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gotober.com

An Introduction to Bluetooth Mesh

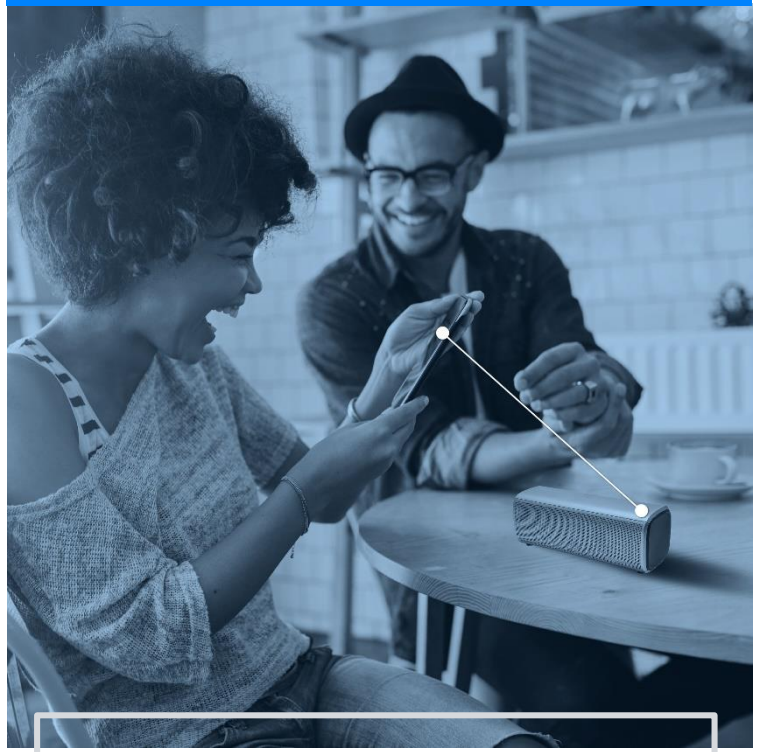
Martin Woolley

Bluetooth SIG Developer Relations Manager, EMEA

Twitter: @bluetooth_mdw

Bluetooth now comes in three delicious flavours

BR/EDR

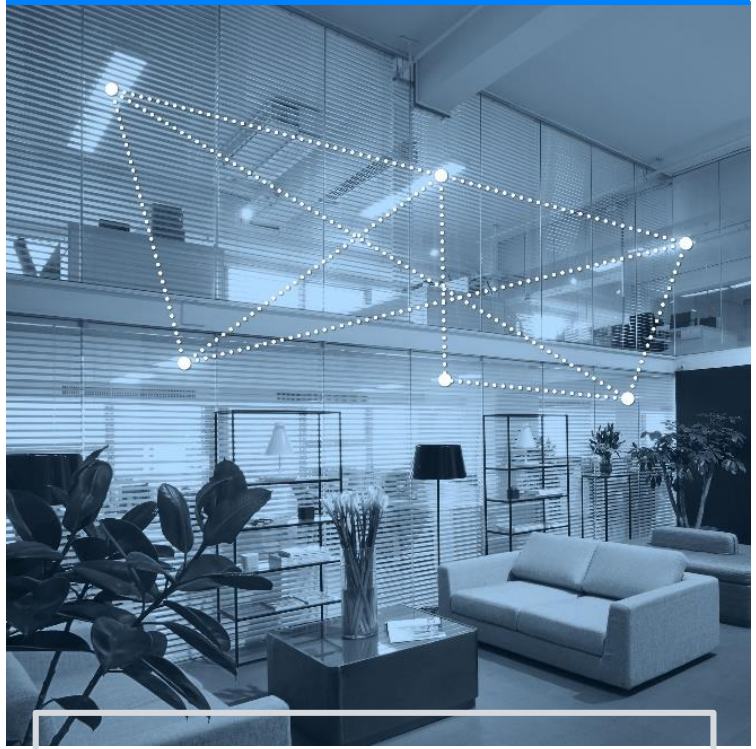


point-to-point 1:1

Low Energy (LE)

broadcast 1:m

Mesh

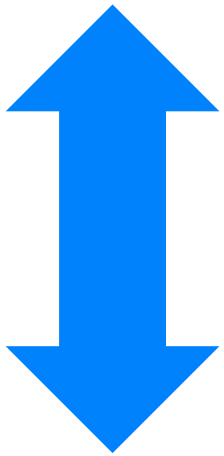


many to many m:m

relationship between Bluetooth technologies

NETWORKING

Bluetooth mesh networking



RADIO

Bluetooth BR/EDR

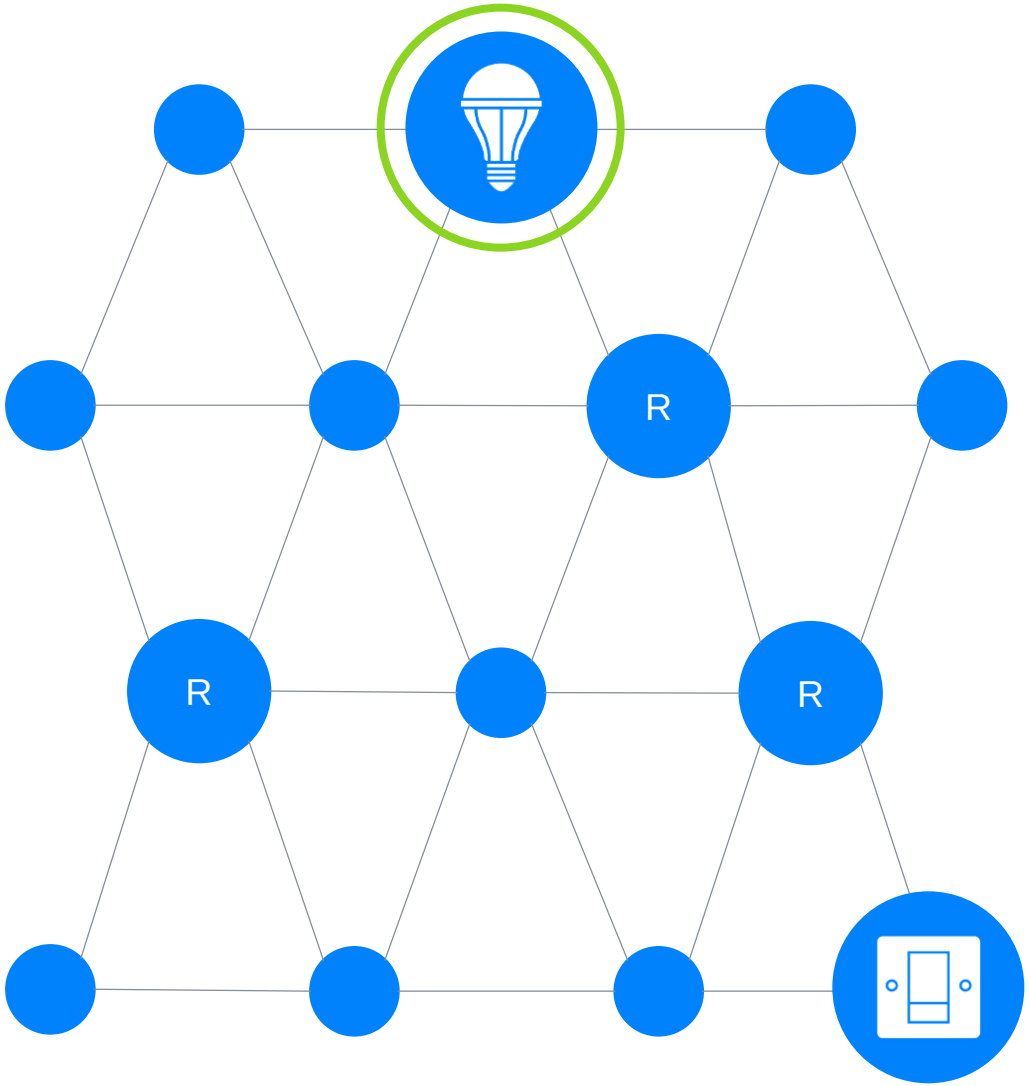
Bluetooth Low Energy

Bluetooth Mesh Networks

multi-hop, multi-path, multicast

Bluetooth Mesh

Node Network Roles



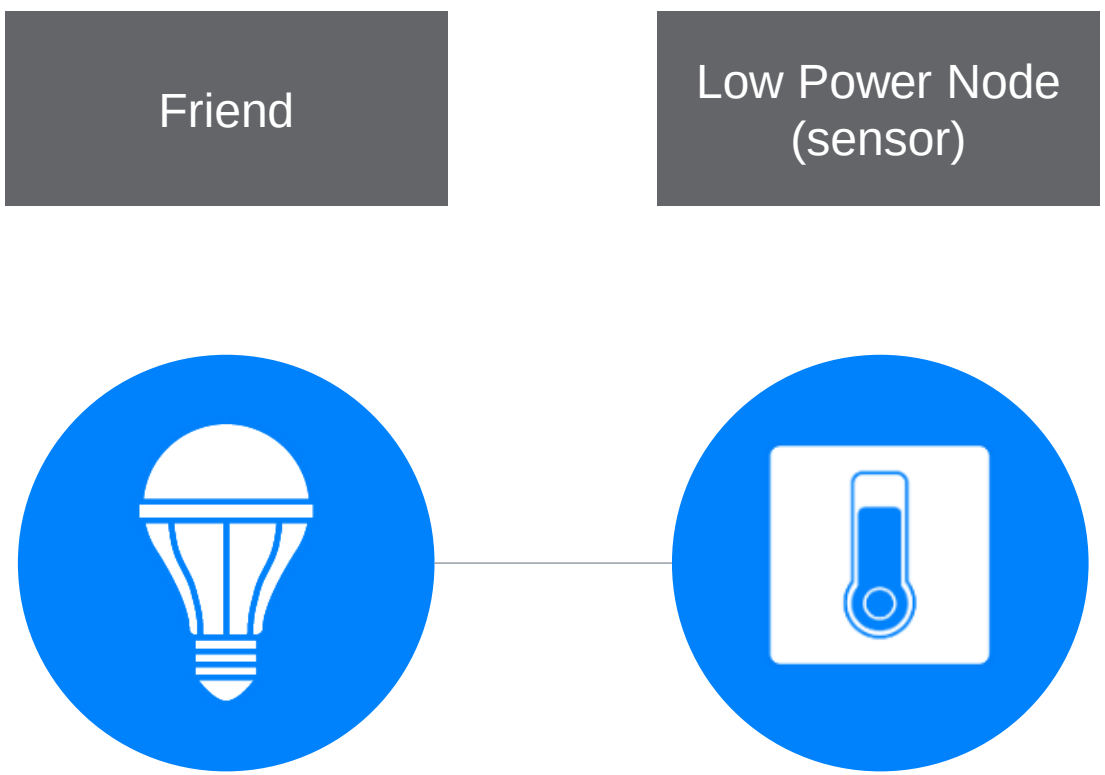
R = Relay function on

relay nodes

Messages get sent to other nodes that are in direct radio range of the publishing node

Some nodes can act as “relays” however

Relays retransmit messages so that they can travel further, in a number of “hops”

