same as the network protocol under ZigBee PRO



## ZigBee 3.0

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- Inclusion of ZigBee Green Power
- ZigBee Base Device Specification
  - New functionality for device joining, finding and binding, touch-link
- ZigBee Cluster Library R06
  - Latest updates to cluster library
- New Test Plan, Standard Test Harness from ZigBee Alliance
- Update to ZigBee Core Stack
  - R21 includes all ZigBee 3.0 functionality



## ZigBee 3.0 Base Device Behavior

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- Provides a consistent behavior for all nodes connecting to a ZigBee network.
- Common Commissioning modes
  - Network Formation
  - Find and Bind
  - Touch-linking (optional)
- Provides common enhanced security for the network
  - Centralized-security networks
  - Distributed-security networks

## ZigBee 3.0: Benefits

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- Simplicity and Flexibility
  - No more application profiles, one logo, one ZigBee
  - Allow networks without a Trust Center
- Improved User Experience
- Interoperability
  - Devices with the “ZigBee Certified” logo will interoperate
- Robust Networking
  - Shared mesh networking infrastructure
- Compatibility
  - Backward compatibility with legacy devices



## ARTIK 710 Wi-Fi

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- The ARTIK 710/710s modules have a fully integrated WLAN chip covering IEEE 802.11 a/b/g/n/ac
- The most important hardware features of the module are
  - 802.11 a/b/g/n/ac dual-band 2.4GHz/5GHz
  - Support for 20MHz, 40MHz, and 80MHz bandwidth ( up to 433.3Mbps PHY rate)
  - Single-stream spatial multiplexing (SISO)
  - Enhanced 802.11/Bluetooth coexistence control to improve transmission quality
  - Use SDIO interface for better performance
  - Supports WEP, WPA, WPA2 Wi-Fi security



## ARTIK 710 Bluetooth

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- The ARTIK 710/710s Module has a fully integrated 4.0 chip (BLE+Classic).
- The most important hardware features of the module are:
  - Bluetooth 4.0 (BLE+Classic)
  - Enhanced 802.11/Bluetooth Coexistence control to improve transmission quality in different profiles
  - 4-wire HS UART interface
  - ARTIK 710 Ubuntu OS uses BlueZ stack version 5.42

## ARTIK 530 Wi-Fi

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- The ARTIK 530/530s modules have a fully integrated WLAN chip covering IEEE 802.11 a/b/g/n
- The most important hardware features of the module are
  - 802.11 a/b/g/n dual-band 2.4GHz/5GHz
  - Support for 20MHz, 40MHz bandwidth ( up to 150 Mbps PHY rate)
  - Single-stream spatial multiplexing (SISO)
  - Enhanced 802.11/Bluetooth coexistence control to improve transmission quality
  - Uses SDIO interface
  - Supports WEP, WPA, WPA2 Wi-Fi security



## ARTIK 530 Bluetooth

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- The ARTIK 530/530s Module has a fully integrated Bluetooth chip.
- The most important hardware features are:
  - Bluetooth 4.2 (BLE+Classic)
  - Bluetooth Class 1 and 2
  - Enhanced 802.11/Bluetooth Coexistence control to improve transmission quality
  - Uses SDIO interface.
  - ARTIK Ubuntu OS uses BlueZ stack version 5.42



## Useful connectivity Documentation and App Notes

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- ARTIK 05X
  - <https://developer.artik.io/documentation/artik-05x/getting-started/>
  - [AN115 - Wi-Fi Provisioning With SoftAP With an ARTIK 053 Application Note](#)
  - [AN114 - Wi-Fi and ARTIK Cloud Onboarding With an ARTIK 053 Application Note](#)
- ZigBee
  - [AN120 - Controlling A ZigBee Light from A ZigBee Switch Via A ZigBee Gateway Application Note](#)
  - <https://developer.artik.io/documentation/developer-guide/wireless-iot/zigbee/>
- Thread
  - [AN102 - Thread Border Router Application Note](#)
  - <https://developer.artik.io/documentation/developer-guide/wireless-iot/thread.html>

