Advantages of Bluetooth® Mesh in Smart Building Applications

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Agenda

Presentation

Introduction: The IoT – Bluetooth evolution
Bluetooth Mesh

- Application
- Stack Architecture
- Topology
- Security
- Messaging
- ST BlueNRG-Mesh
- Mesh resources

Speaker

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RF Product Marketing Manager

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The IoT Revolution…

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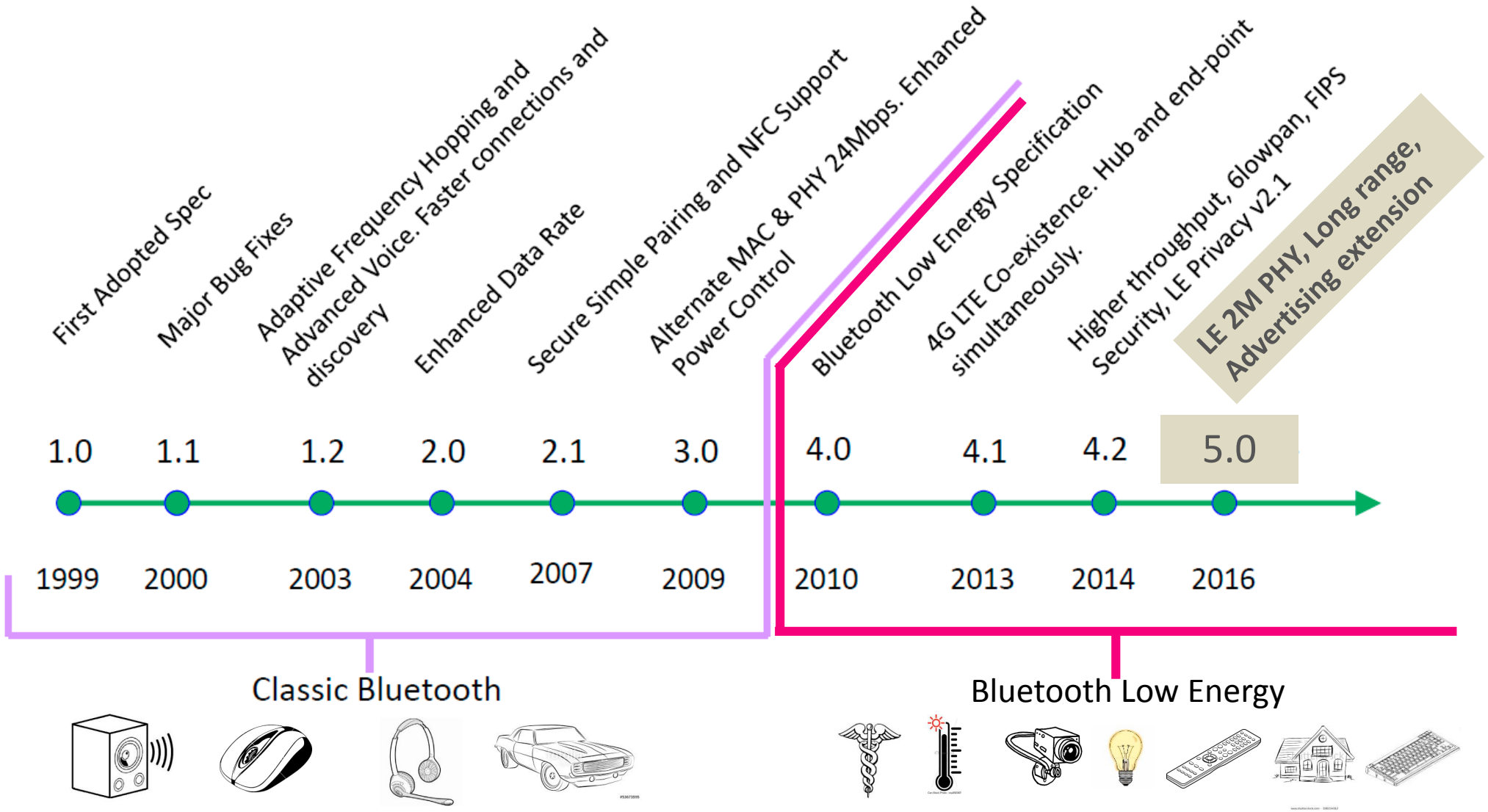
… Powered by Bluetooth®



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Bluetooth Networking Evolution

PAIRING
one-to-one

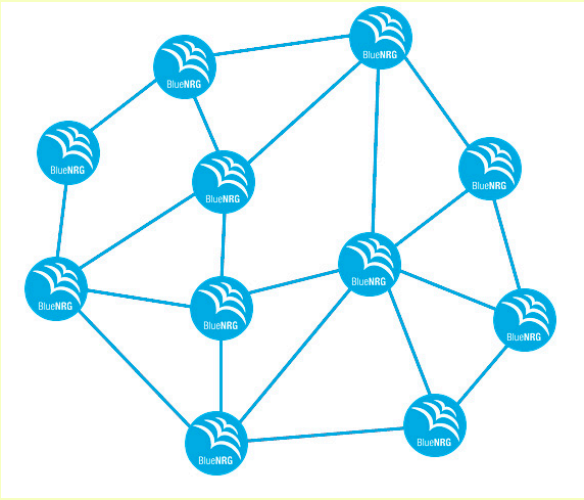
DATA TRANSFER
- Sports & fitness devices
- Health and wellness devices
- Peripherals and accessories

BROADCASTING
one-to-many

LOCALIZED INFORMATION
- Point of interest beacons
- Item finding beacons
- Way finding beacons

NEW

MESH
many-to-many



LARGE DEVICE NETWORKS
- Building automation
- Wireless sensor networks
- Asset tracking

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PRESS RELEASES

Bluetooth SIG Announces Mesh Networking Capability

7/18/2017 8:00:00 AM

Bluetooth MESH is Here!

