

# Benefits of DALI for Lighting



# Benefits of DALI for lighting

# What can DALI do?

## Digital control of light quality with intelligent feedback

- Precise, repeatable **light-output control** and standardized dimming curve
- **Occupancy and light-level sensing**
  - DALI-2 sensors and other input devices provide information to the system
- **Luminaire, energy & diagnostics data**
  - Data for enhanced asset management & performance monitoring
- **Emergency lighting**, automated tests
- **Colour control** for human-centric lighting, enhanced comfort and well-being
- DALI is already positioned for the **Internet of Things (IoT)**
- New specifications enable DALI connectivity via **wireless networks** and **IP-based networks**



# DALI for dimming

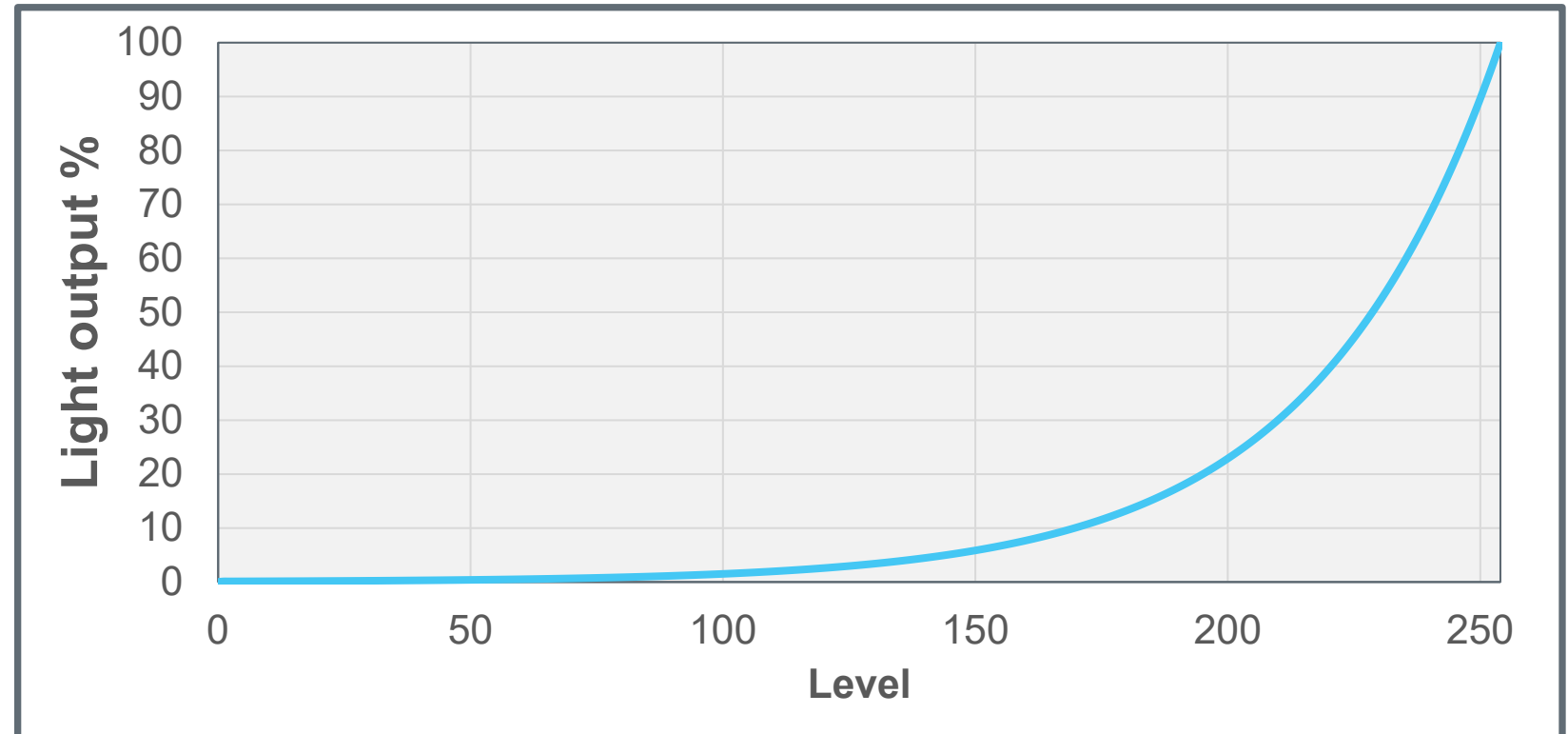
Accurate, repeatable, standardized light-output control

- Certified DALI-2 control gear follow a **standardized dimming curve**
  - Dimming curve is designed to match human-eye sensitivity and brightness perception
- Testing procedure requires **measurement of light output**

If you ask for 50% light output, you get 50%

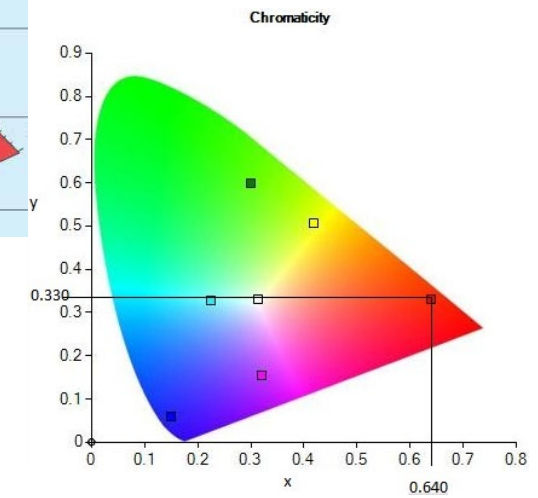
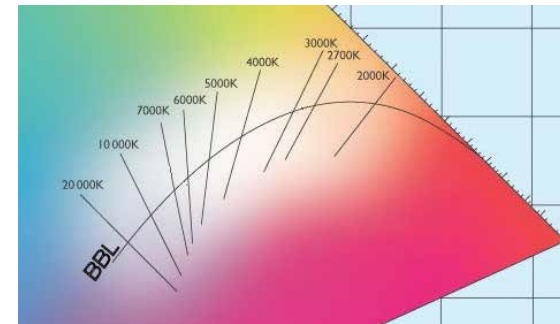
Consistent from fixture to fixture

Consistent between manufacturers



# DALI for colour control

- Enables control of the colour output of two or more lamps from DALI control gear
- Allows simple control of colour:
  - **RGBWAF** for individual control of each colour channel
  - **Tc (tunable white)** for colour-temperature control
- Allows precise and repeatable selection of colour:
  - **xy coordinate** (chromaticity)
- DALI scenes allow recall and smooth fading of colour as well as brightness
- For colour accuracy, xy and Tc colour types allow calibration



# DALI-2 certification for colour control

- DALI-2 tests are available for 3 colour types
  - Tests are based on Part 209. Colour control gear are also known as device type 8 (DT8)

Colour type	Common name	Also known as	Features
Tc (colour temperature)	Tunable white colour control	DT8(Tc)	Allows control of the correlated colour temperature (CCT) along the black-body line, from warm white to cool white.
RGBWAF	RGB colour control	DT8(RGB)	Allows simple control of up to 6 channels of colour (Red, Green, Blue, White, Amber and Free-colour).
xy coordinate	xy colour control	DT8(xy)	Allows precise and repeatable selection of the colour co-ordinates from the CIE colour space chromaticity diagram (1931).

