Connected DALI-2 lighting control for intelligent, occupant-friendly buildings

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Lux Review webinar

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Digital Illumination Interface Alliance

DALI®

DALI 2®

D4™

Agenda & Speakers

- Introduction: DALI, DALI-2 and DiiA
- Key technical features
- Benefits for lighting
- DALI in smart buildings
- Connectivity
- Conclusions
- Q&A

Scott Wade, Technical & Certification Manager, DiiA

Paul Drosihn, General Manager, DiiA

Overview: 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
  - Tunable white colour control is now part of DALI-2
- DALI is already positioned to participate in the **Internet of Things**
- New specifications will create DALI connectivity via **wireless networks and IP-based networks**

Introduction:
DALI, DALI-2 and DiiA

DALI and DALI-2: The basics

Digital **A**ddressable **L**ighting **I**nterface

- DALI® is the industry-standard protocol (language) for bi-directional, digital communication between lighting-control devices.
  - Dedicated to lighting, with a rich feature set
- DALI is technically managed in the open, global standard IEC 62386.
- DALI-2™ is the latest version of the DALI protocol.
- DALI-2 certification is driven by DiiA, the global DALI alliance.
  - Ensures interoperability through testing and certification with trademark use
- DALI, DALI-2 and D4i trademarks are controlled by DiiA.

Key features of DALI-2

The latest version of the DALI protocol

More features and **clearer specifications**.

Focuses on **multi-vendor interoperability,** backed by DALI-2 **certification.**

More detailed and comprehensive **testing requirements**.

Extends to all devices in a lighting-control system, including **input devices** (e.g. sensors) and **application controllers**.

Designed for **backwards-compatibility** with older DALI systems.

DiiA: The global industry alliance for DALI®

- The Digital Illumination Interface Alliance (DiiA) is an open, global consortium of lighting companies that aims to grow the market for lighting-control solutions based on DALI.

Digital Illumination Interface Alliance

- Almost **250 members** worldwide
- Three membership types:
  - Regular, Associate, Community registration for luminaire makers
- Membership allows certification or registration of products:
  - Over **1,000 DALI-2 certified products**
  - Over 1,350 DALI version-1 registered products
- Membership allows DALI, DALI-2 and D4i **trademark use**

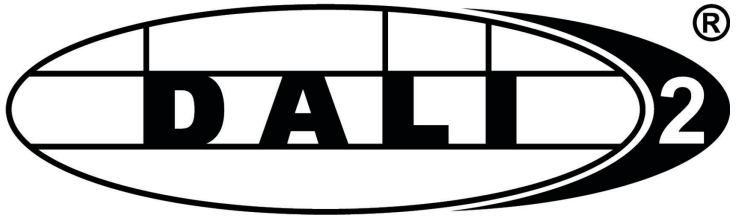
DALI-2 certification

- DiiA drives the DALI-2 certification program
  - Ongoing work to add new features and new products types

- DALI-2 certification involves **rigorous and detailed testing**
  - Approx. 3 days to test a DALI-2 LED driver
- Followed by **verification** of test results

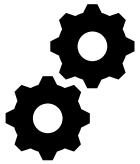
→ **High confidence of interoperability** between products

- Allows **trademark use**
- Products are **traceable** in the DiiA database
  - See www.dali2.org/products