July 2017 - Bluetooth SIG Announces Mesh Networking Capability

Brings proven, global interoperability and the mature, trusted ecosystem of Bluetooth technology to industrial-grade device networks

Bluetooth® companies supporting the launch of Bluetooth mesh networking

3M, AIR CABLE, ARM, BeON home, cortet by CEL, CYPRESS, dialog, ElectricBench, ERICSSON, FULHAM, gooee, Gunitech, hellohub, imagination, muRata, QUALCOMM, SILICON LABS, SILVAIR, smart and green, life.augmented, TOSHIBA Leading Innovation, TRLink, WISILICA

BlueNRG

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Low-Power BLE SoC ARM Cortex-M0 programmable core with up to 256KB eFlash

industrial-grade solution

Reliable, Scalable, Secure

- **Reliability:** Enables inherently self-healing networks with no single points of failure
- **Scalability:** Supports thousands of nodes with industrial-level performance
- **Security:** Provides industrial-grade security for protection against all known attacks

proven, global interoperability

Interoperable

- **A full-stack solution:** A unique full stack approach that defines everything from the low-level radio to the high-level application layer, ensuring all levels of the technology are fully specified
- **An interop-centric spec:** Comprehensive interoperability testing conducted prior to specification release, not after
- **Time-tested tools and processes:** A 20-year history of delivering the qualification tools and processes necessary to ensure global, multi-vendor interoperability

mature, trusted technology

Bluetooth®

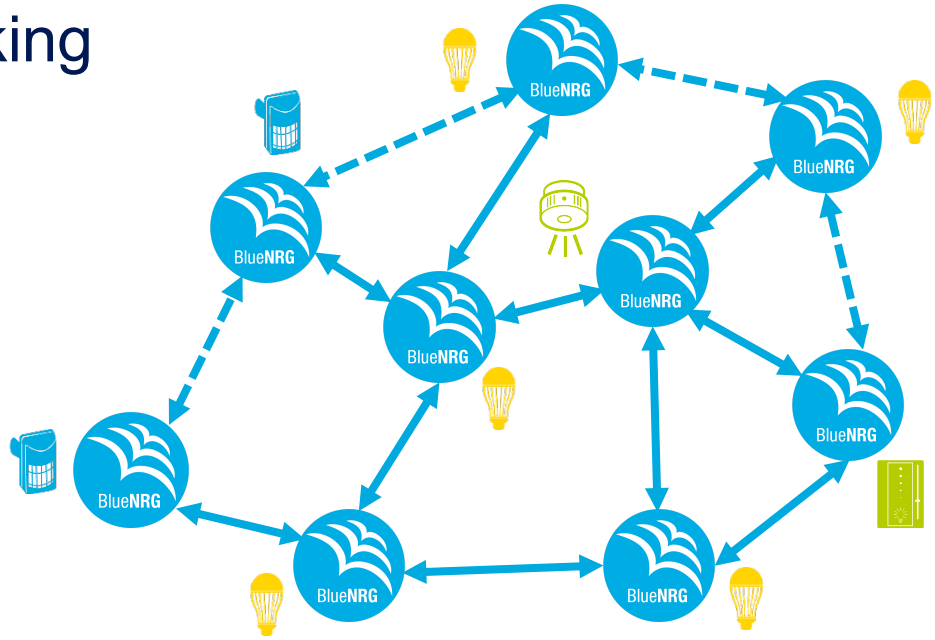
Trusted Global brand: Bluetooth SIG

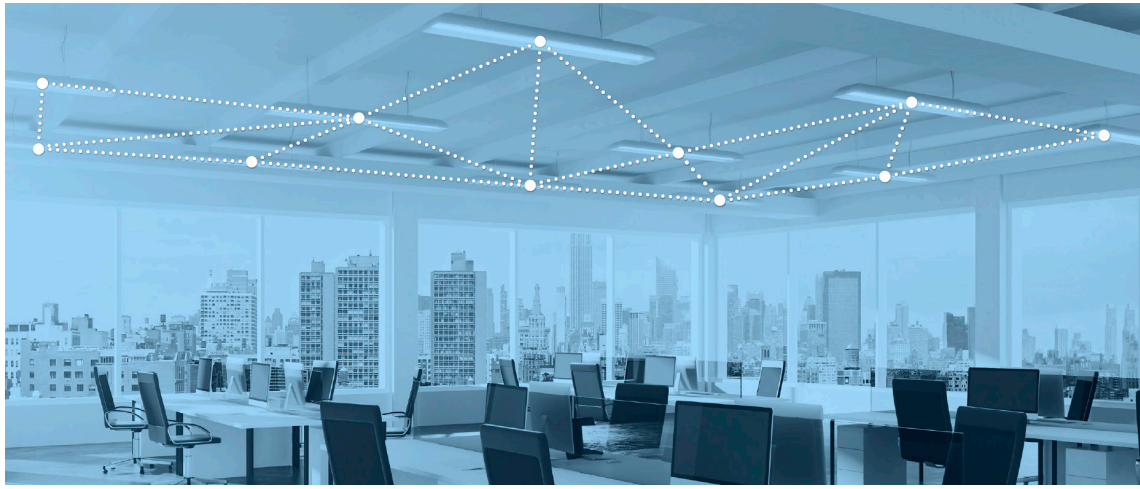
- **Value-added services:** A mesh network built on Bluetooth can also provide localized information, asset tracking and way-finding services
- **A mature ecosystem:** The best enabling technology, along with the development and test tools and services needed to shrink your time to market
- **Global brand awareness:** A trusted global brand that stands for simple, secure wireless connectivity

Bluetooth Mesh Applications

The Bluetooth SIG MESH Specification intends to extend the capabilities of Bluetooth Smart chips to answer **more and more complex applications**. The protocol has been developed with the **Smart Lighting industry** in mind.