# DALI-2 certification for colour control

- DALI-2 certification is offered for:
  - Tunable white: Tc only
  - RGB colour control: RGBWAF only
  - Multi-type colour control: All 3 colour types available in the same product



# DALI for emergency lighting

- Widely used globally as a robust and reliable solution
  - Provides light when the mains supply fails
  - Safety-critical feature mandated by various regulations
- DALI enables illumination and emergency lighting on same network
- DALI enables automated self-testing:
  - Many countries have a legal requirement for periodic testing
  - Function test: quick test of battery, charging circuit, driver/relay and lamp
  - Duration test: checks operation for the rated duration (e.g. 1h, 3h...)





# DALI-2 certification for emergency lighting

- DALI-2 certification of control gear for self-contained emergency
  - “Self-contained” means the battery is inside, or placed next to, the luminaire
- DALI provides data e.g. test results, information on failures, battery charge levels, lamp operating hours
  - Monitor and report real-time energy usage (Part 252)



# DALI for wellbeing and comfort

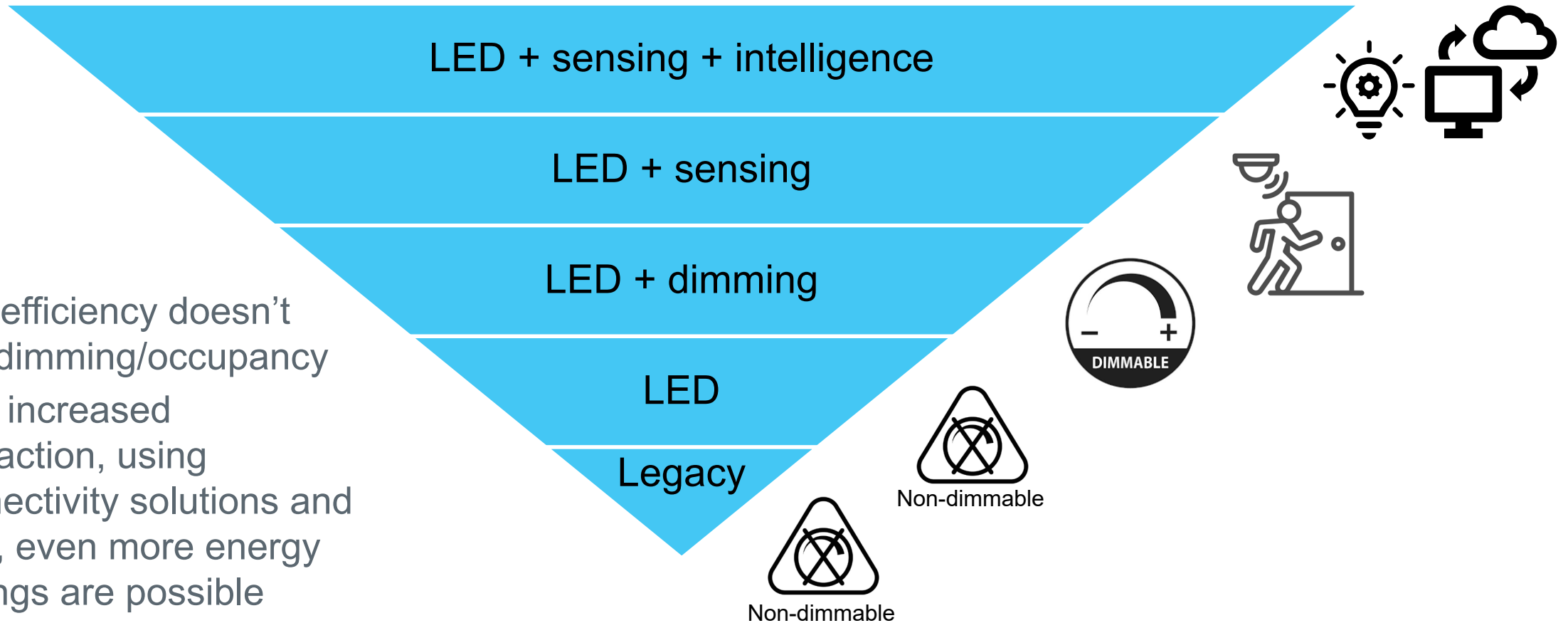
## Efficient, human-centric lighting

- Daylight harvesting: adjust intensity according to ambient light levels through the day
  - DALI-2 light-level sensors
- Match lighting levels to actual utilization of spaces
  - DALI-2 occupancy sensors
- Colour-temperature control according to time of day and/or individual preference
  - DALI-2 tunable white
- Personal control of lighting via user interfaces
  - DALI-2 input devices such a push-buttons, rotary controls or touch panels
- Building occupants experience improved comfort and wellbeing
  - Higher productivity, better staff retention



# DALI for energy efficiency

- DALI builds on energy efficiency gains from using LEDs and basic lighting control (switches, dimmers)

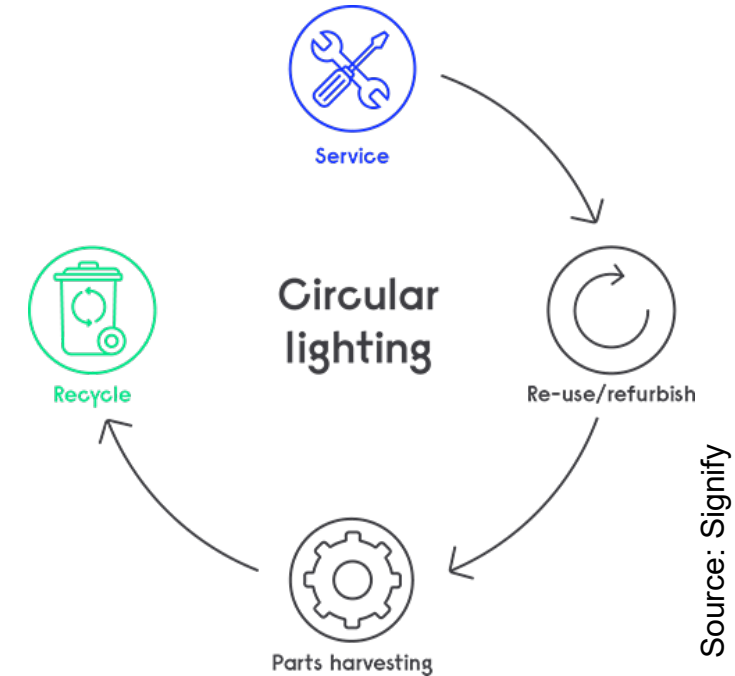


Energy efficiency doesn't stop at dimming/occupancy

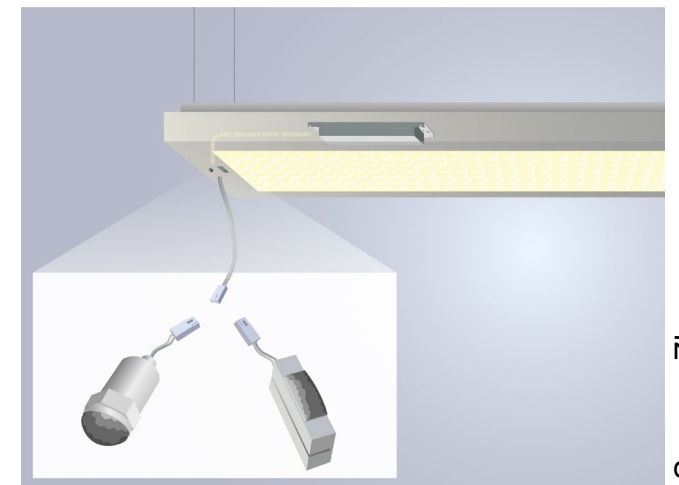
- With increased interaction, using connectivity solutions and data, even more energy savings are possible