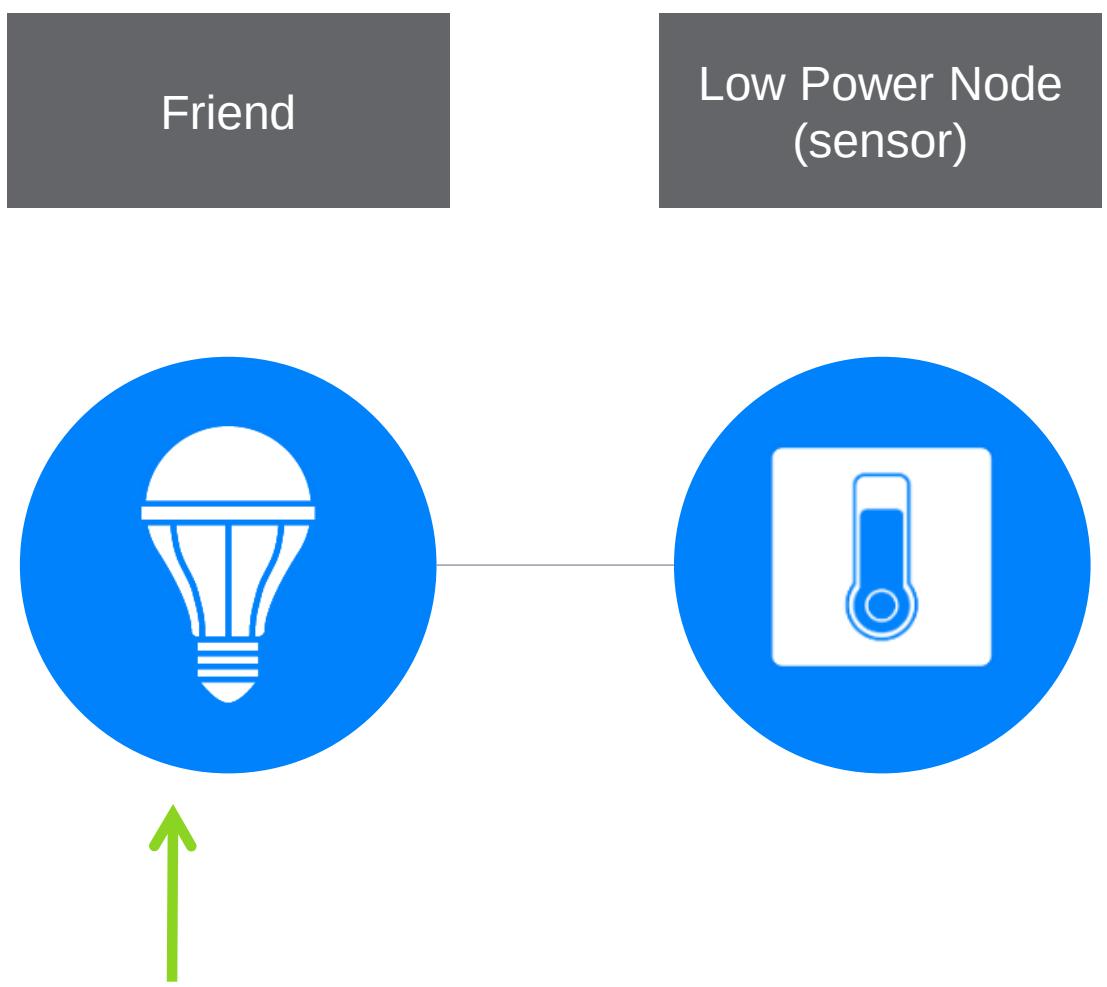


friend nodes and low power nodes

Low power nodes (LPNs) are highly power constrained

To avoid the need to operate at a high(er) duty cycle to receive messages from the mesh, an LPN works with a Friend

Friend nodes store messages addressed to LPNs they are friends with and forward them when the LPN occasionally polls



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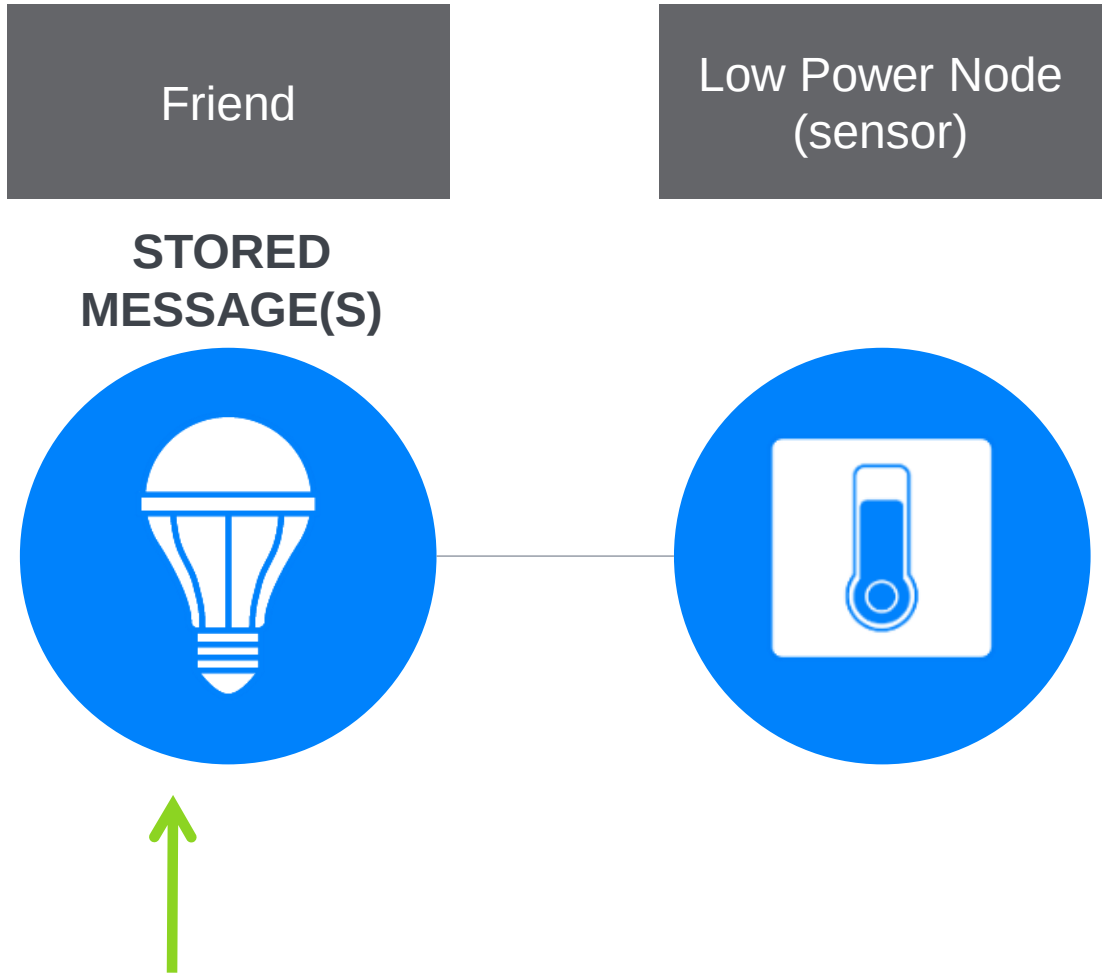

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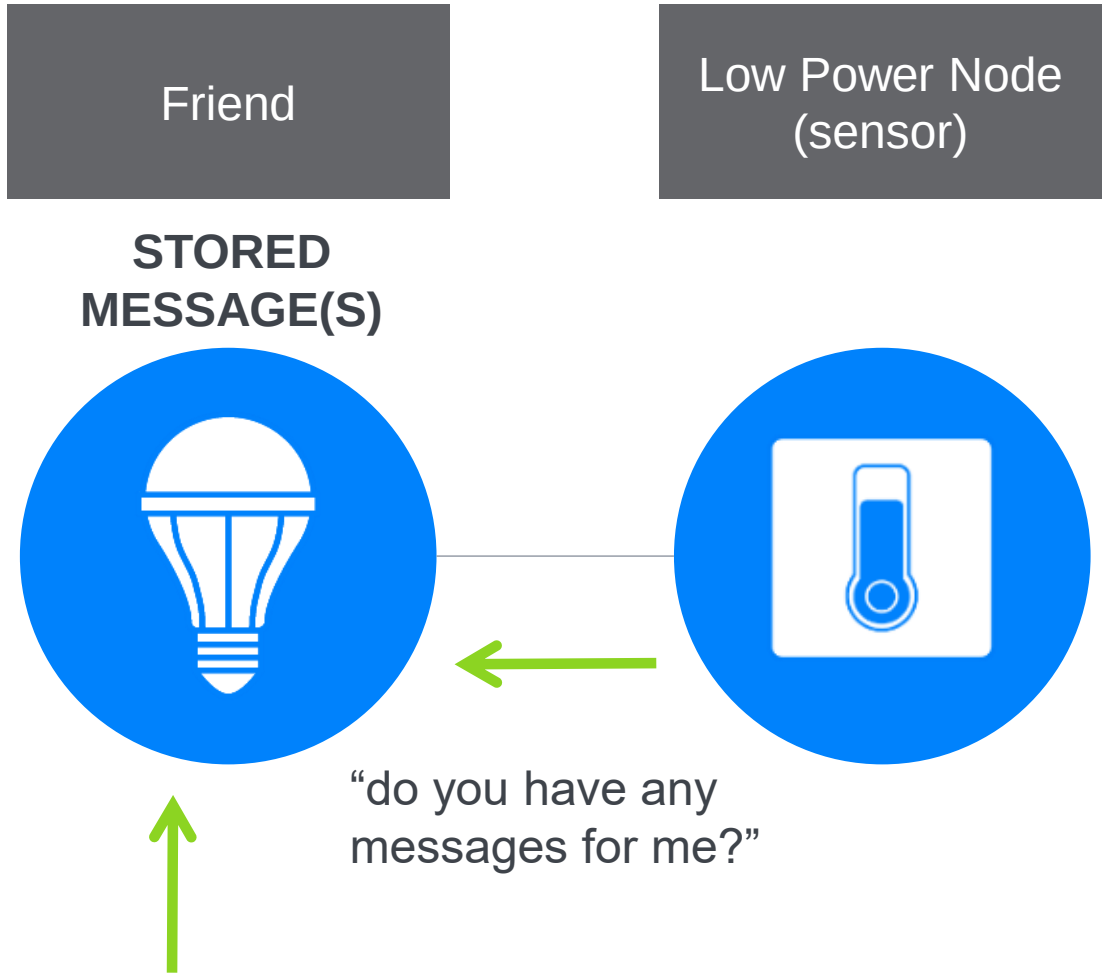