- Lighting
- Smart Home and Building automation
- Wireless sensor networks
- Asset tracking
- Healthcare





- Same network may have multiple applications running
  - Lights, sensors, switches co-exist
- Nodes in a single network have same “Network key”
- Different applications have different “Application key”

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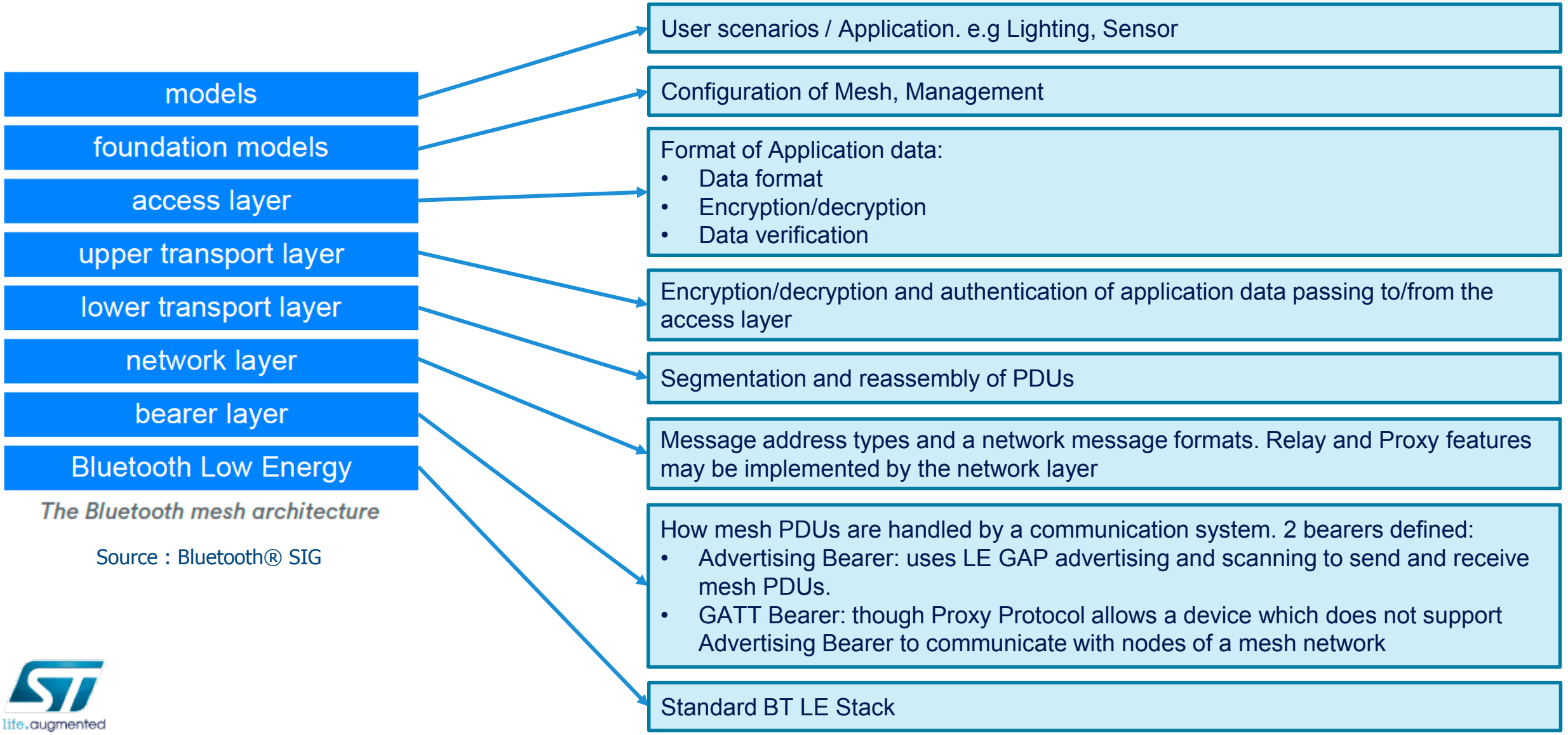
Mesh System Architecture



The Bluetooth mesh architecture

Source : Bluetooth® SIG

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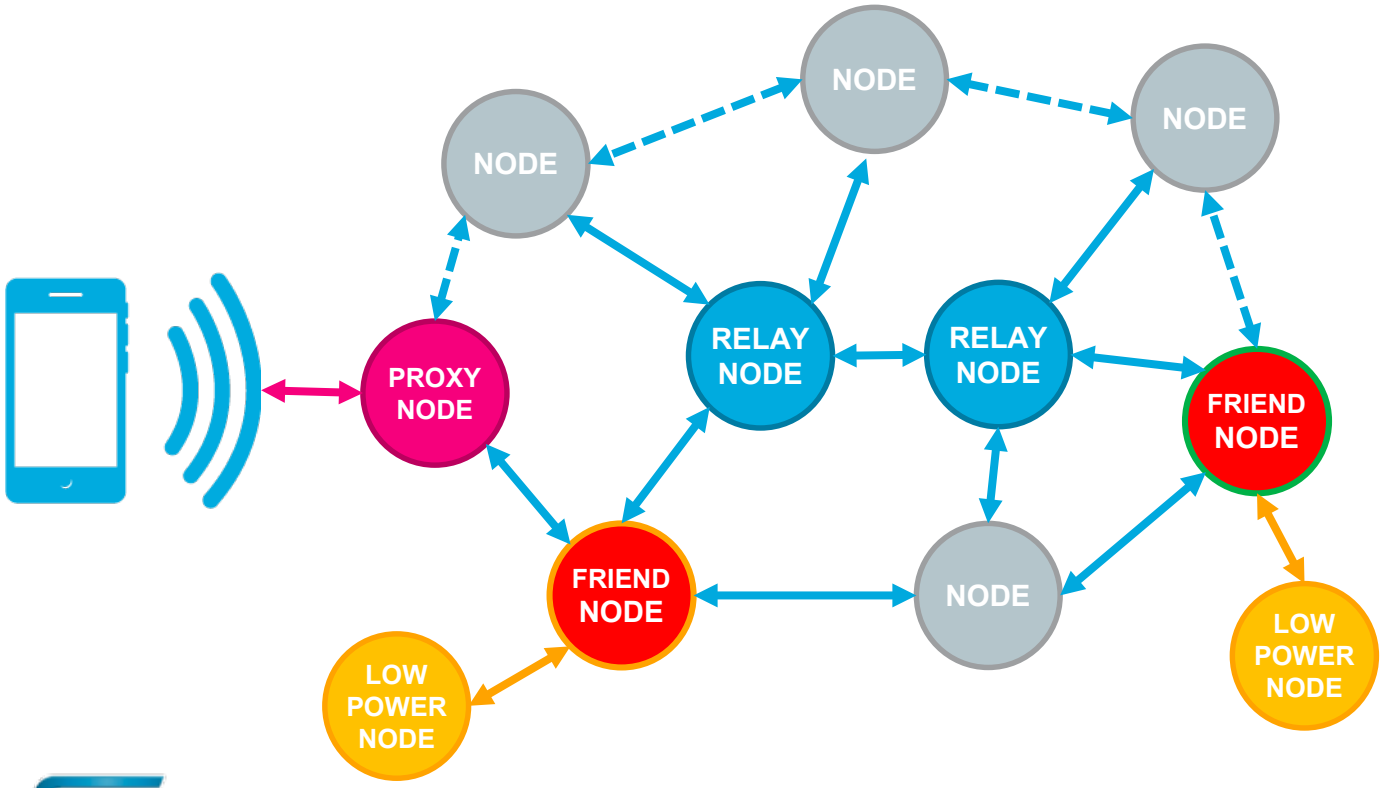
Bluetooth Mesh Topology