Based on open, global standards

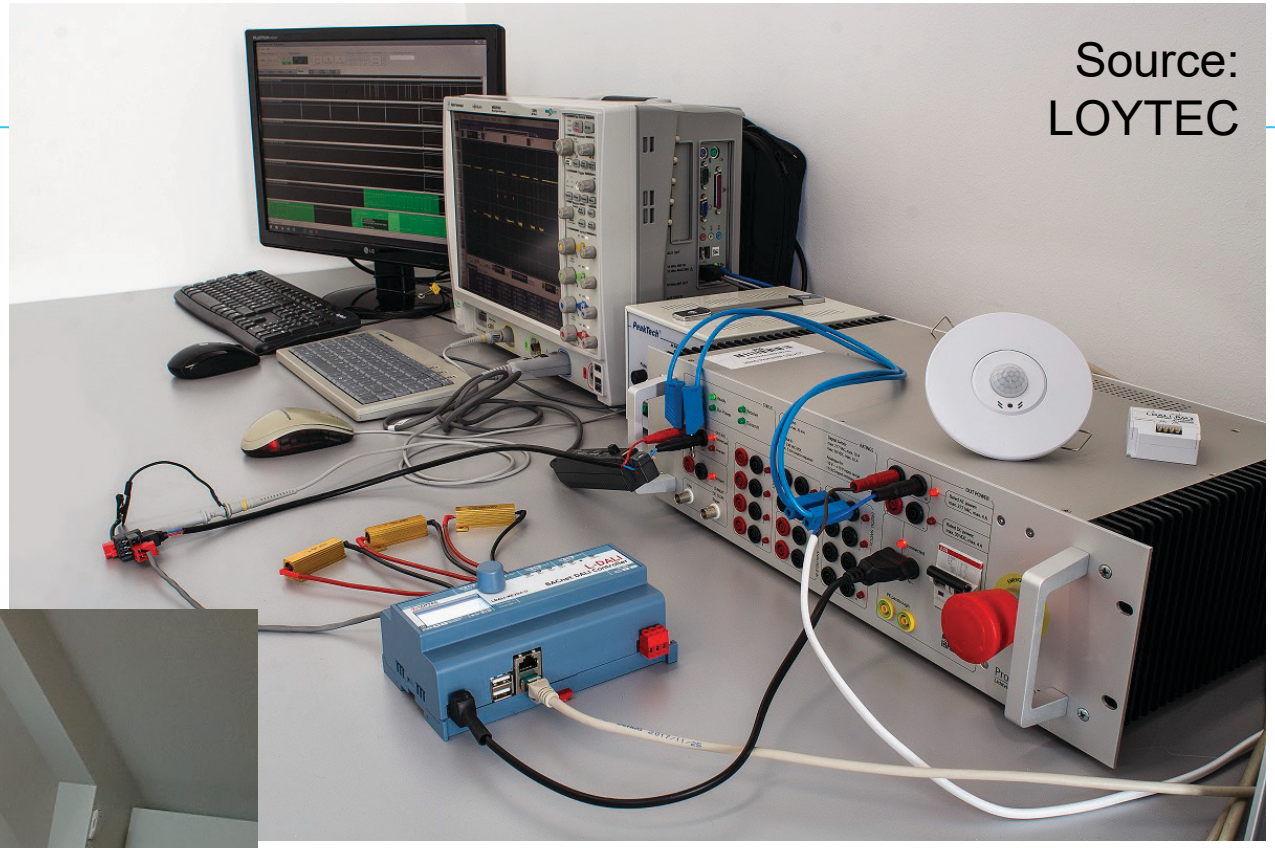
Rigorous testing and verification



Cross-vendor compatibility

DALI-2 testing

Regular DiiA member “Plugfests” help to improve test procedures



Members perform testing, or use accredited Test Houses. Photo shows a typical test set-up.

Key technical features

DALI protocol: Key features

DALI enables:

- **Control, configuration & querying** of DALI devices over a 2-wire bus
  - DALI **power and data on same pair of wires**

- **Individual, group & broadcast addressing** to any DALI device
- Recall of pre-programmed scenes
- Flexible reconfiguration using software

- Each DALI subnet has a maximum of **64+64 addresses**
  - 64 control gear (e.g. LED drivers) AND 64 control devices (e.g. sensors)

- Robust digital communication
- Two-way data exchange and feedback

DALI protocol: Commands and scenes

- Commands allow **control, configuration and querying** of DALI devices.

Command type	Examples
Control	• start a fade to a defined light output level • recall scenes • turn the lights off
Configuration	• change the fade time • change the light level stored in a scene
Query	• ask what the current light output level is • ask whether there is a lamp failure

- Commands can be **addressed** to **individual** devices, to a **group** of devices, or **broadcast** to all devices. This makes communication very efficient.
- **Scenes** allow fast and efficient recall of light levels across the system.
  - Each item of control gear has 16 scenes. A single GO TO SCENE command instructs all the lights, or any combination of the lights, to go to individually pre-defined levels and/or colours.