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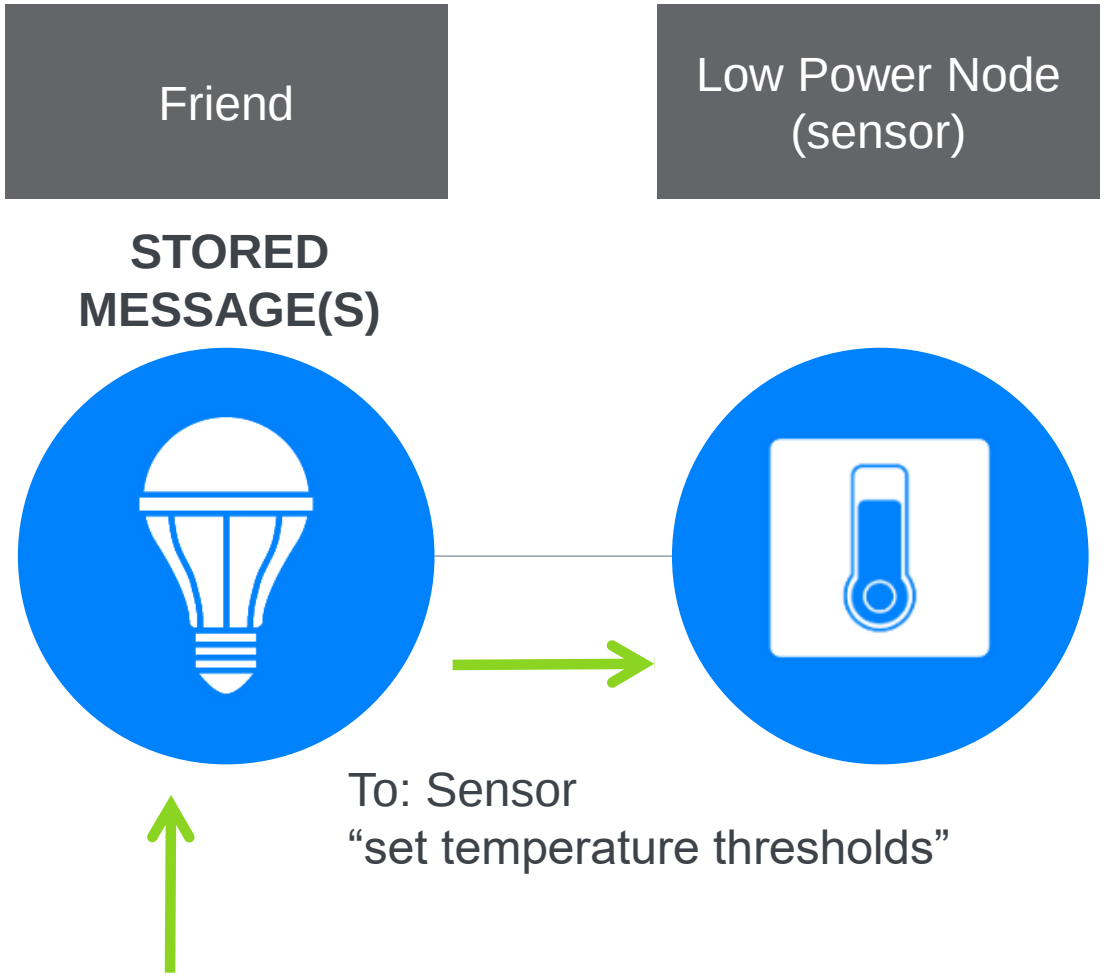

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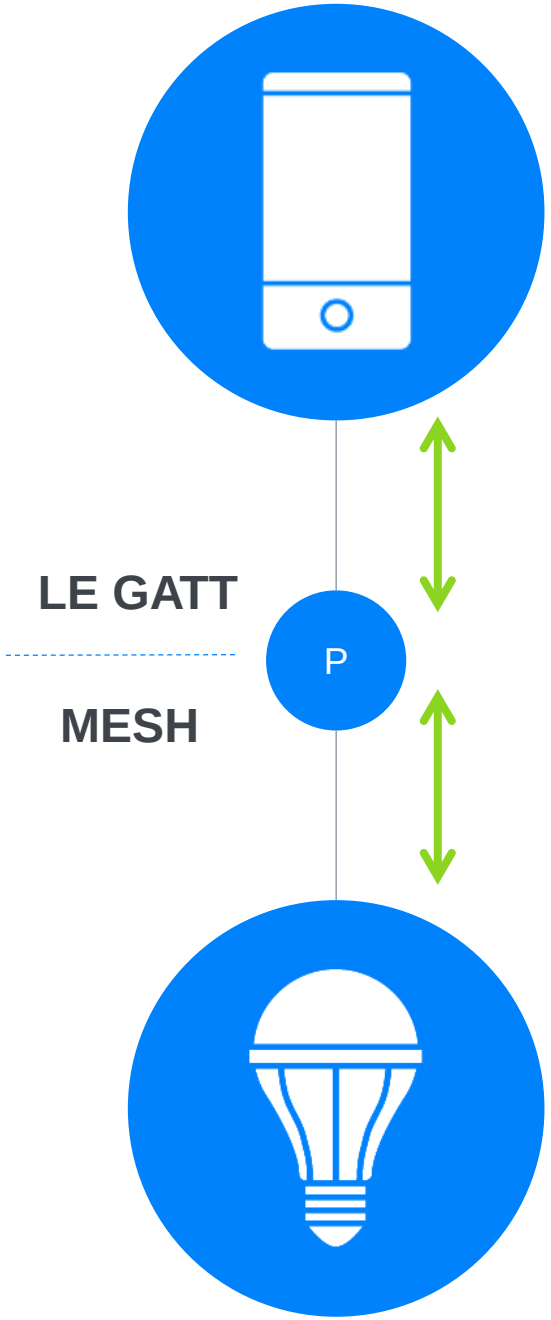
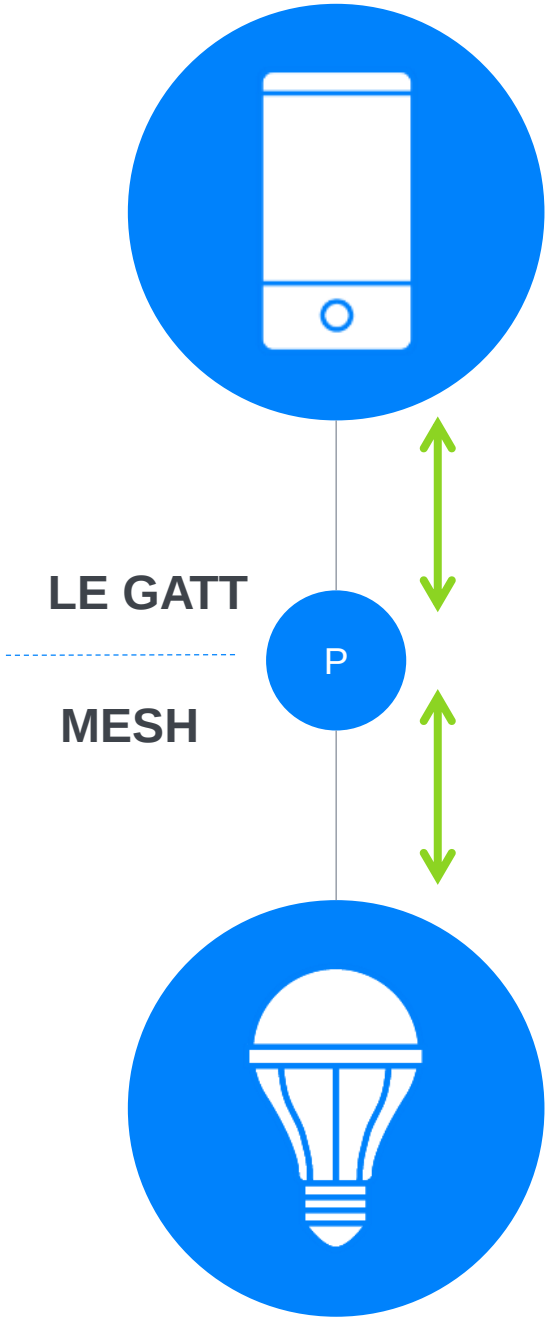
proxy nodes



Bluetooth low energy devices like smartphones can communicate with a mesh network via a proxy node



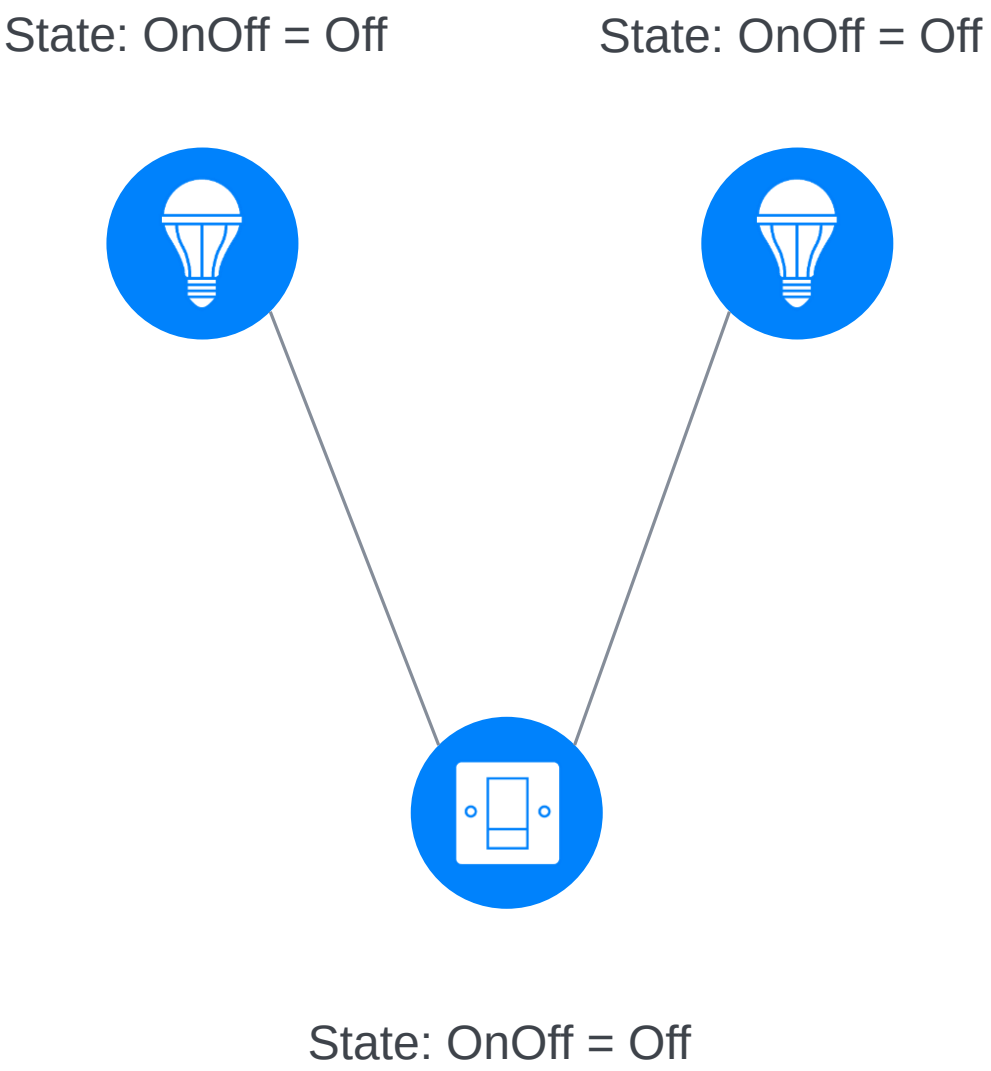
proxy nodes

Bluetooth low energy devices like smartphones can communicate with a mesh network via a proxy node