# DALI and the circular economy

- DALI enables modular systems/designs
  - Enables components to be interchangeable
  - Certified, interoperable
- Replacement components from multiple sources enable supply-chain longevity
  - Removes supply-chain constraints: Not reliant on single supplier
  - Future-proof by backwards compatibility
- DALI enables the potential to extend the lifetime of luminaires and luminaire designs
  - Easily upgradeable
  - Plug and Play if socketed and standardized e.g. Zhaga-D4i



Source: Signify



Source: Zhaga

# DALI data

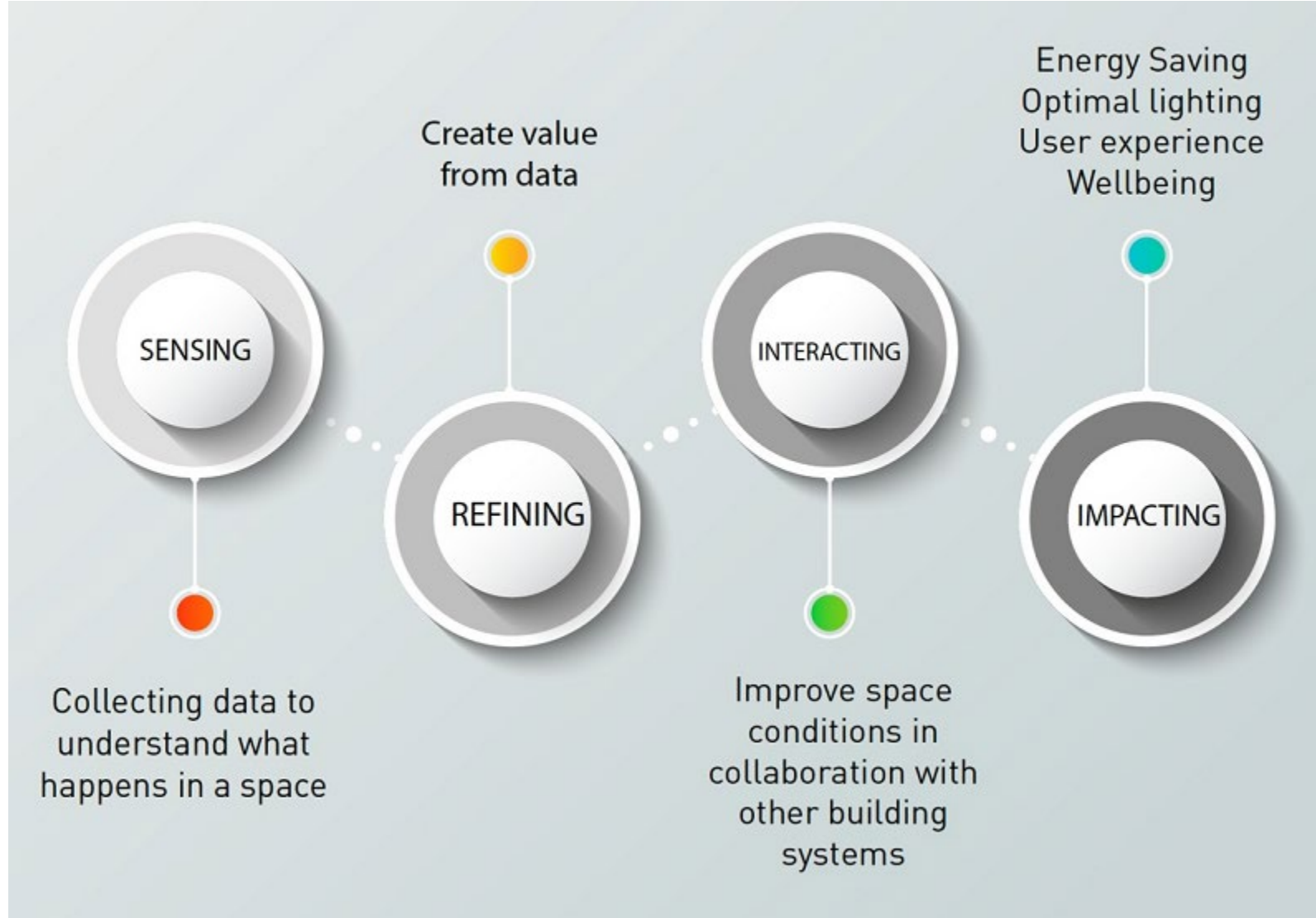
# DALI for data

DALI is built to enable smart, data-rich networks

- Feedback & exchange of data is enabled by two-way communication
  - Control gear provide data on output level, lamp failure, emergency test data and more
- DALI-2 sensors and other input devices
  - Environmental information and user inputs
- DiiA Specifications for data storage and reporting
  - Data for enhanced asset management, performance monitoring & diagnostics, real-time energy usage
  - Data for luminaires, control gear & light sources



# Elements of lighting intelligence



Source: Helvar

# DALI sensors & other input devices

- Sensors provide information for automated control
- User inputs allow occupants to make adjustments
  - Dimming, colour, scene recall etc
- DALI-2 input device types include:
  - Push-buttons
  - Absolute input devices (switches, sliders, rotary controls)
  - Occupancy sensors (movement or presence type)
  - Light sensors (illuminance level)
- Other sensor types in development include:
  - Colour sensors
  - General-purpose sensors
- Operation can be event driven, or by polling, or by periodic transmission.





# DALI data specifications



- Data for enhanced asset management & performance monitoring
- Data storage in DALI memory banks, with standardized format & locations

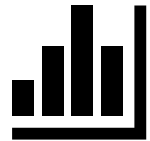
## Luminaire Data



### DALI Part 251 – Luminaire Data

- Information about the luminaire (e.g. GTIN, light output, CCT & CRI, light distribution etc) can be stored in the control gear
- Enables asset management

## Energy Data



### DALI Part 252 – Energy Reporting

- Provides real-time power & energy usage for control gear

## Diagnostics Data

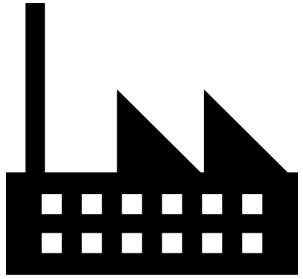


### DALI Part 253 – Diagnostics & Maintenance

- Operating data for control gear and lamps, including failure conditions, run-time data
- Enables predictive maintenance

These specifications are available from DiiA, and are also included in ANSI C137.4

# Using DALI data



**In the factory:**  
Luminaire data is programmed into drivers

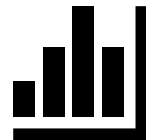


Network



**During operation:**  
**Performance monitoring**

- Energy usage data can be used e.g. for billing



**In the field:**

## **Automated commissioning**

- When installed, luminaires can automatically transfer data to a remote network
- Reduces human error, saves installation time and cost
- Operator has a full map of asset information

**During operation:**

## **Predictive maintenance**

- Diagnostics data allows network operator to anticipate need for maintenance
- Repair team has knowledge of location and type of fixture

# D4i and IoT luminaires

# D4i overview

- D4i is an extension of DALI-2 certification
- D4i components have a compulsory set of features
  - Based on power-supply and data specifications from DiiA
- All D4i LED drivers provide luminaire, energy & diagnostics data
- D4i enables DALI inside intelligent, IoT-ready luminaires
  - Other D4i implementations are also permitted
- D4i simplifies addition of sensors and communication devices to luminaires
- D4i enables plug-and-play interoperability when combined with a connector system
  - e.g. Zhaga Books 18 & 20, or NEMA/ANSI