Nodes Features

The Bluetooth Mesh working group chose for mesh network mechanism a **flooding protocol**.
Compared to routed protocols, it is **much more simpler** to deploy.
To stay efficient, the BLE Mesh take advantage of a **managed flooding network**.



- **PROXY NODE**
  - Expose the interface for Smartphone/Tablet to interact with a mesh network
- **NODE**
  - Simple leaf node whom cannot relay messages
- **RELAY NODE**
  - Able to retransmit received messages
  - Enable multiple “hops” in the network
- **LOW POWER NODE**
  - Battery operated devices
  - Primarily send messages Rarely receive messages
  - No need of 100% duty cycle
- **FRIEND NODE**
  - Stores messages addressed to LPNs and delivers them whenever the LPN polls for “waiting messages”

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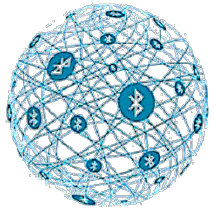
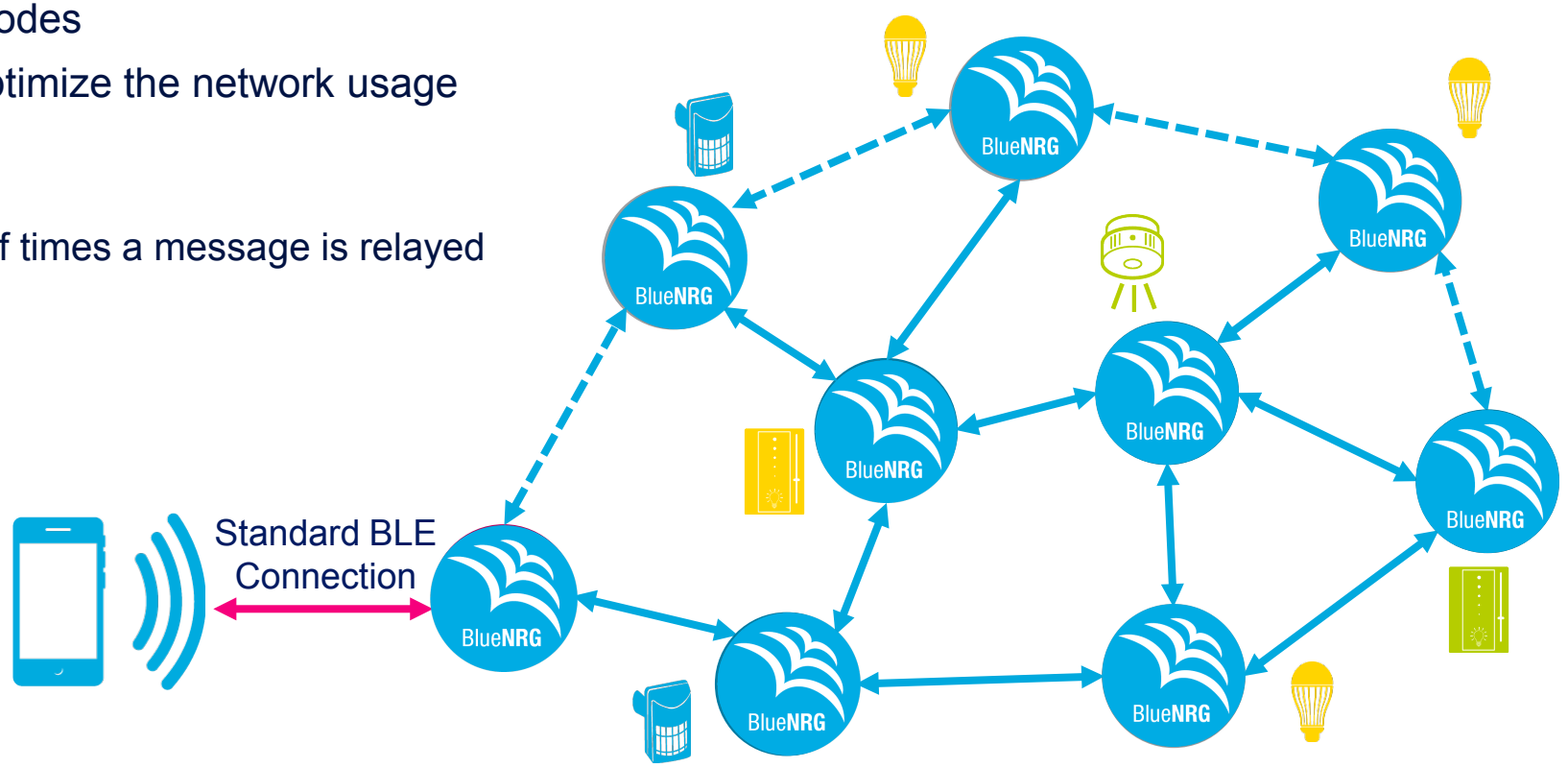


Bluetooth Mesh Topology

Managed Flooding

The Bluetooth Mesh working group chose for mesh network mechanism a flooding protocol. Compared to routed protocols, it is much more simpler to deploy. To stay efficient, the BLE Mesh take advantage of a managed flooding network.