mesh monitoring and control applications

Bluetooth Mesh

Communication and Interaction



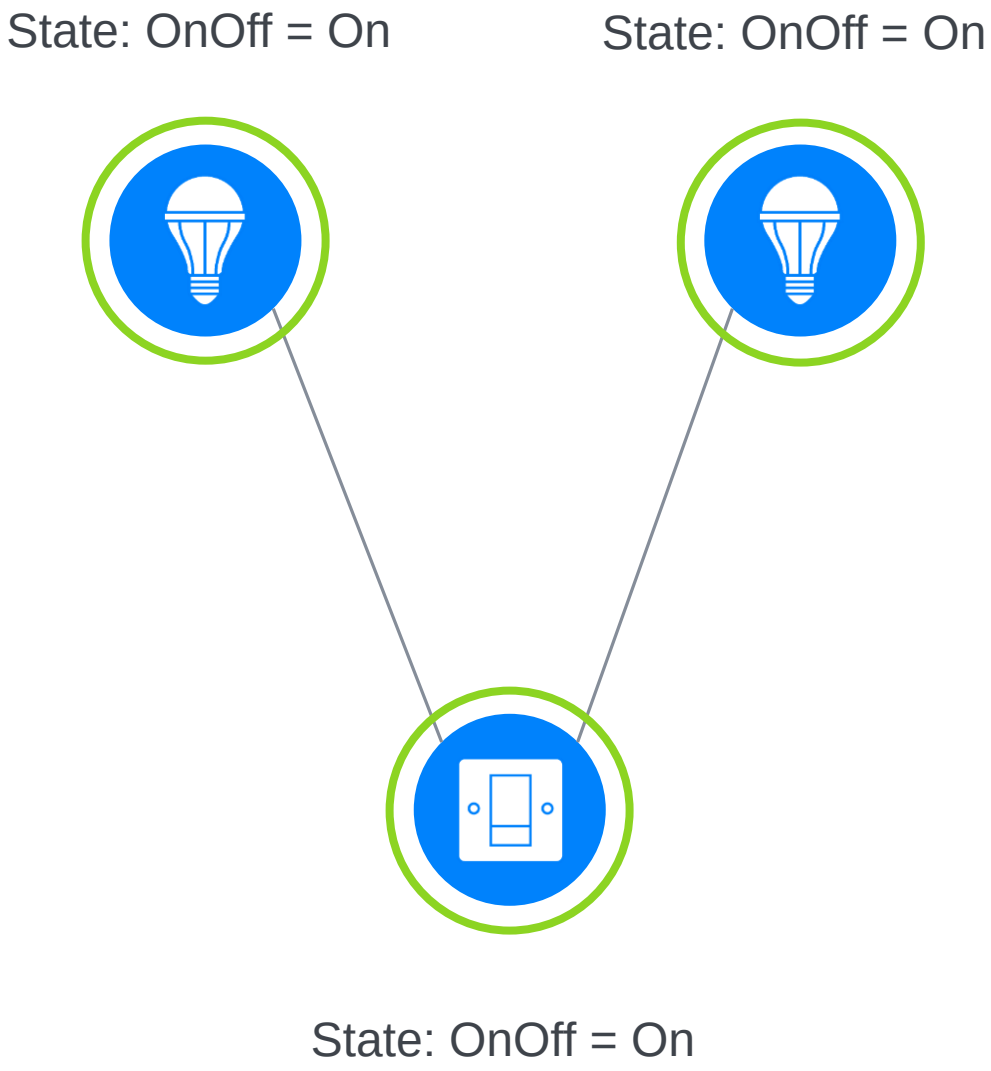
messages and state

nodes communicate with each other by sending messages

nodes have state values which reflect their condition (e.g. ON or OFF)

access messages operate on state values

- **SET** - change of **state**
- **GET** - retrieve **state** value
- **STATUS** - notify current **state**
- **ACK vs UNACK**



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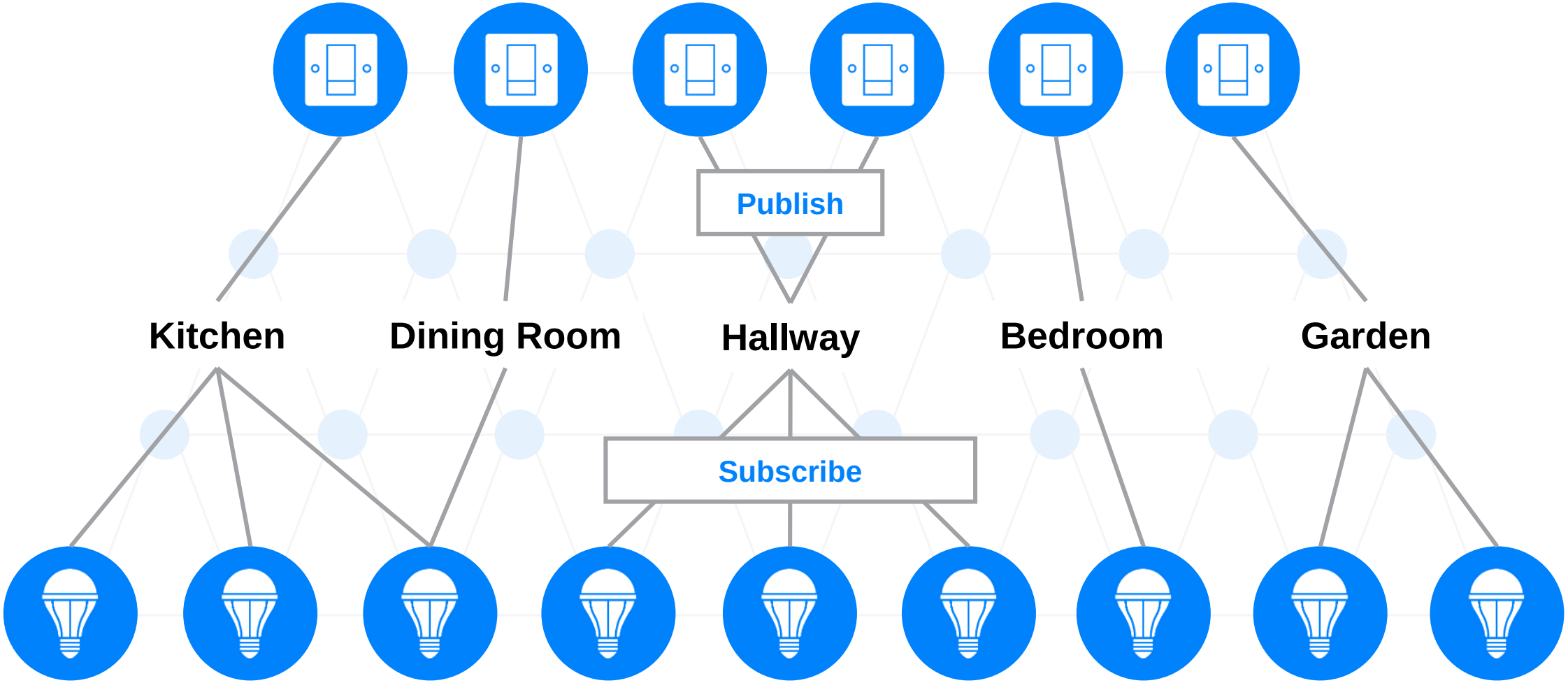
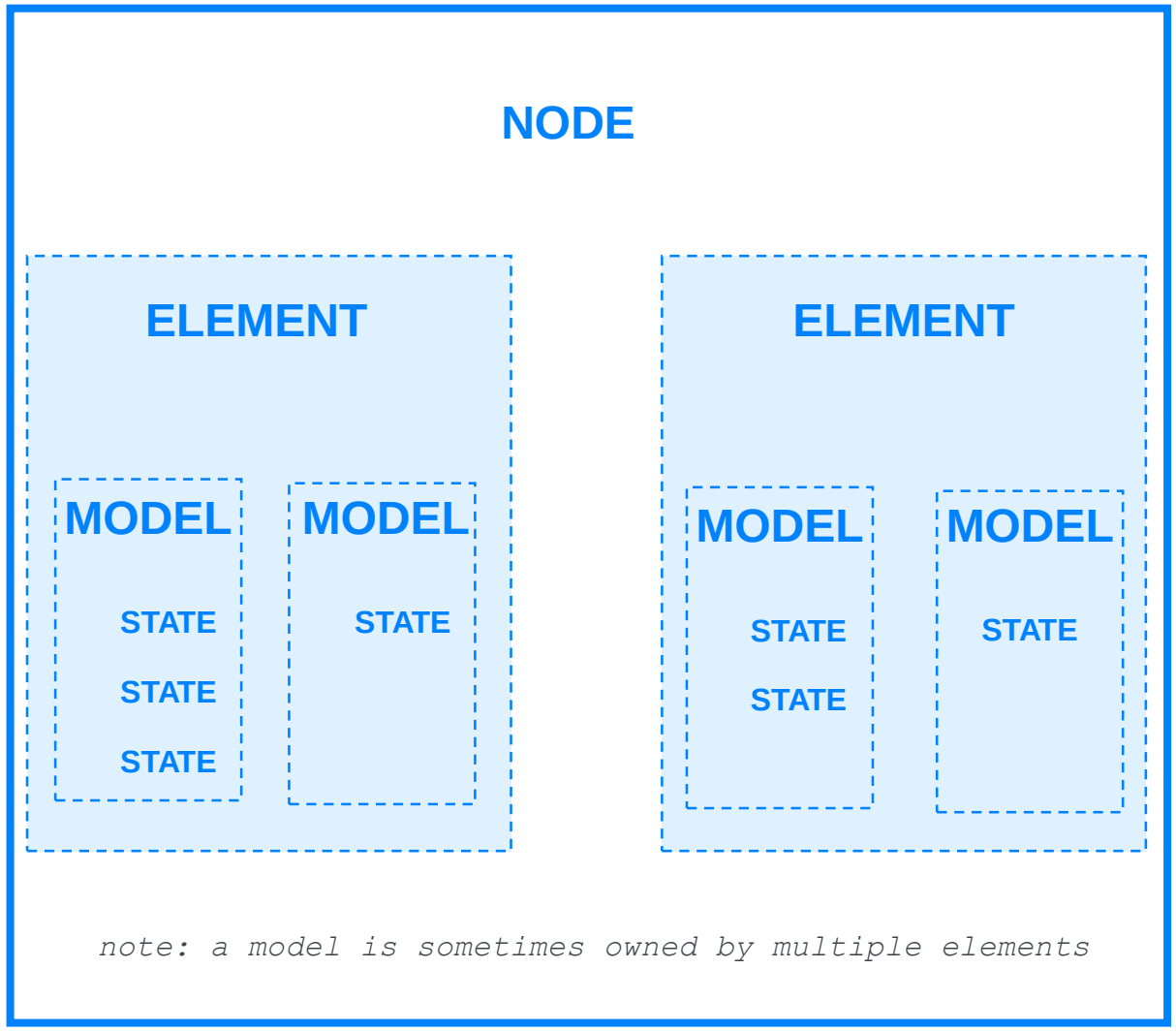
the publish/subscribe communication model