DALI systems: Wiring and bus power

- DALI uses a **2-wire bus** for communication (commands/data)
  - **Power and data** on the same pair of wires

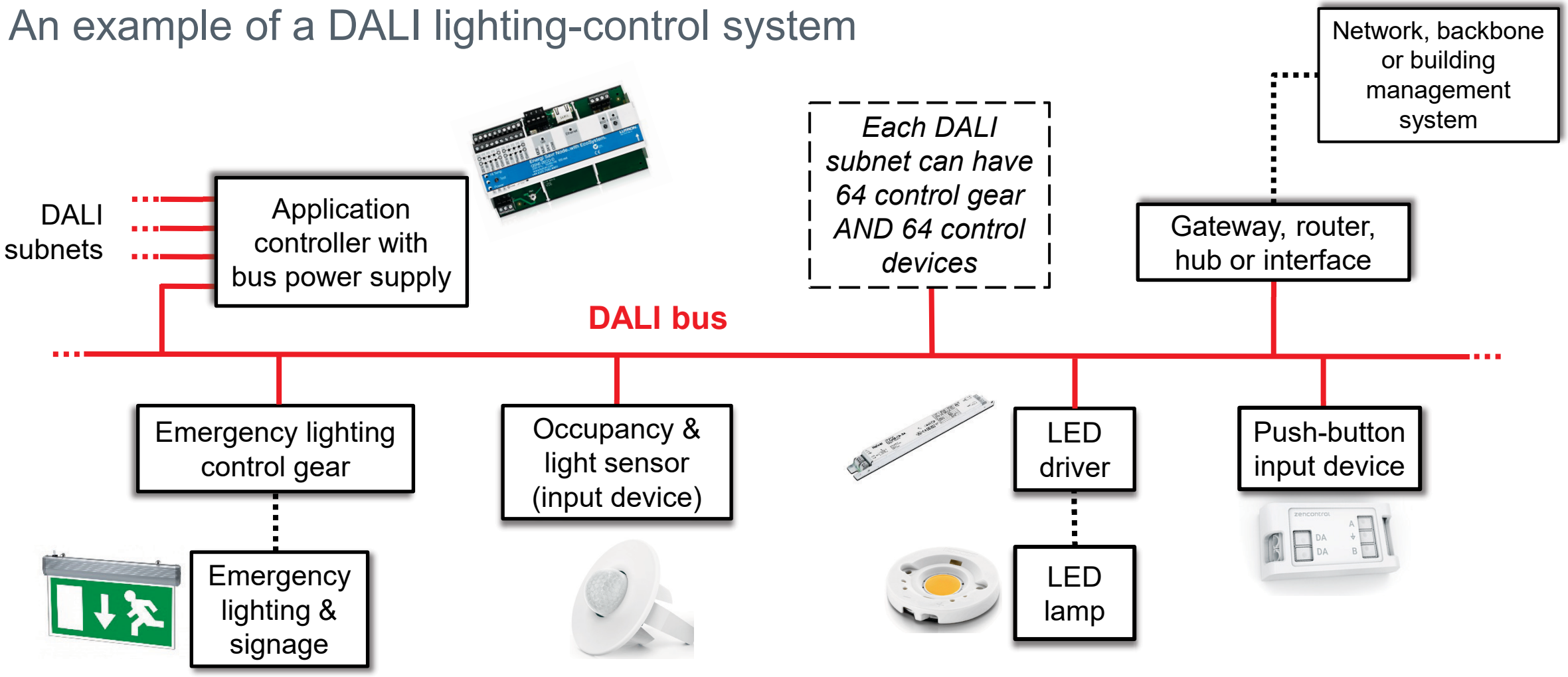
- DALI bus must be powered to allow communication
  - **250 mA max.** bus power supply
  - Same pair of wires also supplies **bus-powered devices** e.g. sensors, push-buttons

- **Standard 2-core cable** (1.5 mm²) can be used
- **Maximum 300 m** cabling recommended (between furthest-apart devices)

- **Polarity-free & free wiring topology** is allowed
  - Bus wiring can use daisy-chain or star connections, or combinations of these
  - A closed loop should not be used