- No single point of failure: self healing
- Direct communication between adjacent nodes
- Messages contain sequence number to optimize the network usage and protect against replay attacks.
  - Reject already received messages.
- TTL/Time to Live method: Limit the number of times a message is relayed



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Built-in Security

Unconfigured device

Provisioning

- 256-bit ECDH algorithm (public/private keys)
- Exchange several **security keys**
- Set a **unique address** for the device
- **Two separate BLE connections** to secure the communication link

Device added to the network

Configured node

Mesh communications

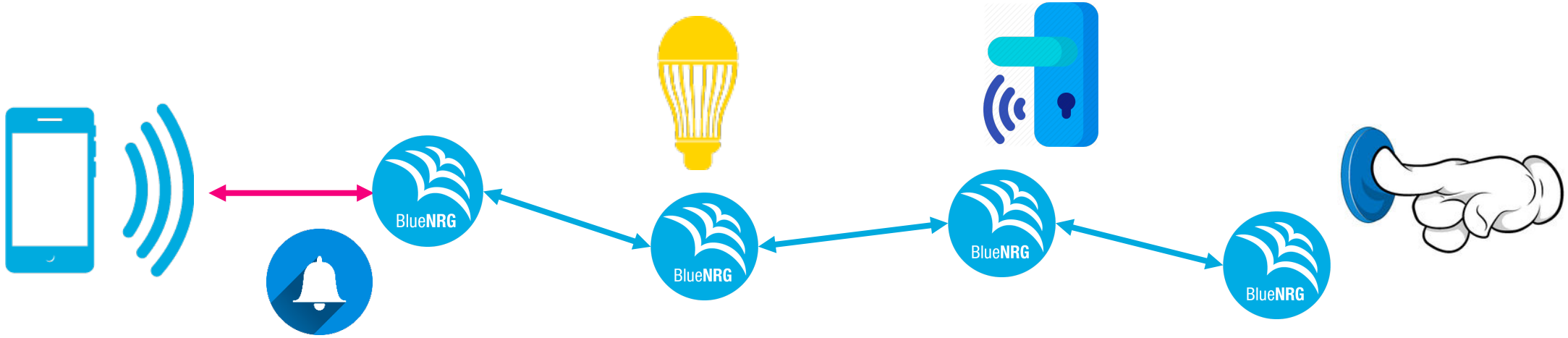
- Encrypted with 128-bit AES-CCM
- Multiple layers security thanks to the network/application keys shared during provisioning
- **Privacy through obfuscation**
- **Protection from multiple types of attack**:
  - Replay attack
  - Bit-Flipping attack
  - Eaves Dropping attack
  - Man-in-the-middle attack
  - Trashcan attack

Security Keys

- Network Key
  - Net Key secures the communication at the Network Layer and is shared across all Nodes in the network. The possession of a given Net Key is what defines membership of a given mesh network.
  - Allows a node to decrypt and authenticate up to the Network Layer and to relay messages throughout a network
  - A single compromised device can compromise the whole network. Some nodes (outside the house) can be given a subnet key instead of the main network key
- Application Key
  - Same network may have multiple applications running: Lights, sensors, switches co-exist
  - Different applications have different “Application key”
- Device Key
  - Unique key for each device, only known by the Provisioner and a single device, used for provisioning, configuration and key management

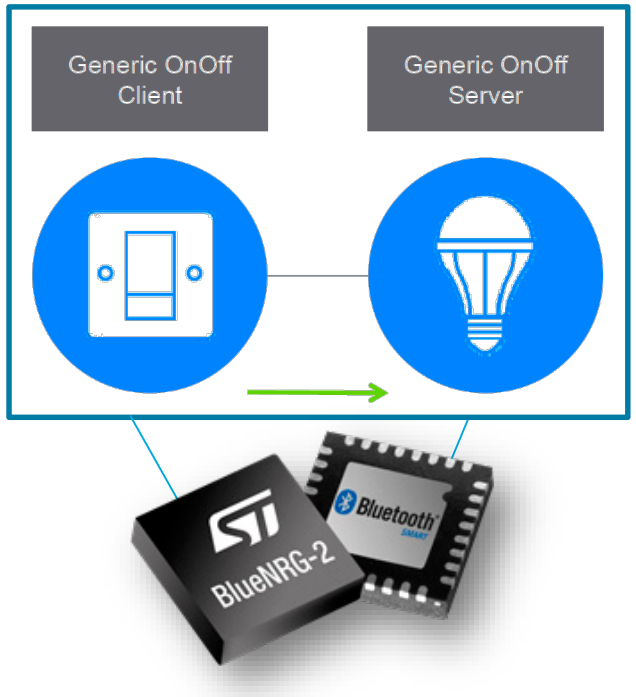
Why both Network and Application Keys?