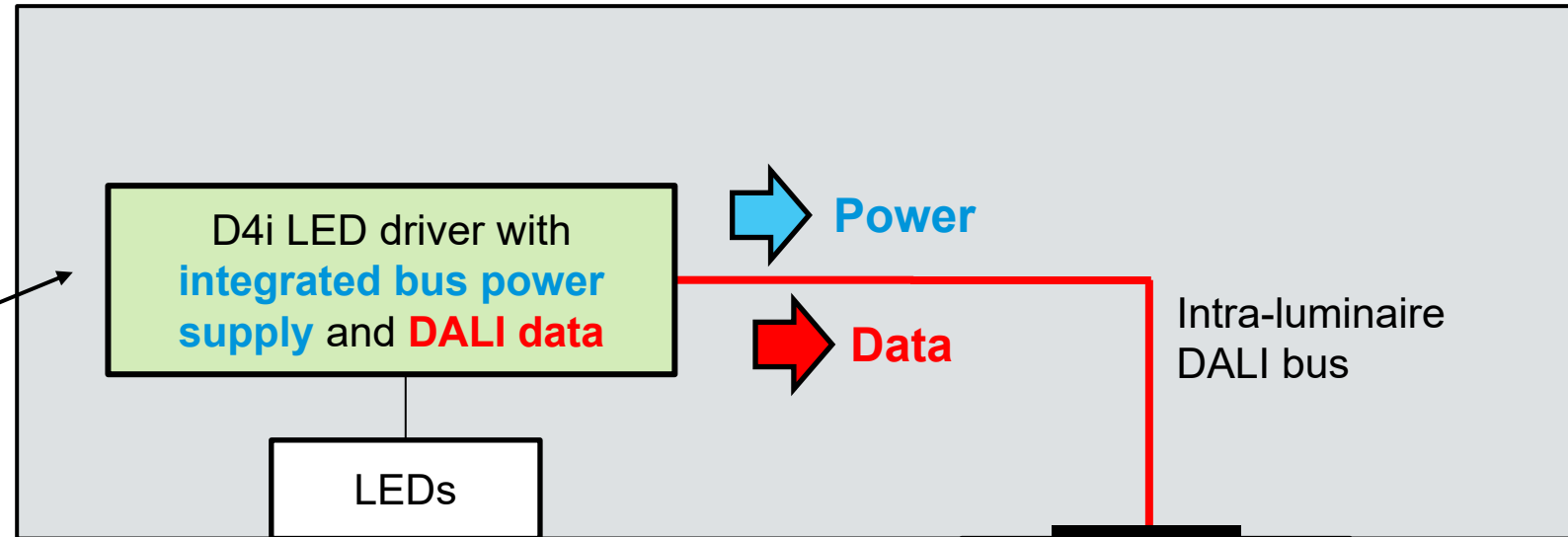


# D4i example: Indoor luminaire



**DALI Part 250**  
(integrated bus power)

**DALI Parts 251-3**  
(luminaire, energy & diagnostics data)

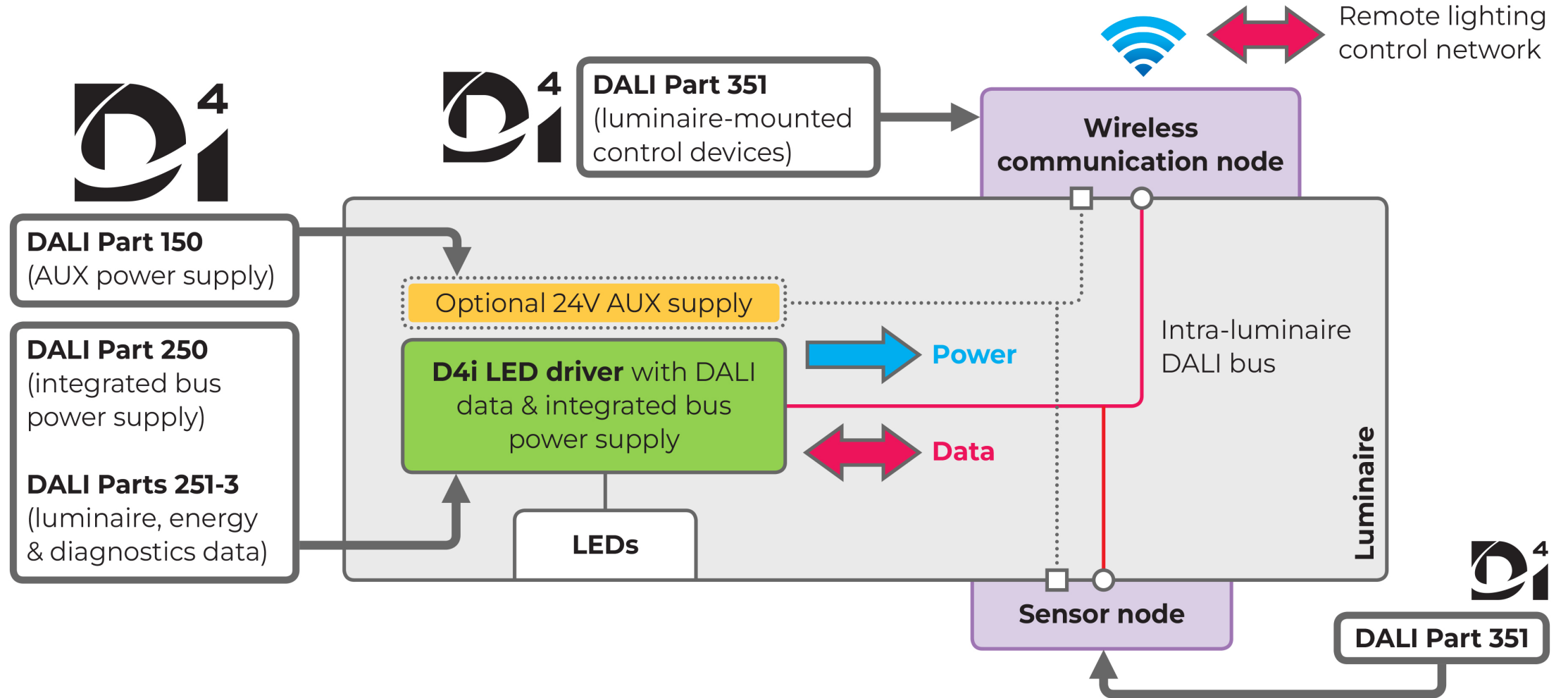


Luminaire



**DALI Part 351**  
(luminaire-mounted control devices)

# D4i example: Two-node outdoor luminaire



# Zhaga-D4i certification

A joint certification program based on complementary specifications

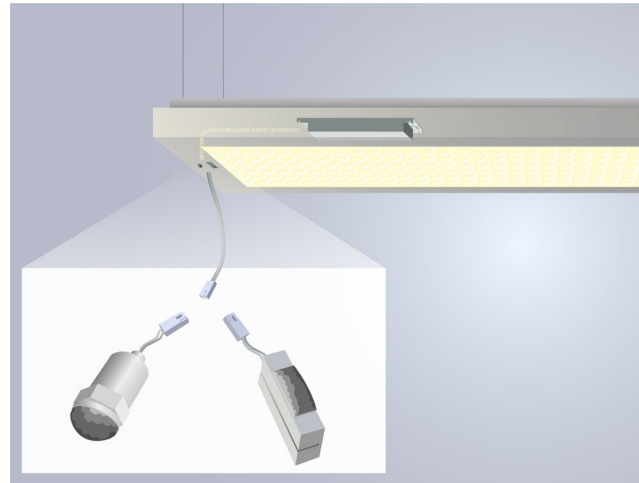
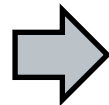