DALI devices

An example of a DALI lighting-control system



Benefits for lighting

DALI for dimming

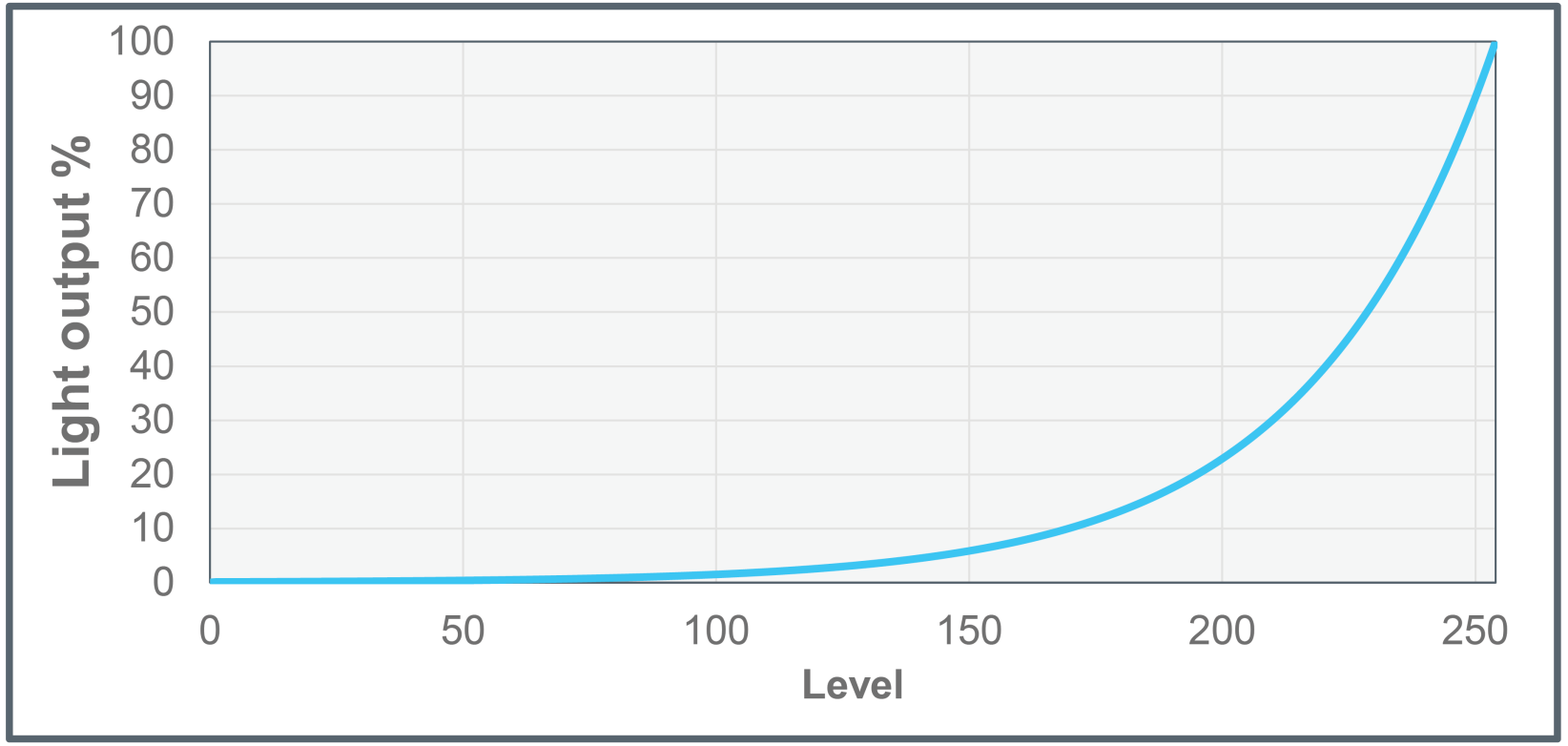
Accurate, repeatable, standardized light-output control