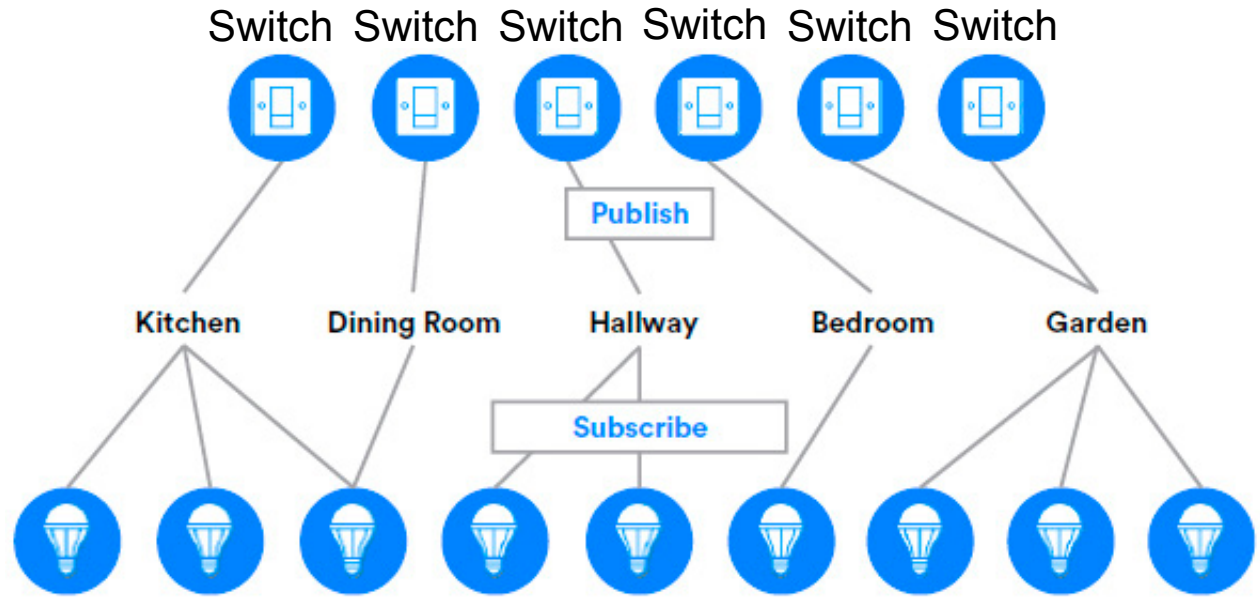
- We can’t have a compromised door bell allow anybody to unlock door.
- Light nodes can relay door access messages without being able to decrypt them



Bluetooth Mesh Messaging Model

Publish and Subscribe





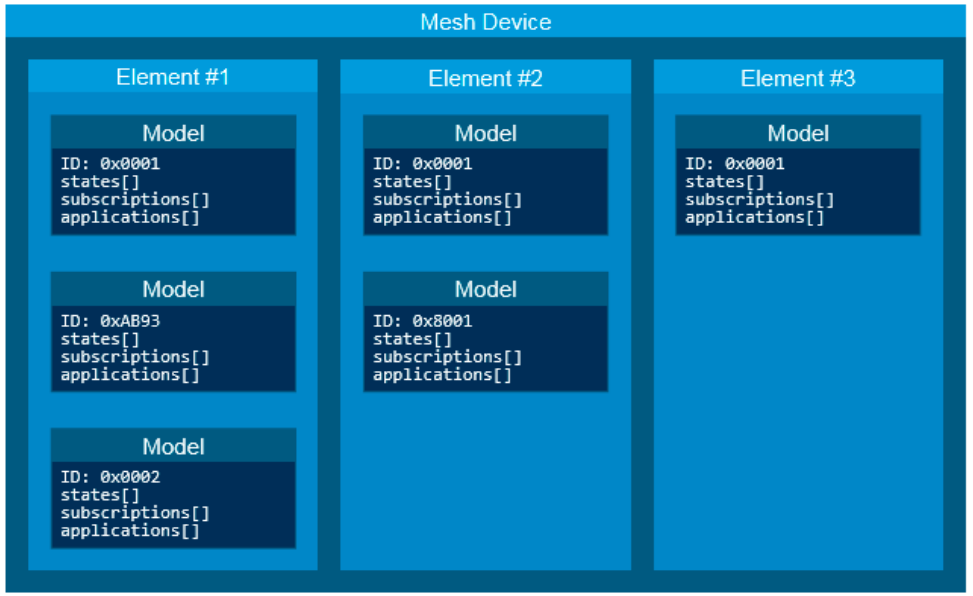
- Publish to Single Group: send a message to unicast /virtual /group address
  - A client device (switch) can publish messages (ON/OFF control) and a server device (light bulb) can be notified (if subscribed) of new command arrival.
- Subscribe on Multiple Groups: nodes (e.g. Lights) configure themselves to receive messages sent to specific addresses. Different nodes can subscribe to the same address.
  - A virtual address can have a semantic meaning to users: e.g. the name of a room

“Elements” and “Models”

based on a full-stack specification and models

The Bluetooth SIG MESH Profile defines a **standard access layer** to **exchange messages** between a BLE device and a Smart Application (Controller) for simple **control and monitoring applications** using “**Elements**” and “**Models**”

HOW DEVICE FEATURES ARE EXPOSED



CONTROLLER

Android, iOS
or embedded

- **Elements**: parts of a single node, can be independently controlled. Messages can be sent from one element to one or more elements
- A **Model** represents a specific **service** and defines a set of **states and messages** that act on these states. Model examples: **Device Configuration**, **Sensor Reading**, **Light Control** or **Vendor Specific** models.

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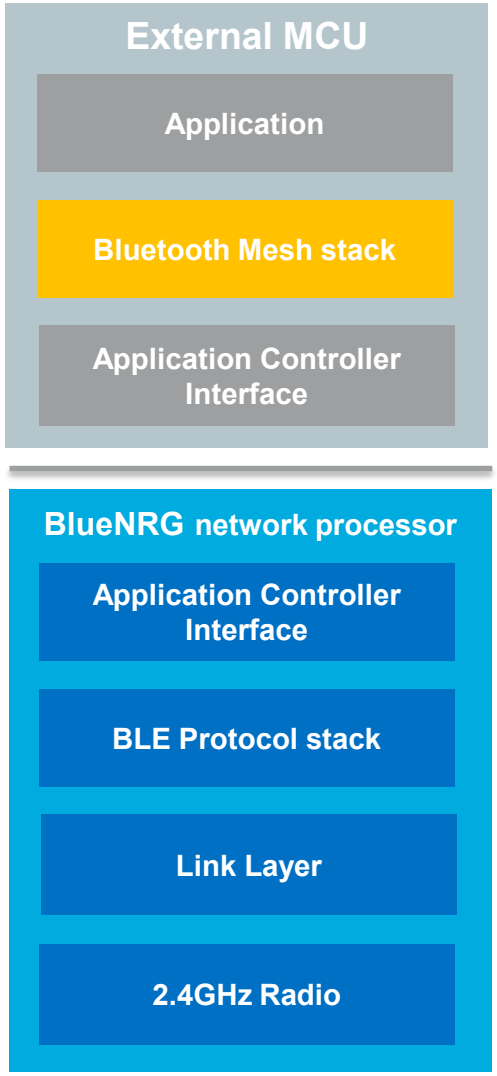
Example: ST BlueNRG-MESH SDK