Bluetooth Mesh

Node Composition

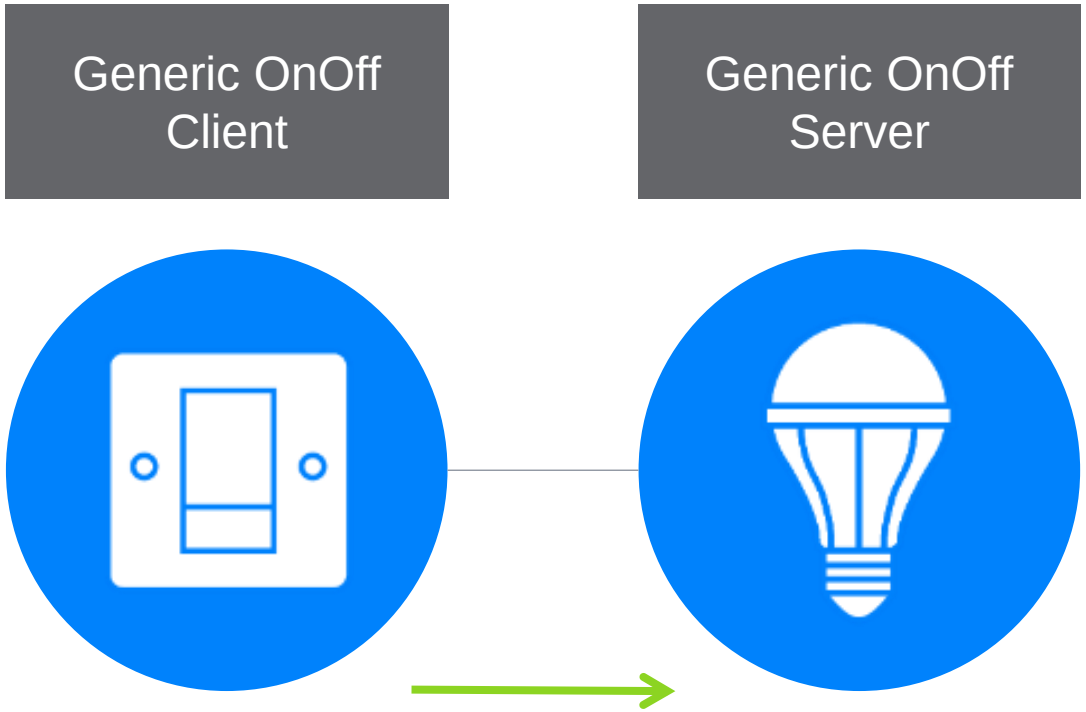


node composition

a node consists of an arrangement of

elements
models
states

each element has its own address



models

define node functionality

define states, messages, state transitions and behaviors

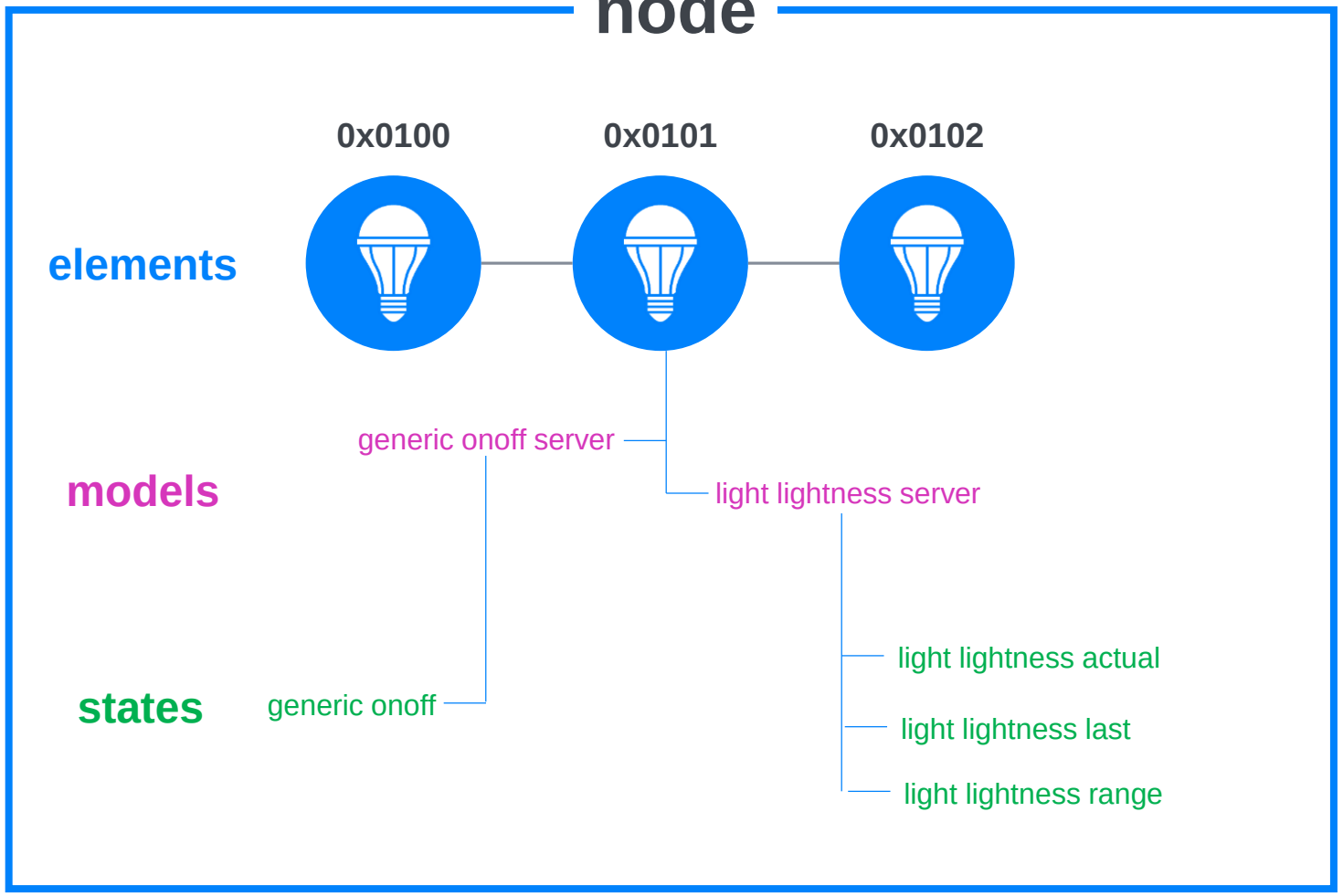
client, server and control types

generics such as onoff client and server

lighting, sensors, scenes & time

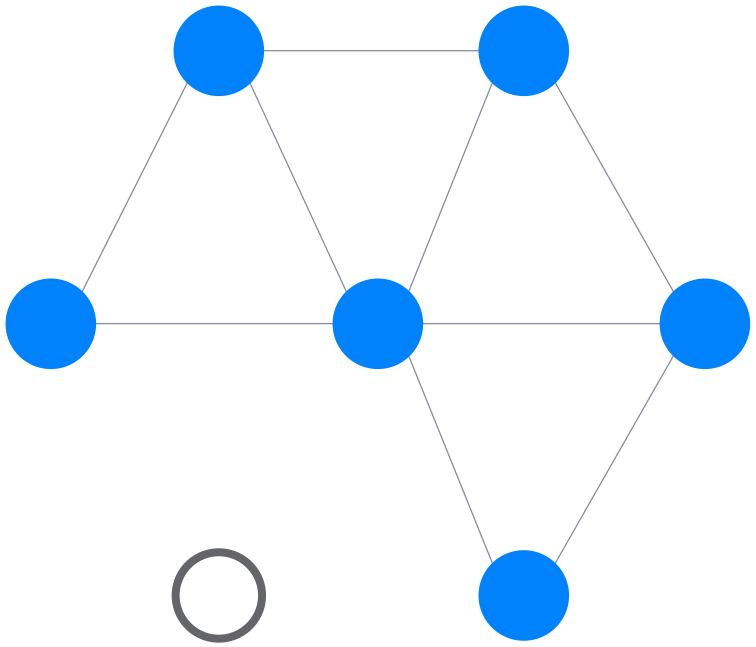
node composition

single node
3 elements
multiple models and states



Bluetooth Mesh

Security

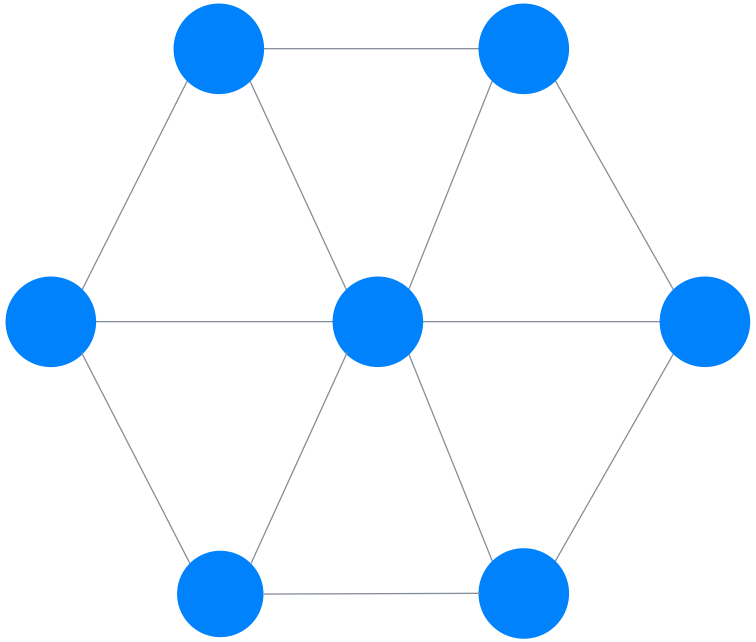


devices and network membership

Bluetooth mesh networks are secure

only members of the same network can talk to each other

a security process called **provisioning** makes a device a member of a network



Device is now a
node on the network

devices and network membership

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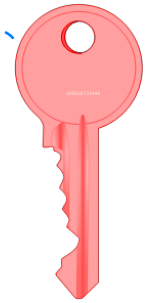
Bluetooth mesh: Security

- Mandatory, cannot be reduced
- Encryption and authentication
- Separate security for network and each application
- Area isolation
- Message obfuscation
- Protection from replay and trashcan attacks
- Secure device provisioning



devkey is bound to all
netkeys known to a node

appkey is bound to a netkey

network key (netkey)
origin: provisioning
use: derivation of other keys

application key (appkey)
origin: created by the config. client and provided to nodes after provisioning
use: secures application data at the upper transport layer
Bound to one or more models.

device key (devkey)
origin: established during provisioning
use: secures communication between the config. client and individual node

encryption key
origin: derived from netkey using the k2 function
use: secures data at the network layer

privacy key
origin: derived from netkey using the k2 function
use: obfuscation of network header information