- 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%

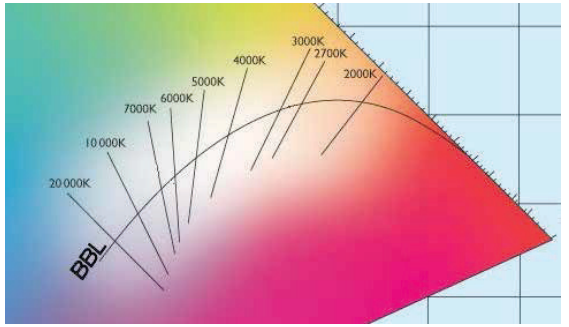
Consistent from fixture to fixture

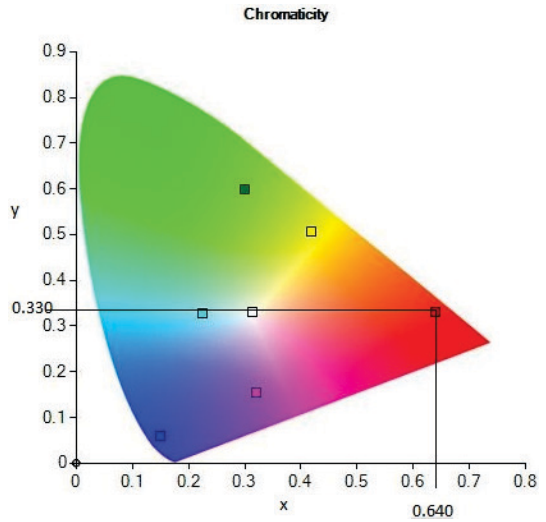
Consistent between manufacturers



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)
- Allows **smooth fading** between colours
- For colour accuracy, xy and Tc colour types allow calibration.





DALI-2 tunable white

- DALI-2 certification program now includes tunable white control
- Allows control of the correlated colour temperature (CCT) along the black-body line, from warm white to cool white.
- Tunable White DALI-2 drivers implement colour type Tc of Part 209
  - Also known as DT8(Tc)
- Scenes allow recall and smooth fading of colour as well as brightness.

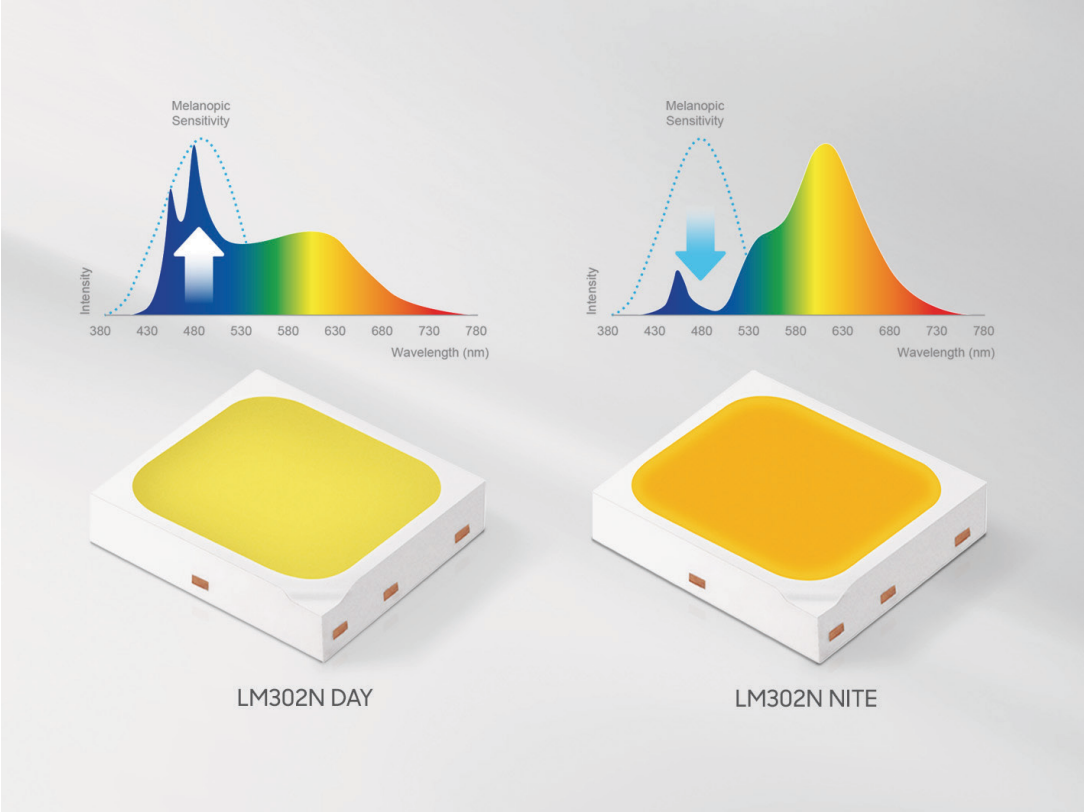


Image shows spectral light output from white LEDs. Cool (daytime) white on the left, warm white on the right. Source: Samsung Electronics (Link)