BLE network processor vs BLE application processor

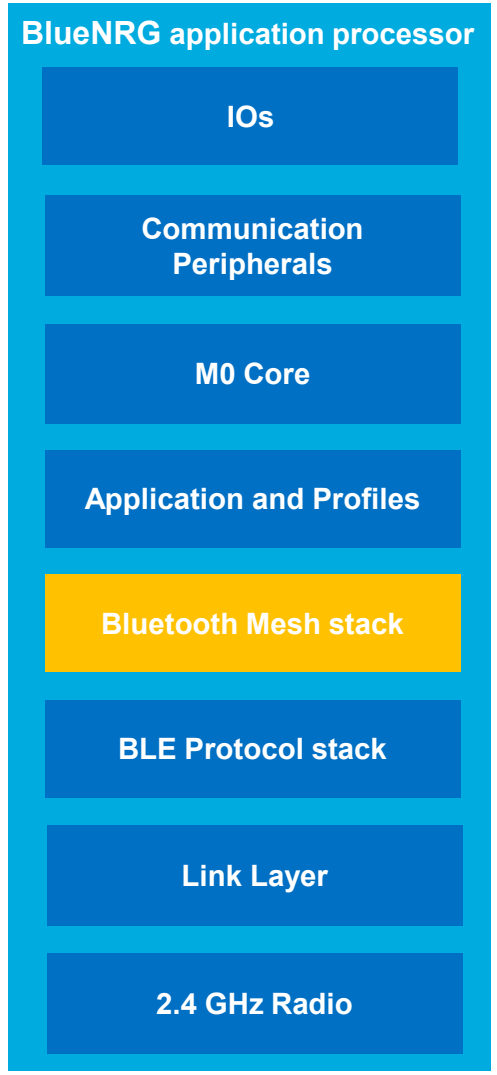
Network processor:

- Dual chip solution
- Peripheral/memory flexibility
- Adding BLE connectivity to existing designs
- SPI interface
- External MCU examples based on STM32
- Support BLE 4.1



Application processor:

- Single chip solution
- Cost reduction
- Hosting customer application
- Small form factor
- Can also behave like a network processor
- UART, SPI interfaces when used as network processor
- Support BLE 4.2



ST BlueNRG-Mesh Facts and Figures

Hop latency
10-20 ms

Power consumption
7 mA average

Provisioning procedure
15 seconds average

BLE Mesh 1.0 certification
End of June 2018

SoC Memory footprint
109 KB Flash
20 KB RAM

Application Payload
8 bytes unsegmented
64 bytes segmented

Dual chip Memory footprint
88 KB Flash
19 KB RAM

Network size
Constantly tested on 30 nodes network

Compatible with both BLE 4.X or 5.0

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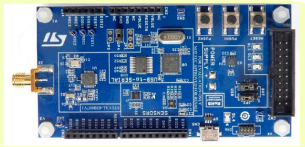
How to Get Started on BlueNRG-Mesh

BLE Mesh SDK resources

HW resources (BlueNRG-Mesh node evalboards)

BlueNRG-1
BlueNRG-2



STEVAL IDB007Vx

STEVAL IDB008Vx

BlueNRG-MS

NUCLEO-L152RE

+

IDB005V1

Documentation resources

- **UM2290**: Android API Guide
- **UM2180**: Getting started with Android
- **UM2361**: Getting started for iOS App
- UM2295: Getting started with Mesh Embedded Firmware

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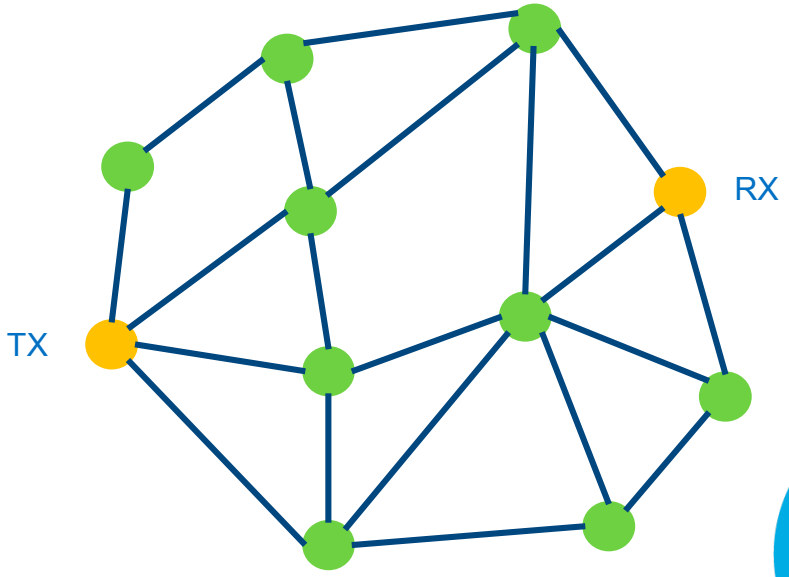
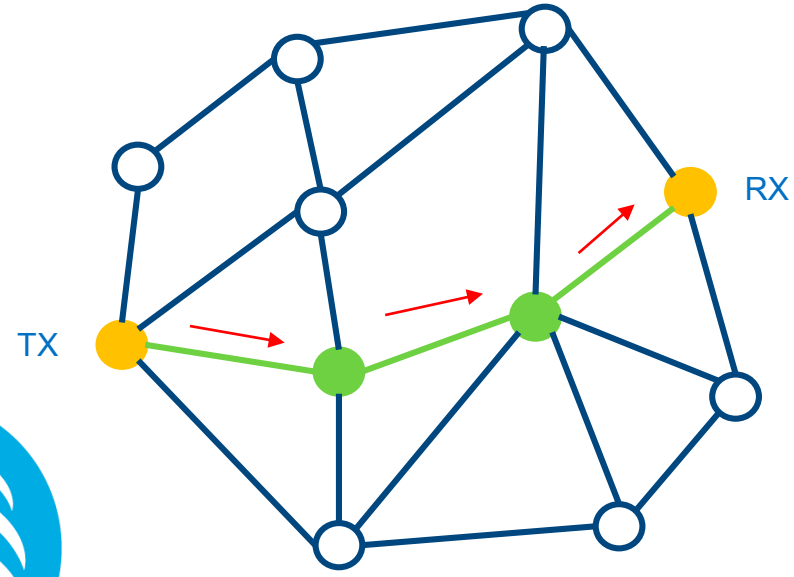
Bluetooth Mesh Roadmap: Routing