ref: mesh profile 1.0 section 2.3.9.1

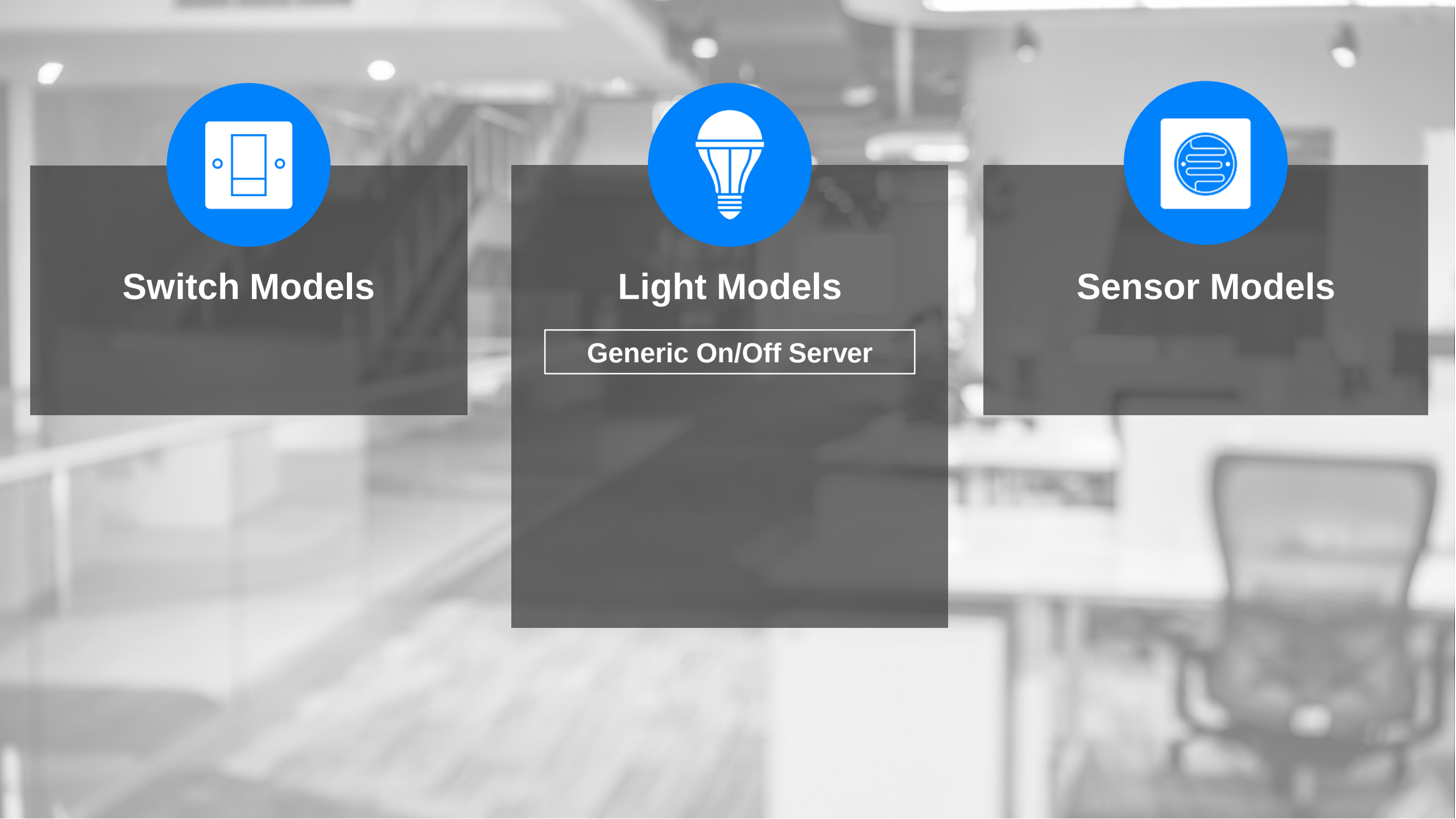
Bluetooth mesh

Anatomy of a smart lighting system

Switch Models

Light Models

Sensor Models

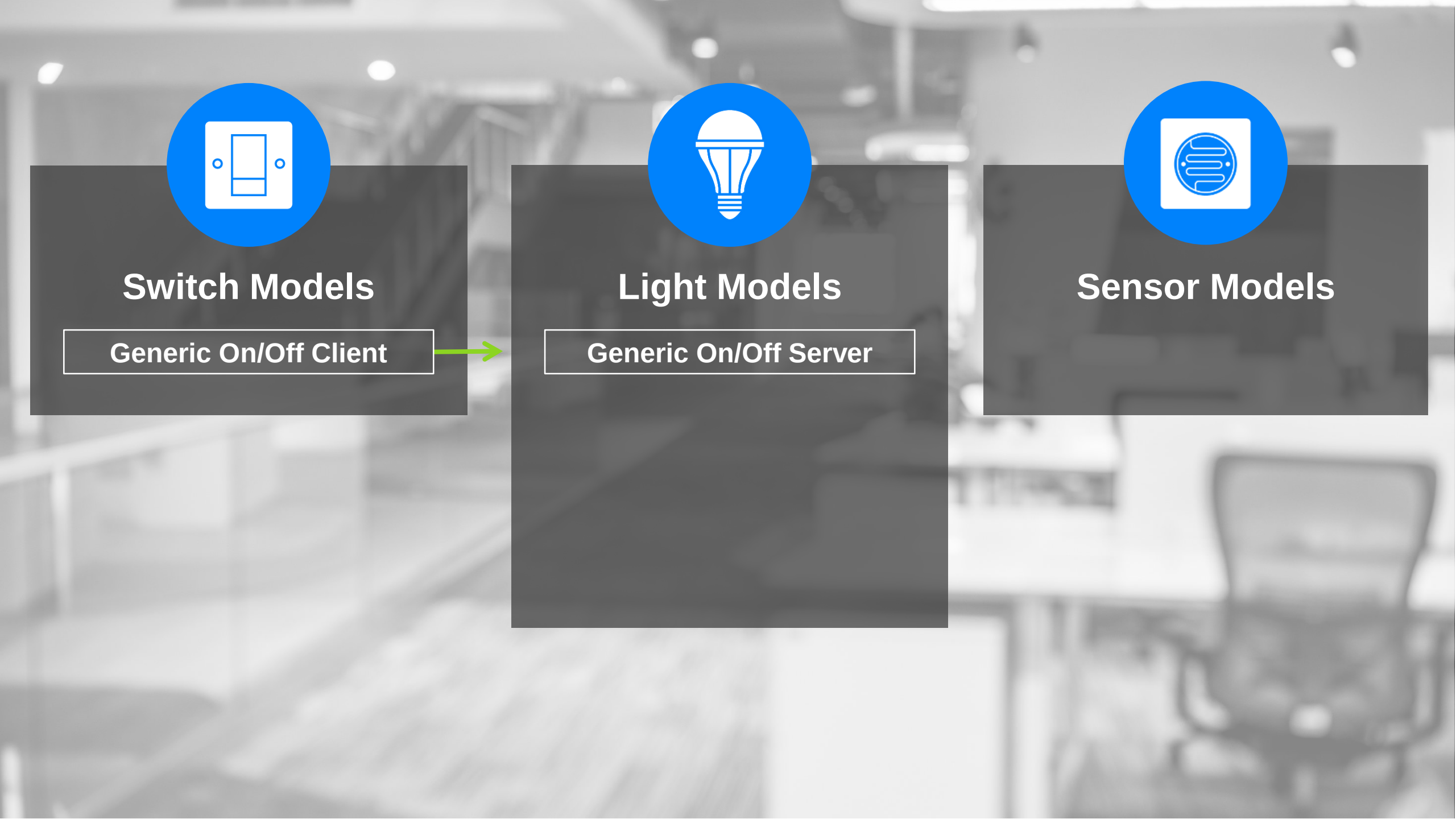


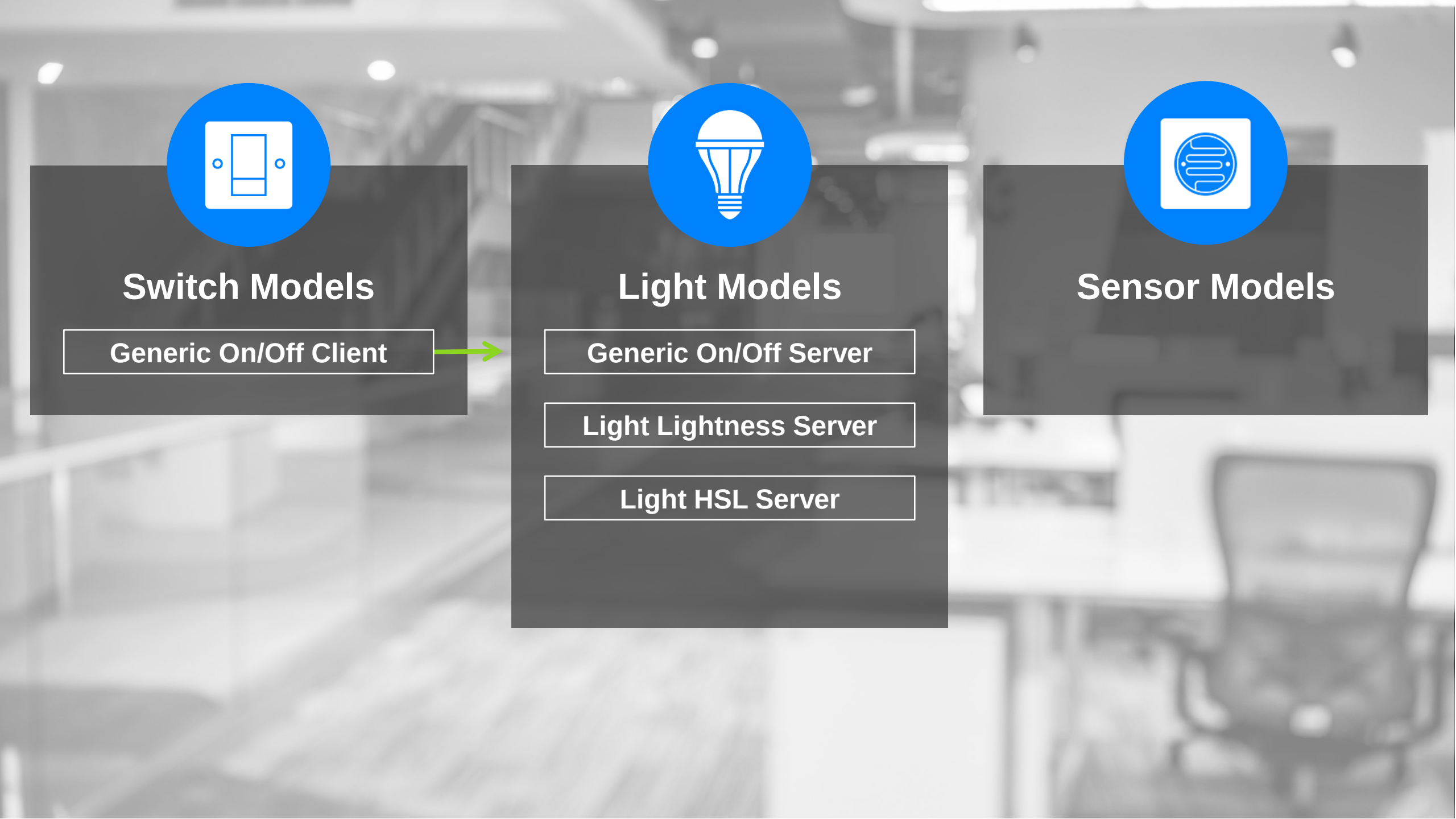
Switch Models

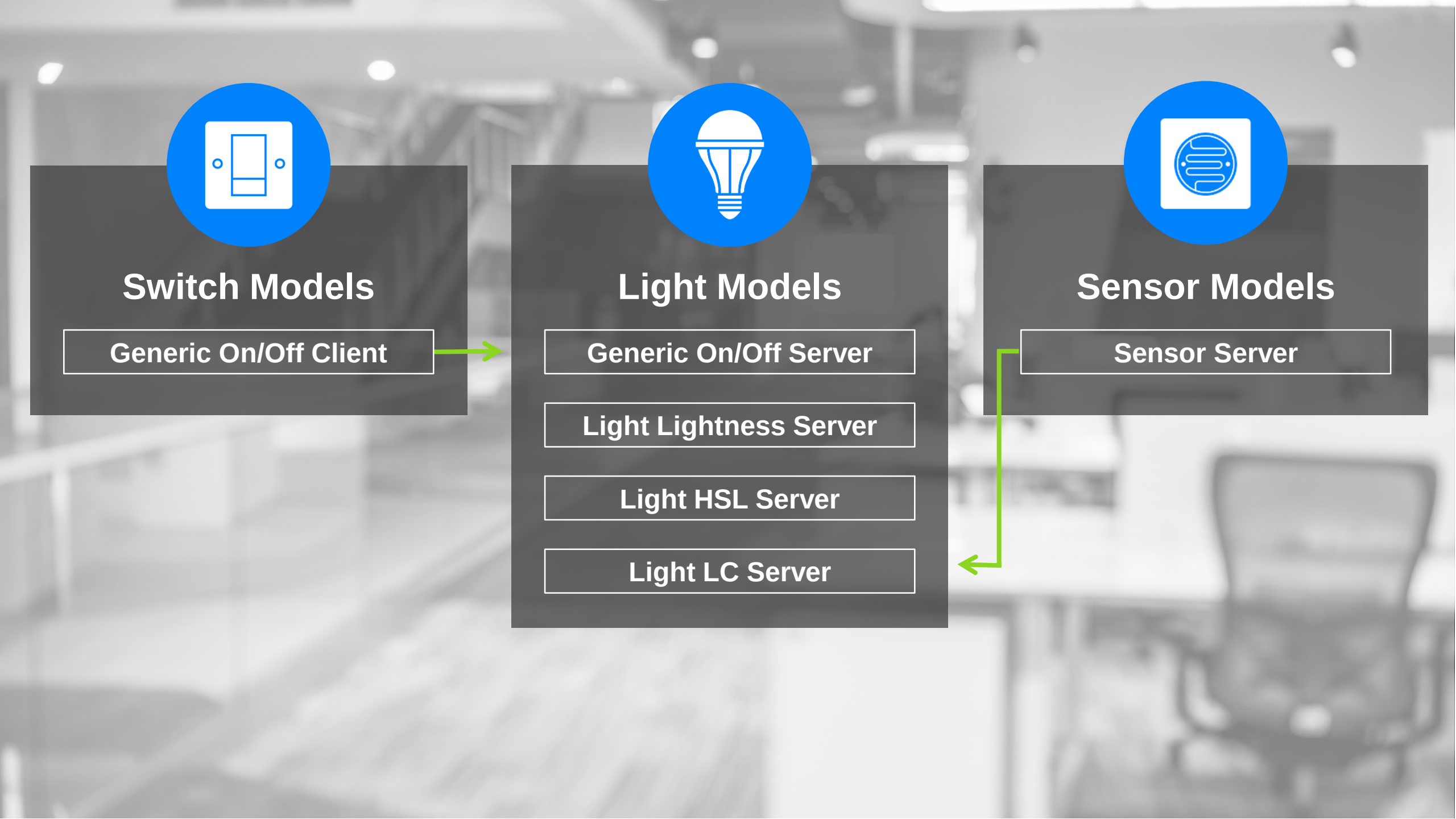
Light Models

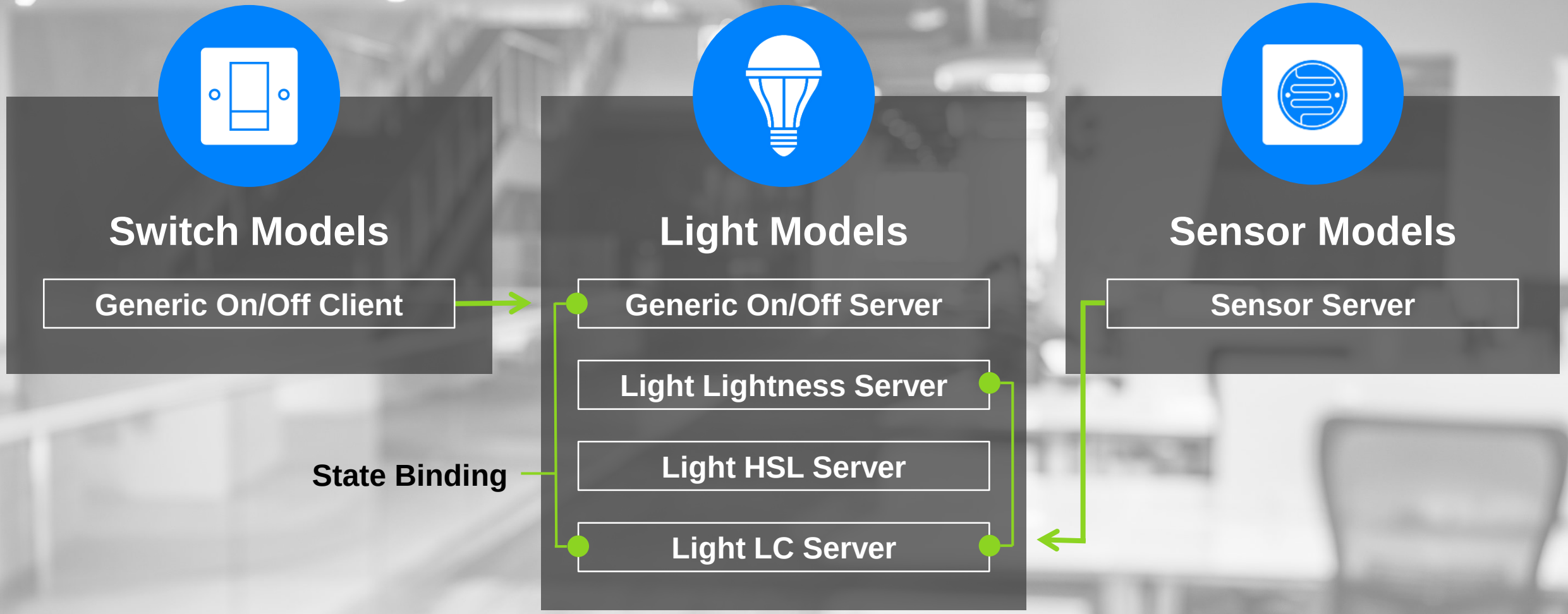
Generic On/Off Server

Sensor Models


Switch Models
Generic On/Off Client
Light Models
Generic On/Off Server
Sensor Models

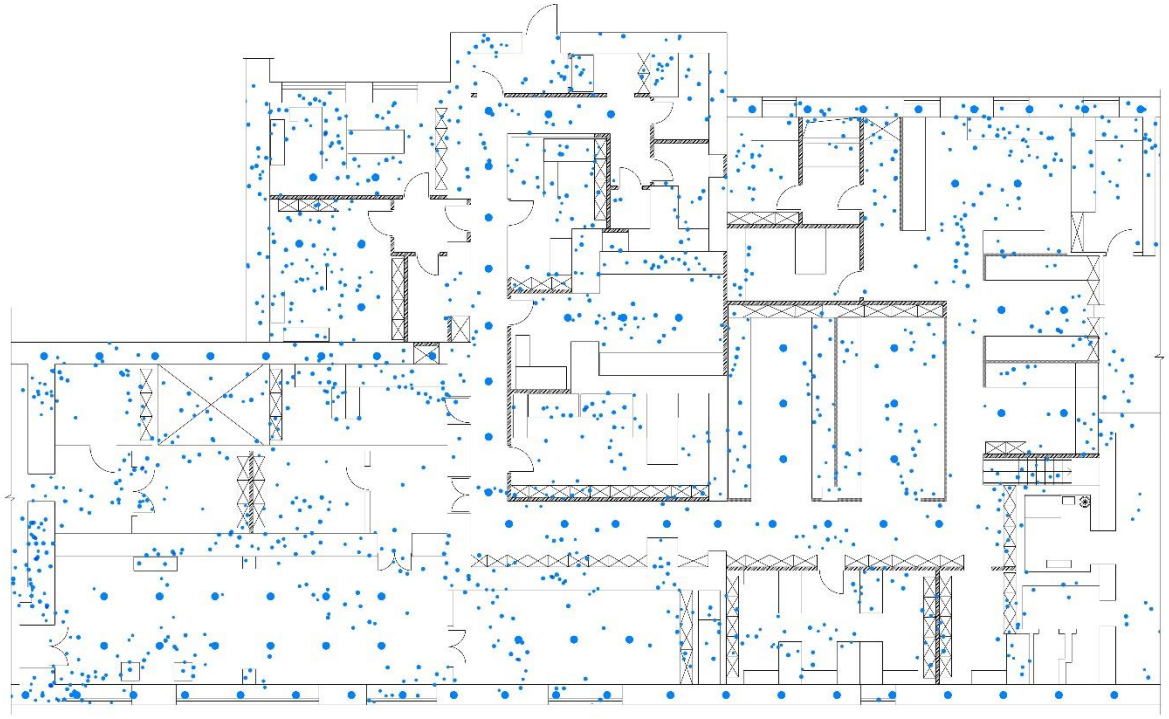

Switch Models
Generic On/Off Client
Light Models
Generic On/Off Server
Light Lightness Server
Light HSL Server
Sensor Models


Switch Models
Generic On/Off Client
Light Models
Generic On/Off Server
Light Lightness Server
Light HSL Server