Forum Groningen, the Netherlands

- Ten-story multifunctional public building
- > 1,000 tunable white LED luminaires
- Tunable white DALI DT8(Tc) LED drivers
- Dimming to 0.1%
- Dynamic adjustment of CCT from 2500K to 4000K

- Source: eldoLED (Link)

DALI for emergency lighting

- Self-contained emergency control gear provide light when the mains supply fails, powered by a battery

- **Automated self-testing**:
  - In many countries, there is a legal requirement for periodic testing of emergency lighting

- DALI allows this to be automated:
  - **Function test**: quick test of the battery, charging circuit, driver/relay and lamp
  - **Duration test**: checks operation for the rated duration (for example: 1 h, 3h…)

- **Feedback**:
  - Test results and information on failures
  - Other information: Battery charge level, lamp operating hours and more

- DALI enables illumination and emergency lighting on the same network

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- Benefits for lighting
- **DALI in smart buildings**
- Connectivity
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DALI in smart buildings

DALI for data

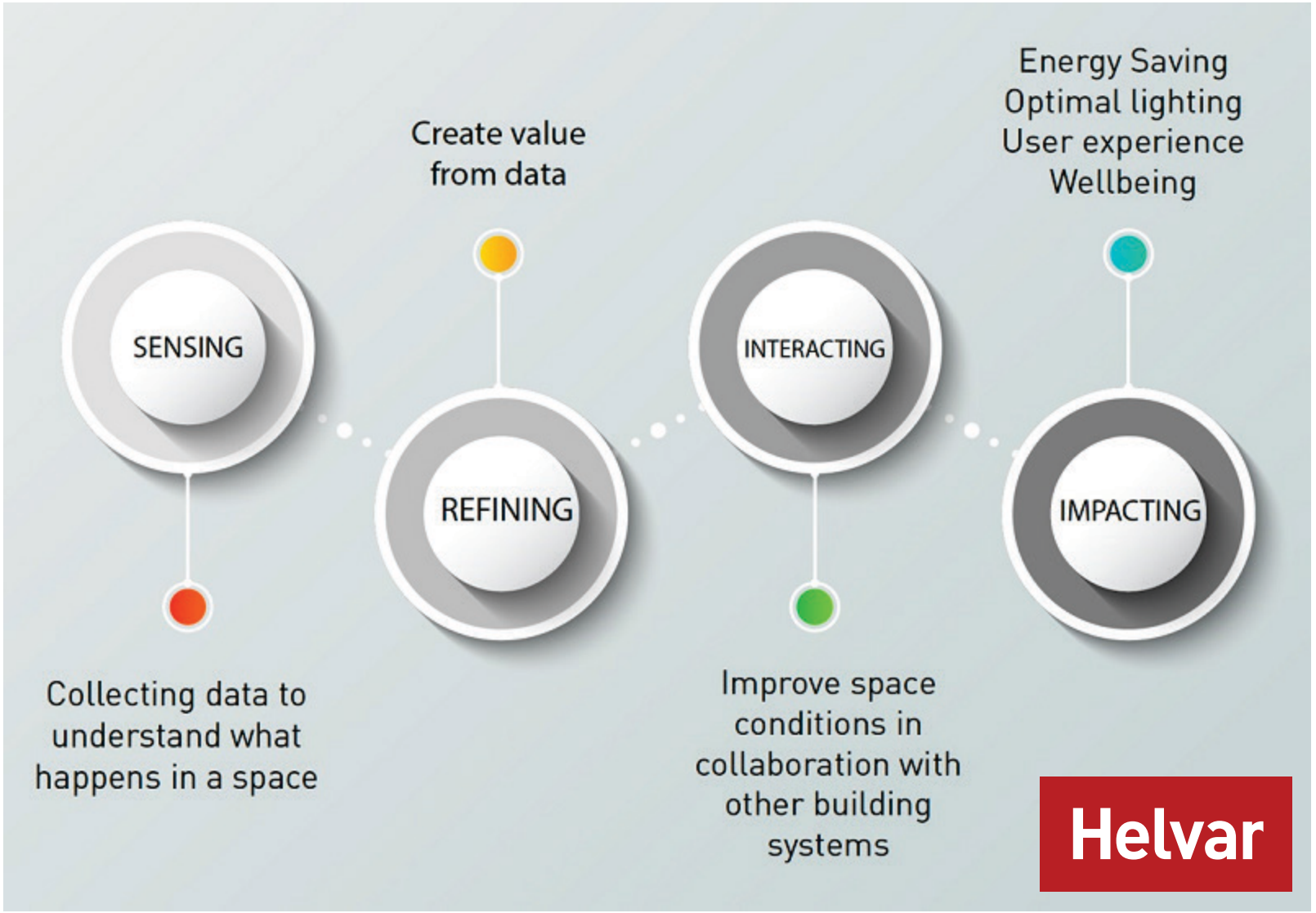
DALI is built to enable smart, data-rich networks