BlueNRG

FLOODING network

All nodes participate to broadcast messages

Available now
in BlueNRG-MESH SDK

ROUTING network

Routing path Tx-to-Rx is known in advance

Specs ongoing by BT SIG
(H1'18 for BlueNRG-MESH)

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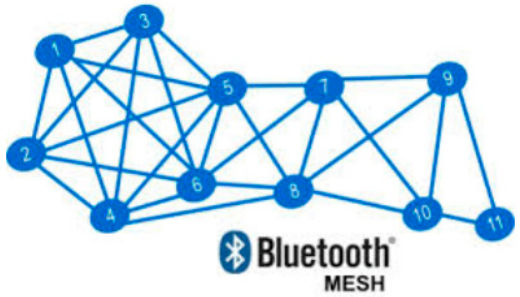
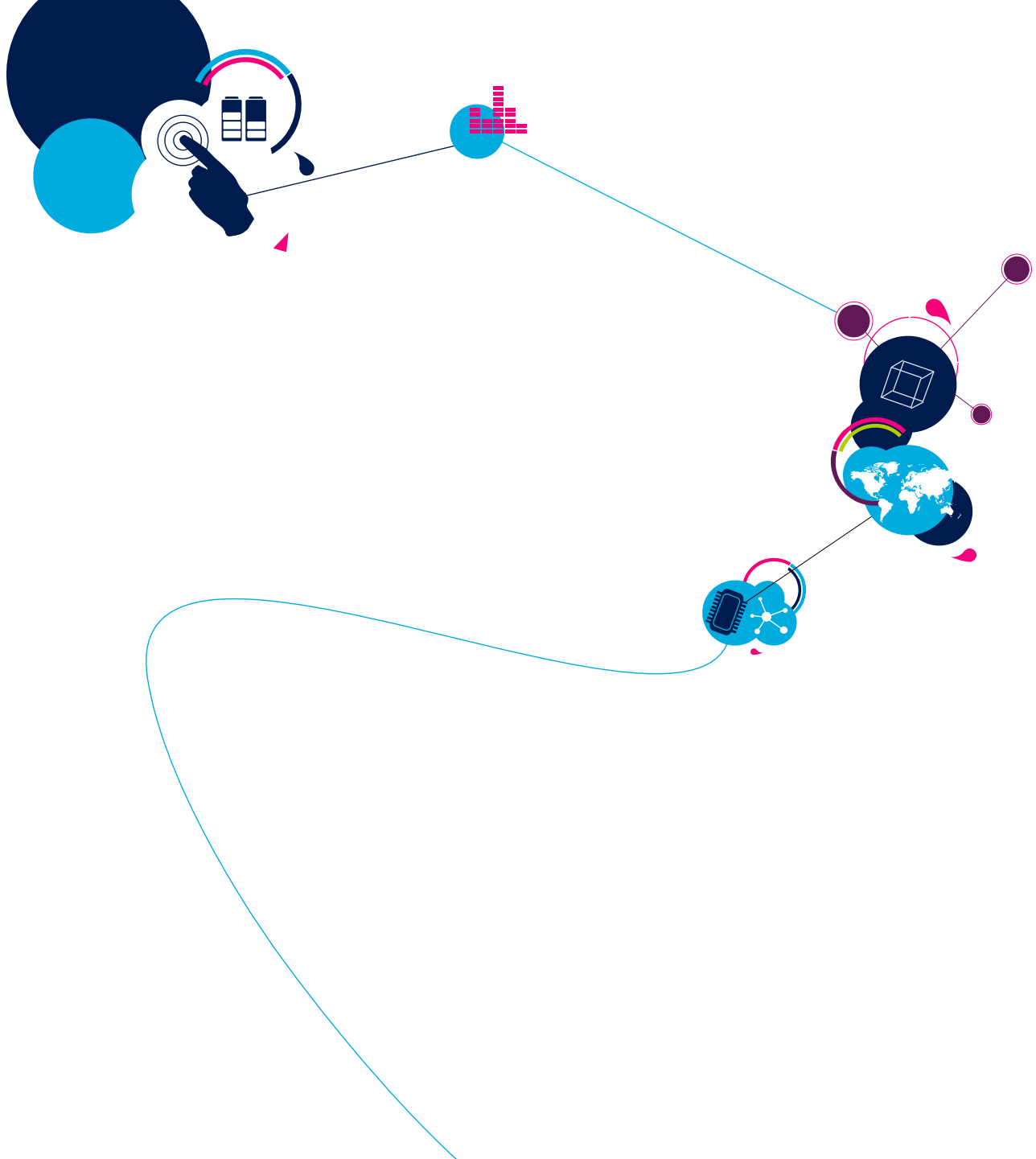
Packet format is optimized for **small control packets**, issuing single commands or reports, and is **not intended for data streaming** or similar high-bandwidth applications.

Additional Resources

- Bluetooth Mesh deep dive:
  - Bluetooth Mesh specification
  - Bluetooth Mesh overview
  - Bluetooth Mesh FAQ



- Software resources available this week (firmware, Android): http://www.st.com/en/embedded-software/stsw-bnrg-mesh.html
- BlueNRG-Mesh Android application available on Play Store: https://play.google.com/store/apps/details?id=com.st.bluenrgmesh&hl=en



Thank you!

Q&A

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