Light LC Server
Sensor Models
Sensor Server


Switch Models
Generic On/Off Client
Light Models
Generic On/Off Server
Light Lightness Server
Light HSL Server
Light LC Server
State Binding
Sensor Models
Sensor Server

Bluetooth mesh

Scalability



scalability

max 32,767 nodes per network

hundreds of **multicast** messages per second

***multicast**: 1 message can control many devices*

The fastest low power radio

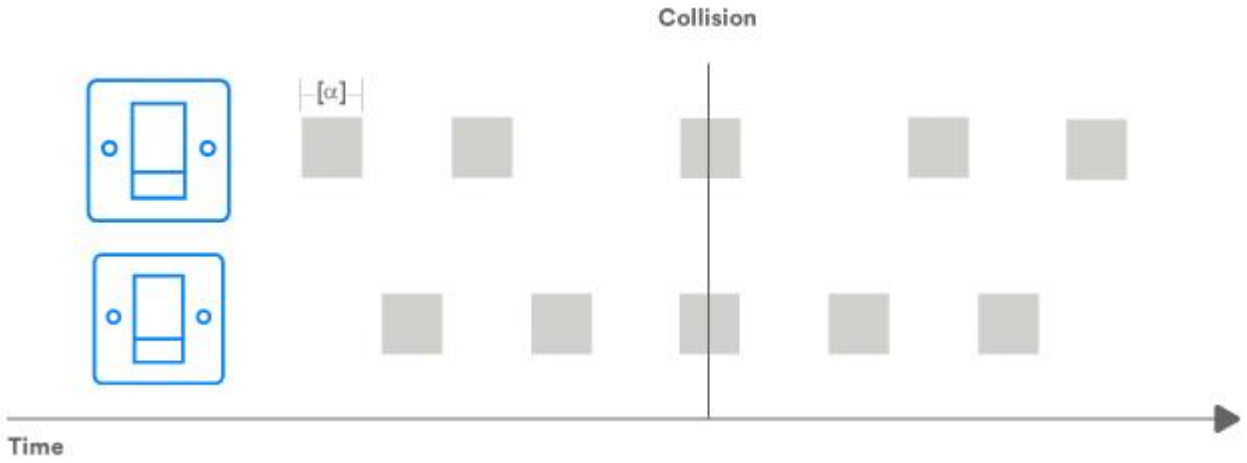
small, highly optimised packets

point to point range hundreds of metres

scalability and the fundamentals of RF

radio is a shared medium

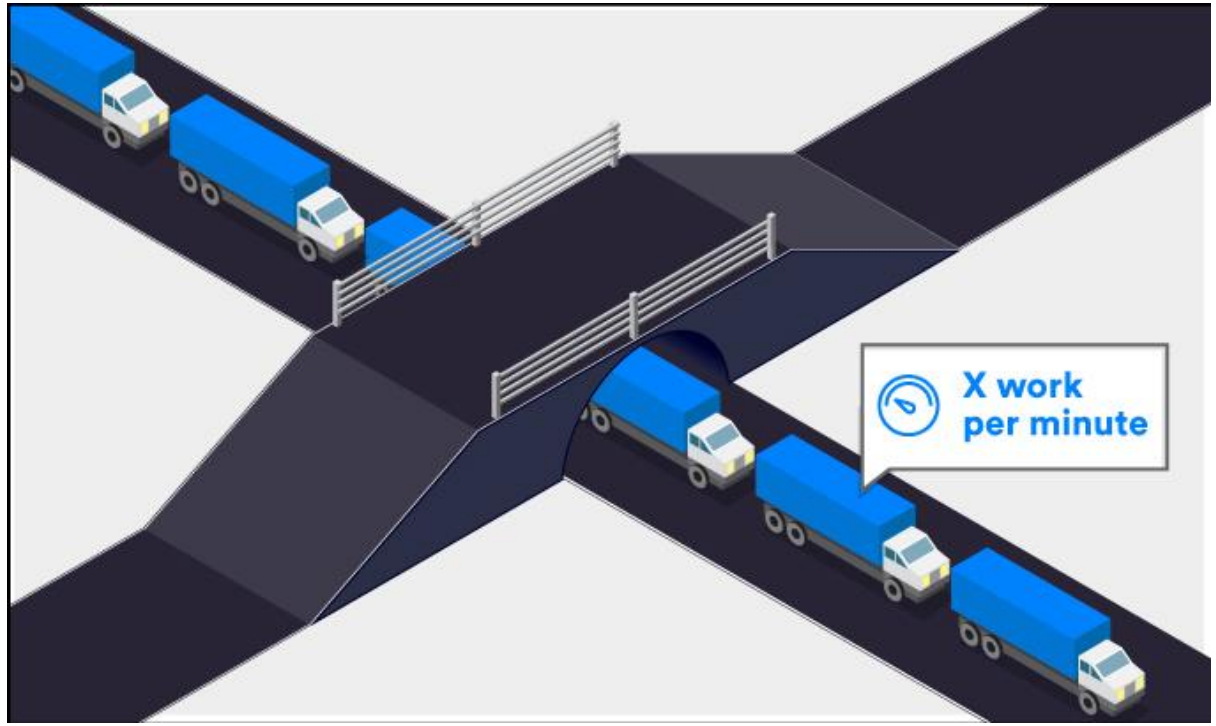
collisions are what limits scalability



scalability and the fundamentals of RF

an anonymous technology
(not Bluetooth)