**Specifications from DiiA  
enabling D4i certification**

**Book 18 & Book 20  
specifications from Zhaga**



**DALI Part 250:** Integrated bus power supply  
**DALI Part 251:** Luminaire data  
**DALI Part 252:** Energy data  
**DALI Part 253:** Diagnostics data  
**DALI Part 351:** Luminaire-mounted control devices  
**DALI Part 150:** AUX power supply



**Book 18 for outdoor:**  
**Book 20 for indoor:**

- Mechanical interfaces
- Electrical pin assignment (Book 18)
- Electrical connectors (Book 20)
- References to D4i specs for power & control, and luminaire tests



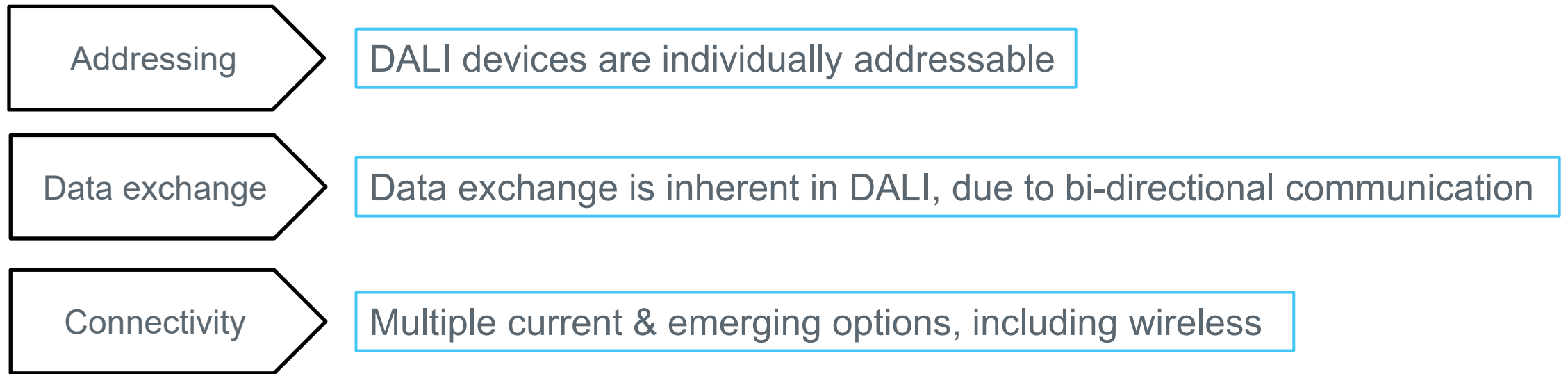
# Connectivity



# DALI in an IoT world

How does DALI fit with this simple IoT definition?

- IoT: A system of devices with unique identifiers and ability to transfer data over a network



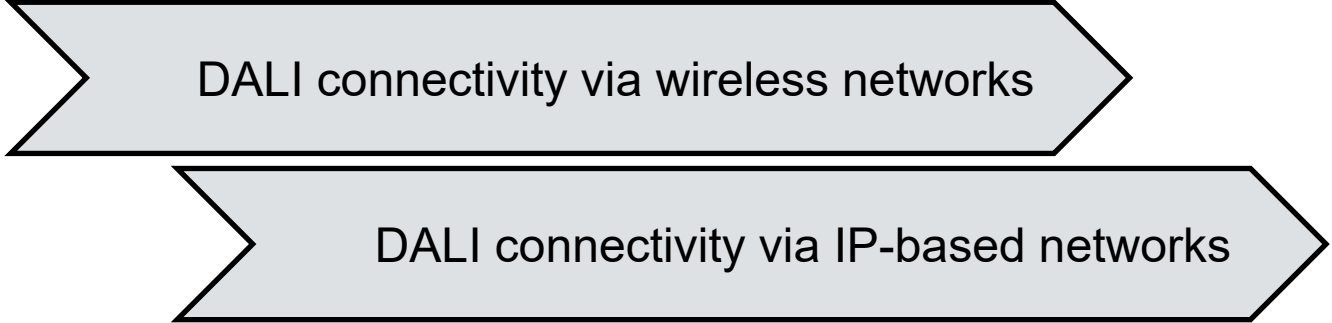
DALI is already positioned to participate in the Internet of Things

# DALI in an IoT world – Connectivity

## Current DALI capabilities:

- Multiple DALI subnets can be networked together, for building-wide control
  - A single application controller can control multiple DALI subnets
  - Several application controllers can be connected together via a backbone e.g. Ethernet-based
- DALI systems can connect with other networks via non-standardized gateways
  - e.g. Gateways connecting with building-management systems (BMS)
- D4i facilitates addition of wireless nodes (network lighting controllers) to luminaires
  - Standalone luminaires can participate in remote lighting-control networks

## Emerging DALI capabilities:



DALI connectivity via wireless networks

DALI connectivity via IP-based networks

# DALI in a wireless world

Two distinct solutions for combining DALI with wireless networking

## Wireless to DALI Gateways

Gateways allow existing DALI wired products to be used in a non-DALI wireless ecosystem

## Wireless DALI

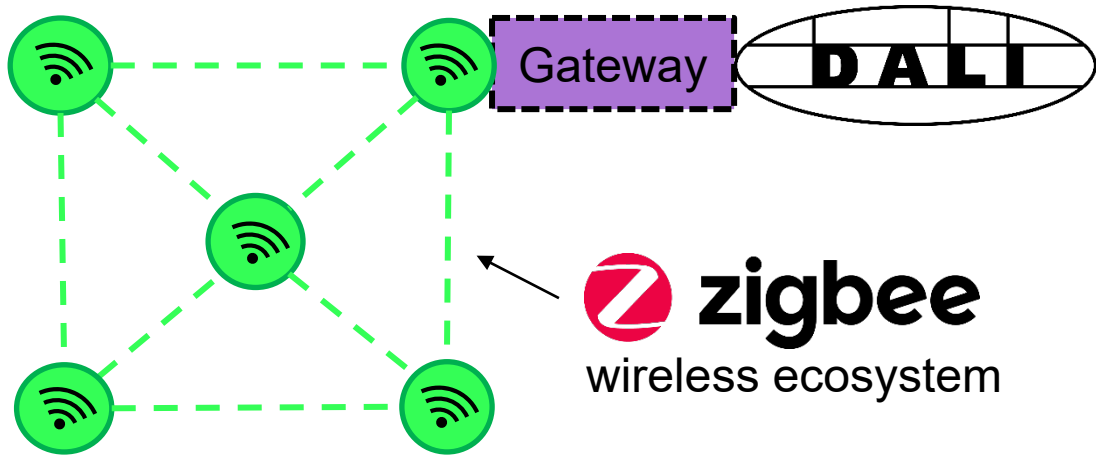
Devices communicate using existing DALI commands, carried over a wireless medium

- DALI Alliance has developed **new specifications** addressing **both options**
- We are developing tests to enable certification programs, in collaboration with partners:

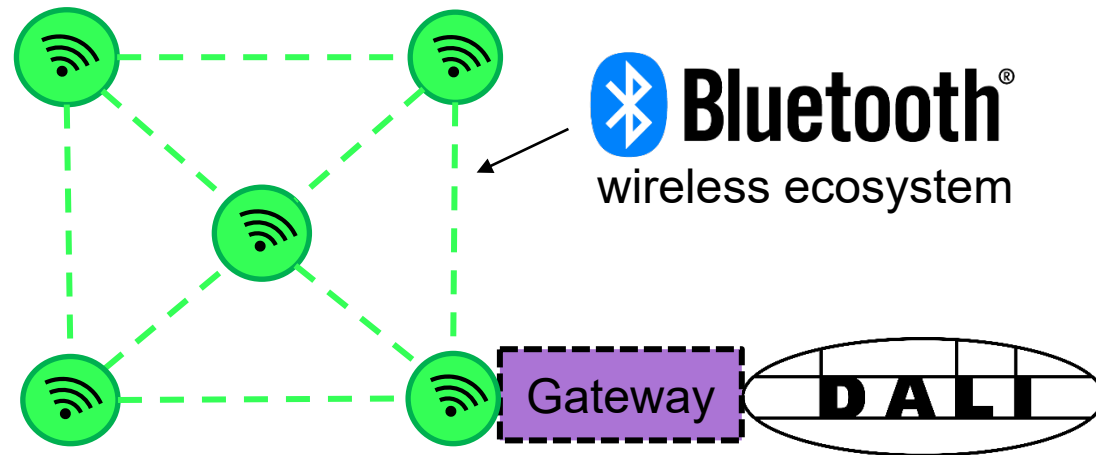


# Wireless solutions for DALI

## Wireless to DALI Gateways

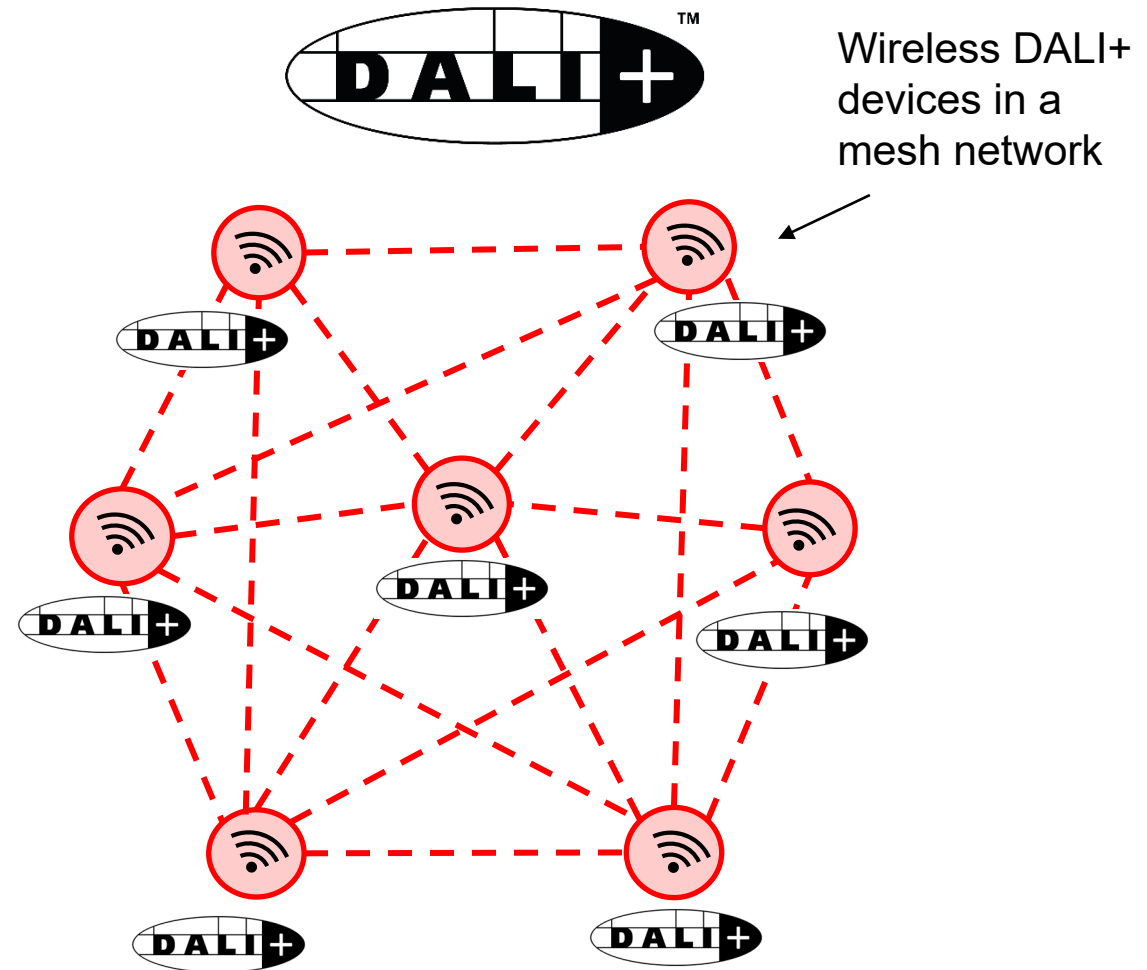


 **zigbee**  
wireless ecosystem

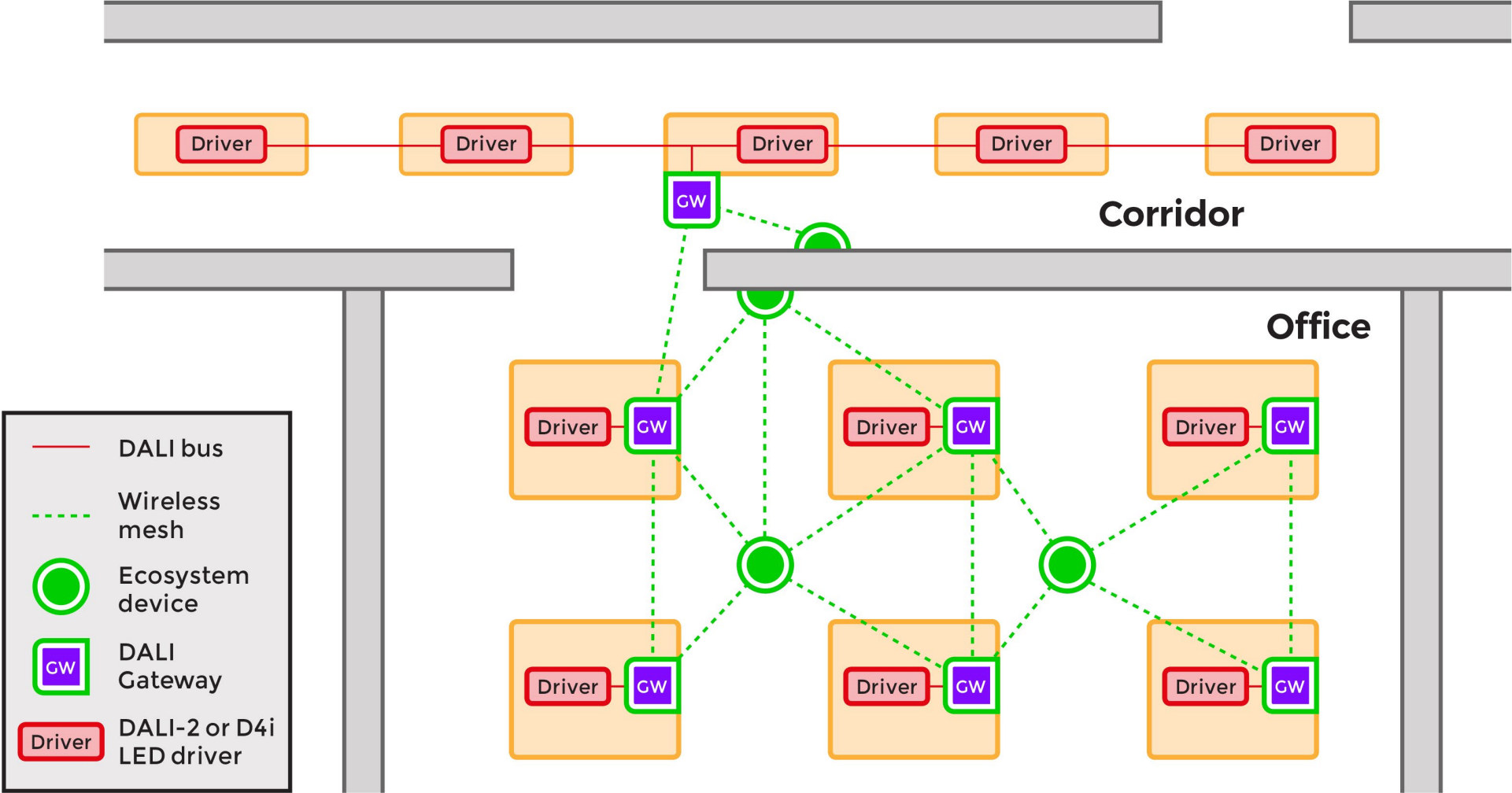


 **Bluetooth**<sup>®</sup>  
wireless ecosystem

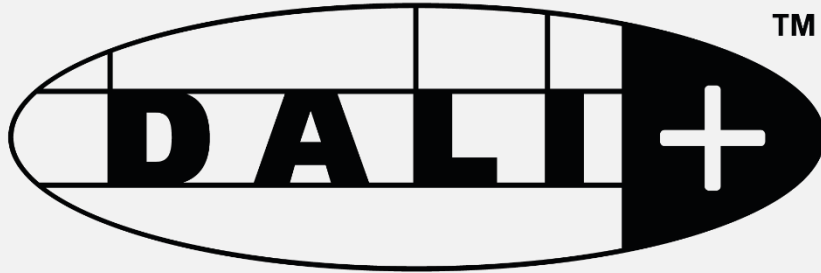
## Wireless DALI



# Wireless to DALI Gateways – Implementation



# Introducing DALI+

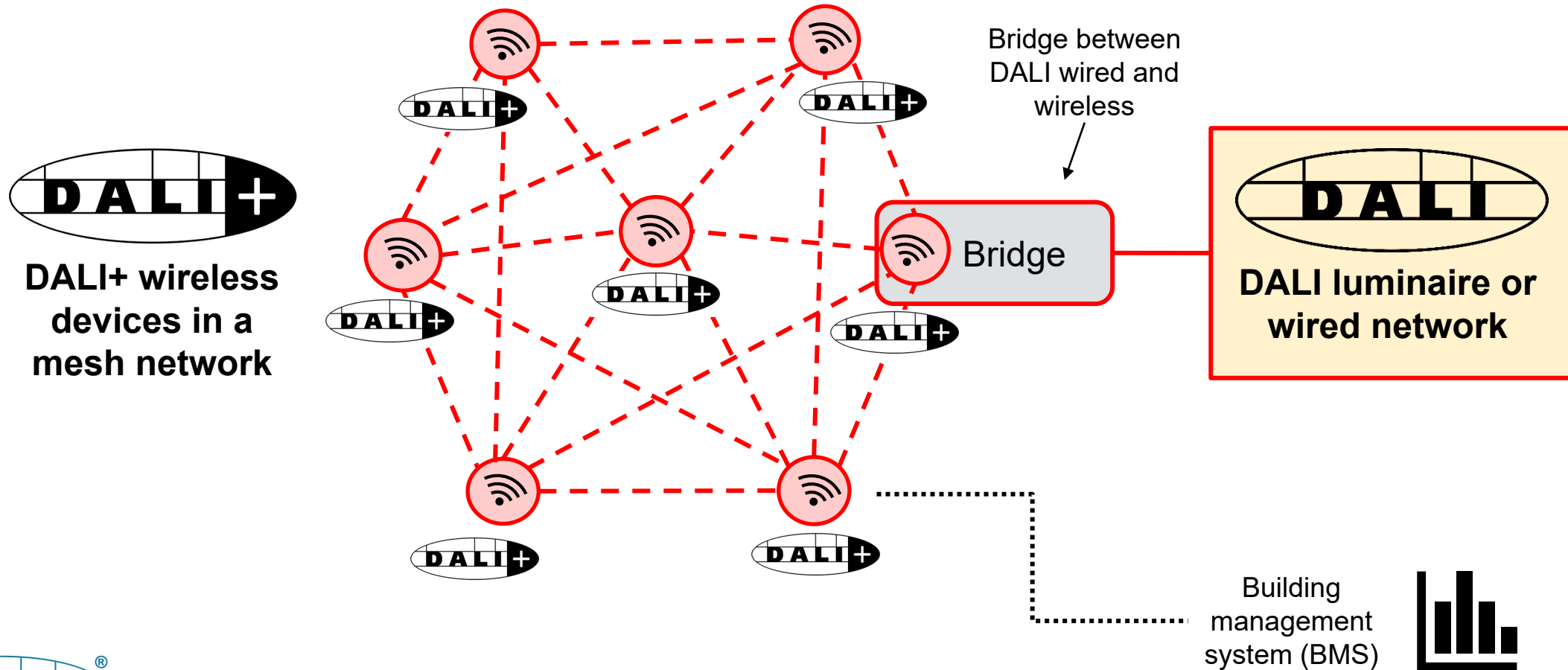


DALI lighting control  
**plus**  
wireless and IP-based networking

- DALI+ devices communicate using existing DALI commands, carried over a wireless and/or IP-based physical medium
  - Different from the dedicated pair of wires used by DALI-2 and D4i
- New DiiA Specification supports DALI+ with IP-based carriers e.g. Thread, Ethernet, Wi-Fi
- We are developing tests → “DALI+ with Thread” certification
- Same sophisticated DALI lighting-control features as wired (DALI-2 & D4i) options
- Same access to rich set of data from control gear, luminaires and sensors
- Additional addressing features

# DALI+ over Wireless – Bridges

- Bridges allow access to DALI wired luminaires or subnets, from the DALI+ wireless network
- DALI commands are used throughout, and there is no translation between protocols



# IP-BLiS (IP for Building & Lighting Standards)

- Internet Protocol for Building & Lighting Standards
- A marketing organization (not a new standards organization)
- Goal: to make commercial buildings more responsive to the needs of users by promoting a secure, multi-standard, IP-based harmonized IoT solution