e.g. 250 kb/s



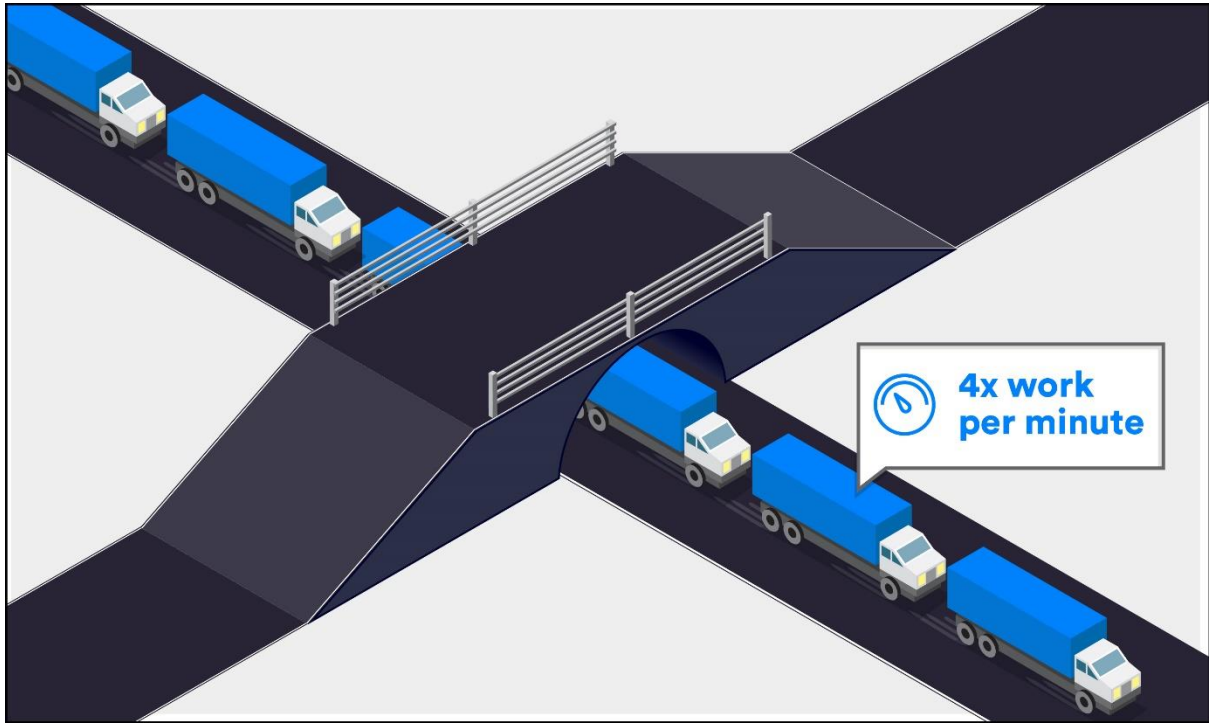
scalability and the fundamentals of RF

Bluetooth mesh
using Bluetooth Low Energy

1000 kb/s

less air time per packet

so more capacity for work



scalability and the fundamentals of RF

Bluetooth mesh

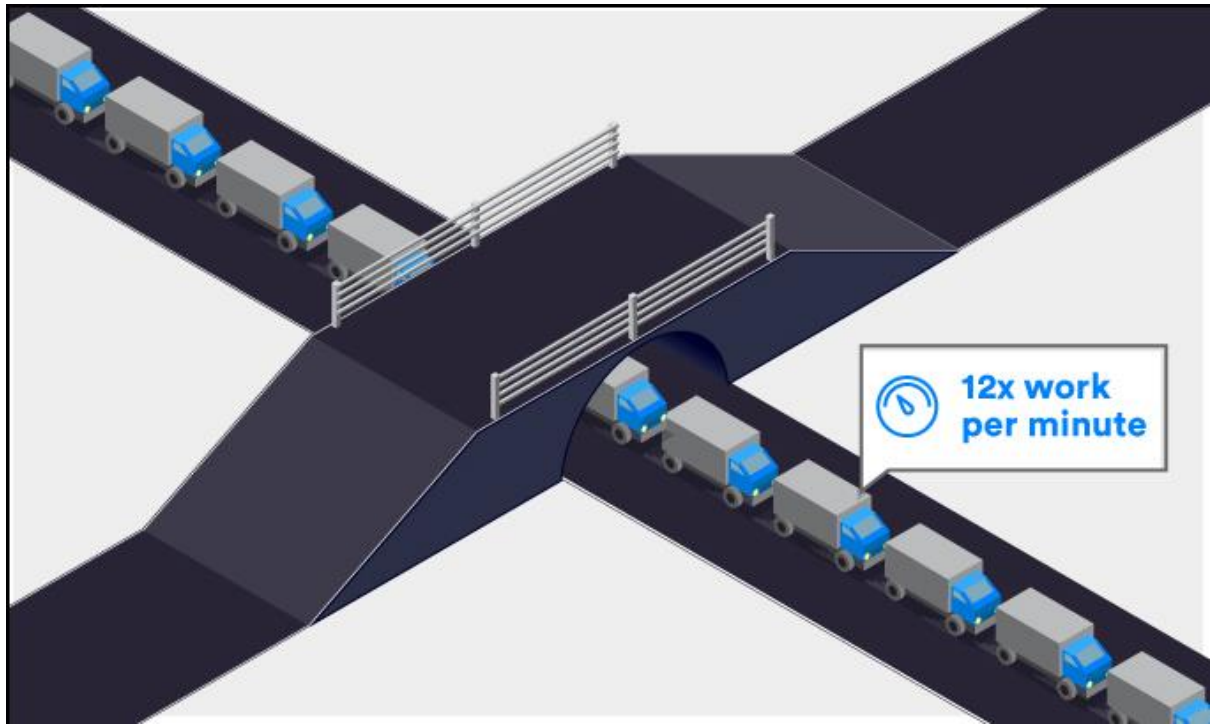
much smaller packets

less airtime

fewer collisions

more “work”

29 octets payload



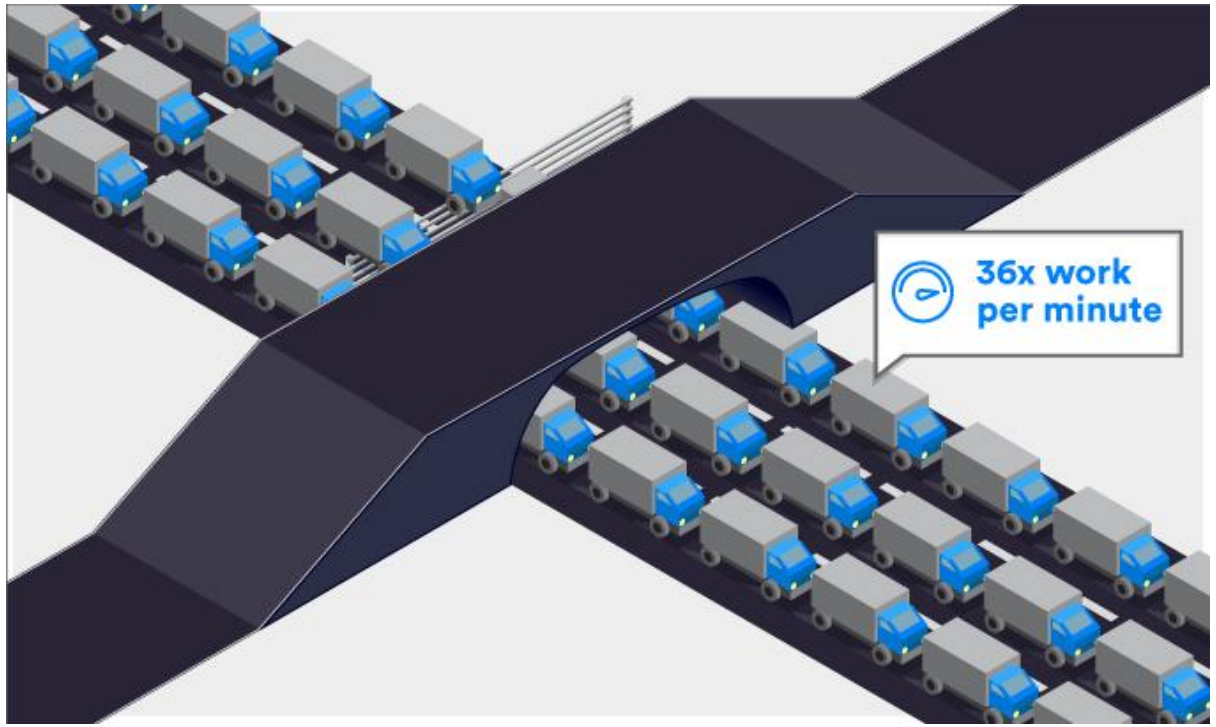
scalability and the fundamentals of RF

Bluetooth mesh
using Bluetooth Low Energy

3 x radio channels

3 x more capacity

used for enhanced reliability



Bluetooth Mesh

Demonstration

Bluetooth Mesh

What next?

Bluetooth SIG Resources at bluetooth.com

Adopted Mesh Networking Specifications

Specification	Date Adopted	Status
Mesh Profile Specification 1.0	13 July 2017	Active
Mesh Model Specification 1.0	13 July 2017	Active
Mesh Device Properties 1.0	13 July 2017	Active

Mesh Resources

- Mesh Networking Specifications
- The Case for Bluetooth Mesh
- Paving the Way for Smart Lighting
- Bluetooth Mesh FAQ
- Bluetooth Mesh Performance Study (Ericsson)
- Bluetooth Mesh Overview
- Bluetooth Mesh Technology Overview
- Related Mesh Blog Posts
- Bluetooth Mesh Glossary of Terms
- Webinar: What Makes Bluetooth Mesh So Disruptive?

Mesh Proxy Kit—is a self-study educational resource which teaches the key technicalities involved in creating applications for smartphones and other platforms which can monitor and control nodes in a Bluetooth mesh network. It introduces the mesh proxy protocol, explains related concepts and provides hands-on coding experience. Developers will learn some theory
proxy client application which they will test ag
for which is provided and which can be run on

Bluetooth Mesh Developer Study Guide—is a self-study educational resource which covers both the theory and practice of Bluetooth mesh device firmware development. By working through its coding exercises, you'll develop a working mesh network, with devices acting as on/off switches, dimmer controls and as a simple light. You'll learn about a variety of Bluetooth mesh models and cement your understanding by implementing these models using the SDK for the Zephyr RTOS.

questions?

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Bluetooth®

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