## STANDARDS JOINING FORCES



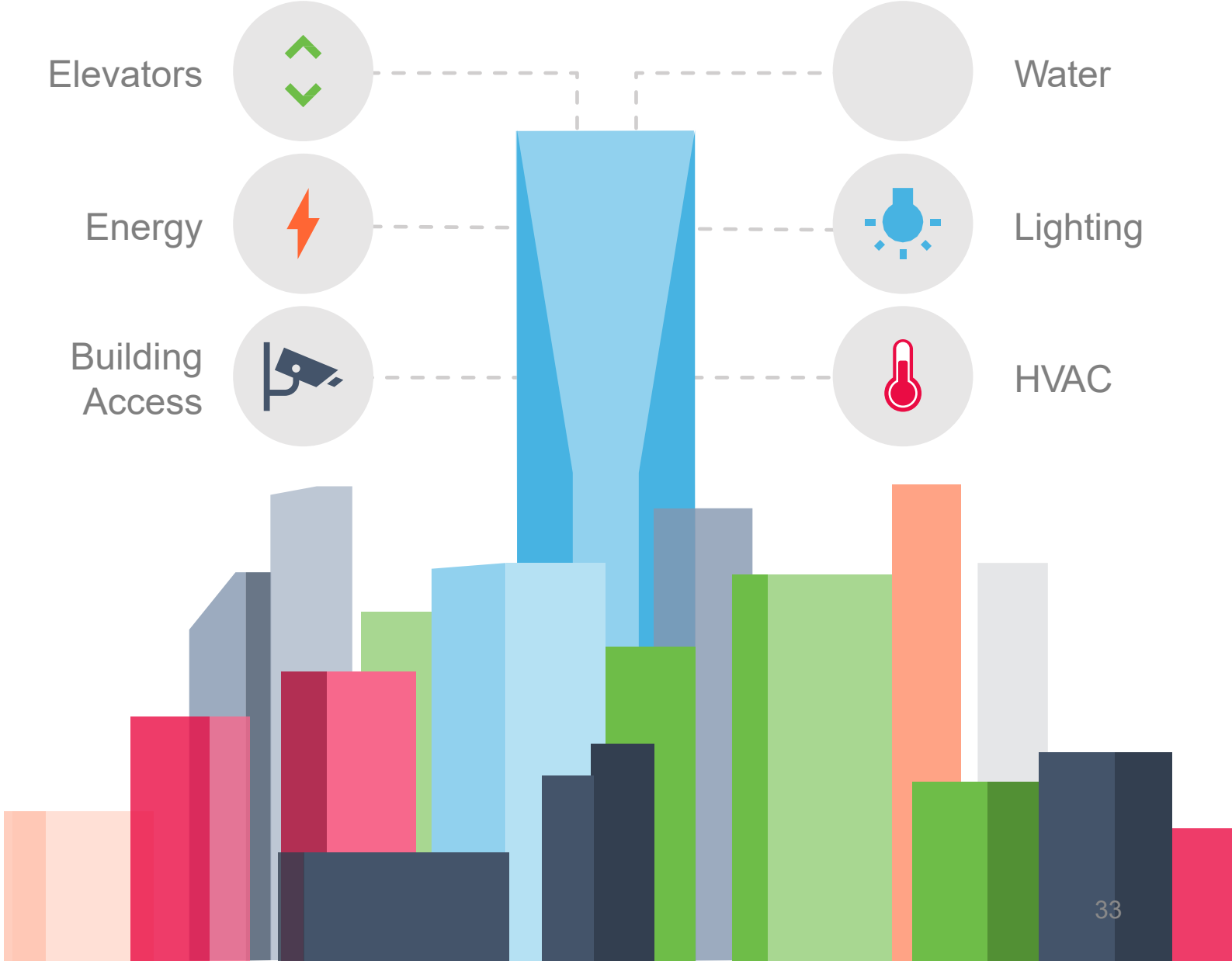
**DALI+ with Thread**  
is an IP-based,  
wireless solution



# Today: Building technologies in silos

There are more connected devices in Smart Buildings every day.

Each system evolved independently with its own proprietary solutions.

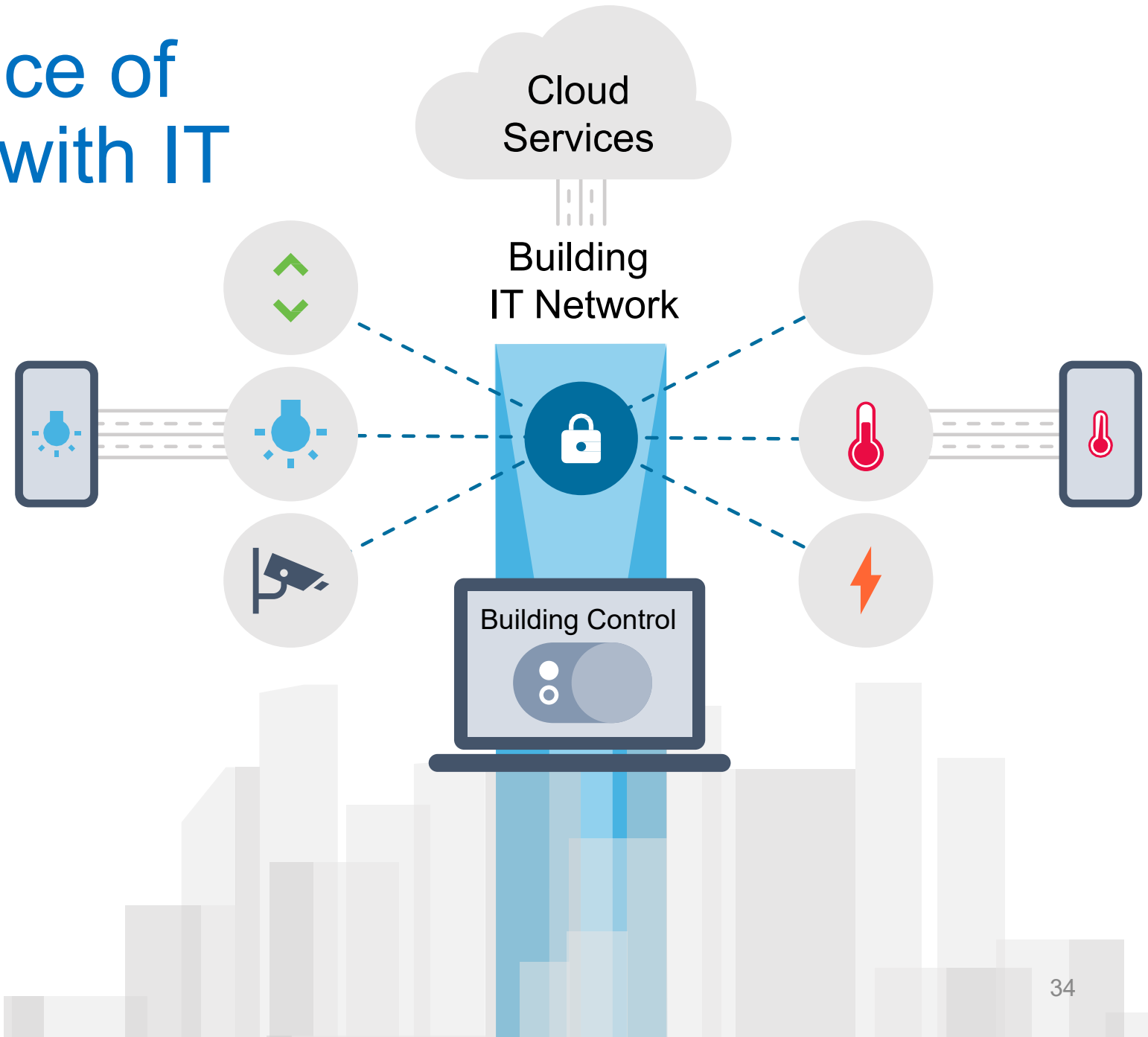


# Trend: Convergence of Building Systems with IT

Facilitates IoT for commercial buildings.

No silos.  
No proprietary applications.

Allows multiple systems to communicate together using cloud services & cloud computing.



# Conclusions

- DALI makes a significant contribution to intelligent buildings:
  - Energy efficiency
  - Data monitoring and reporting
  - Future-proofing
  - Wellbeing and comfort of occupants
  - Predictive maintenance
  - Circular economy
- Standardization and certification increases confidence in cross-vendor interoperability
- New specifications enable:
  - DALI over wireless and IP-based connectivity options
  - Gateways to other wireless ecosystems

# DALI Alliance contact information



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Thank you !!



Alliance