- 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
  - Information and user inputs

- DiiA specifications for data storage and reporting
  - Data for enhanced asset management, performance monitoring & diagnostics
  - Data for luminaires, control gear & light sources

Elements of lighting intelligence



DALI-2 sensors & other input devices

- Sensors provide information for automated control
- User inputs allow occupants to make adjustments
  - Dimming, colour, scene recall etc

- Currently, four types of input device are included in DALI-2:
  - 301: Push-buttons
  - 302: Absolute input devices (switches, sliders, rotary controls)
  - 303: Occupancy sensors (movement or presence type)
  - 304: Light sensors (illuminance level)

- Other sensor types are being developed
  - 305: Colour sensors
  - 306: General-purpose sensors

- Operation can be event driven, or by polling, or by periodic transmission.

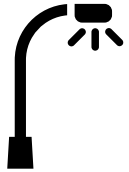
DALI-2 Sensors

DALI-2 data specifications

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

DALI 2

Luminaire Data

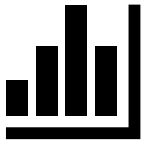


DiiA Part 251 – Luminaire Data

- Information about the luminaire (e.g. ID code, light output, CCT & CRI, light distribution etc) can be stored in the LED driver
- Enables asset management

DALI 2

Energy Data



DiiA Part 252 – Energy Reporting

- Provides real-time power & energy usage for LED drivers

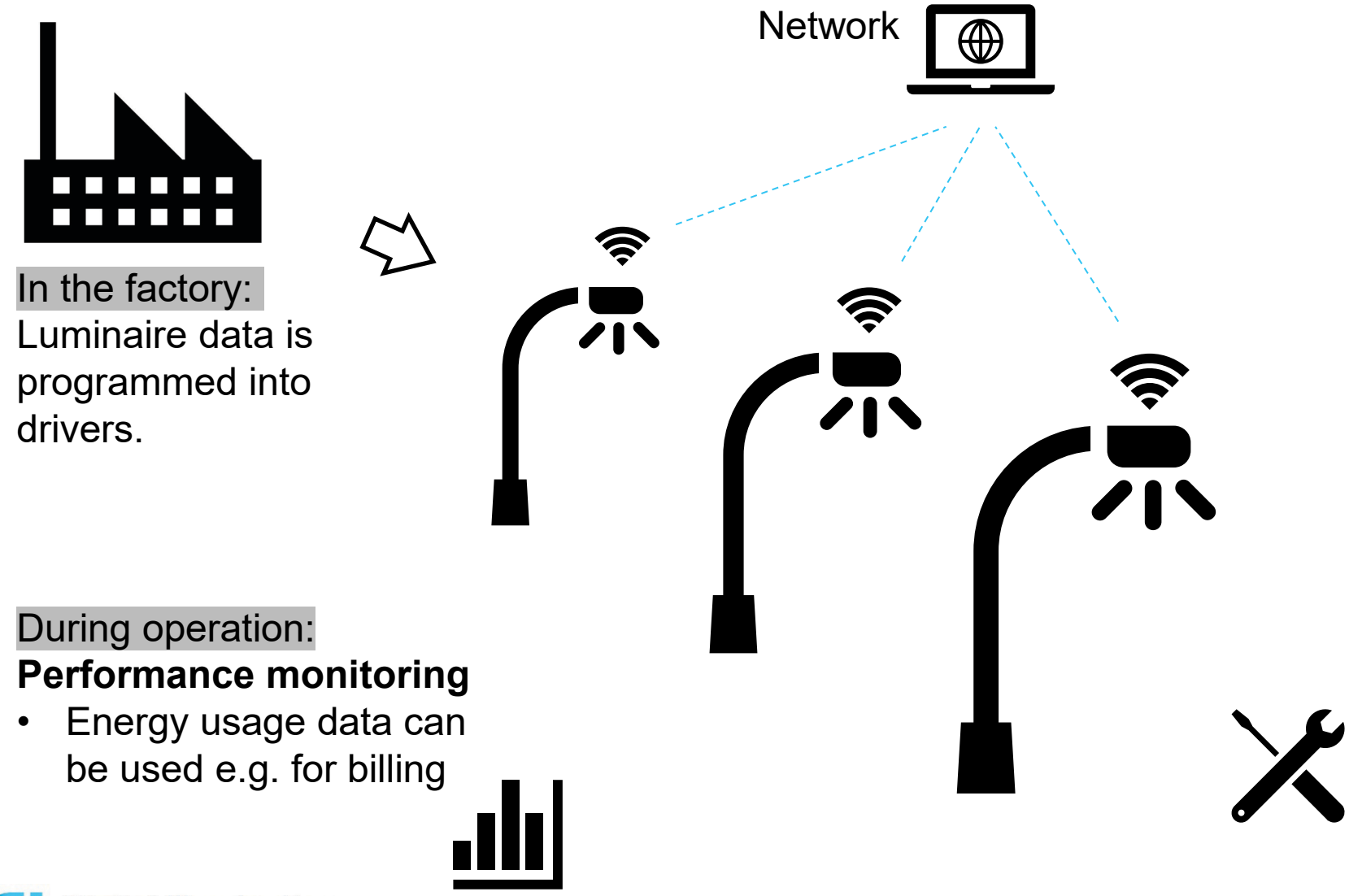
DALI 2

Diagnostics Data

DiiA Part 253 – Diagnostics & Maintenance

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

DALI data: An outdoor lighting example



In the factory:
Luminaire data is programmed into drivers.

During operation:
Performance monitoring
- Energy usage data can be used e.g. for billing

In the field:
Automated commissioning
- When installed, luminaire can automatically transfer data to 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

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

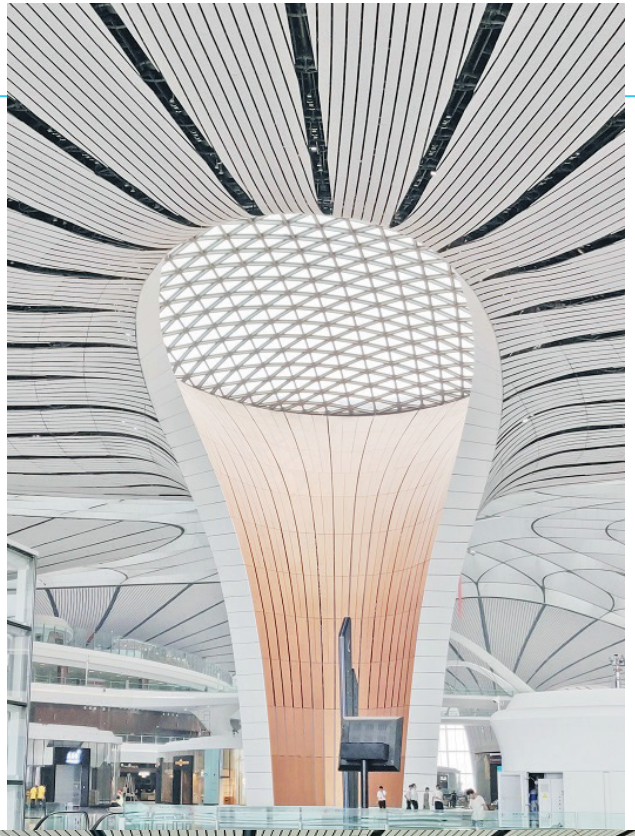
- Safety aspects: DALI emergency

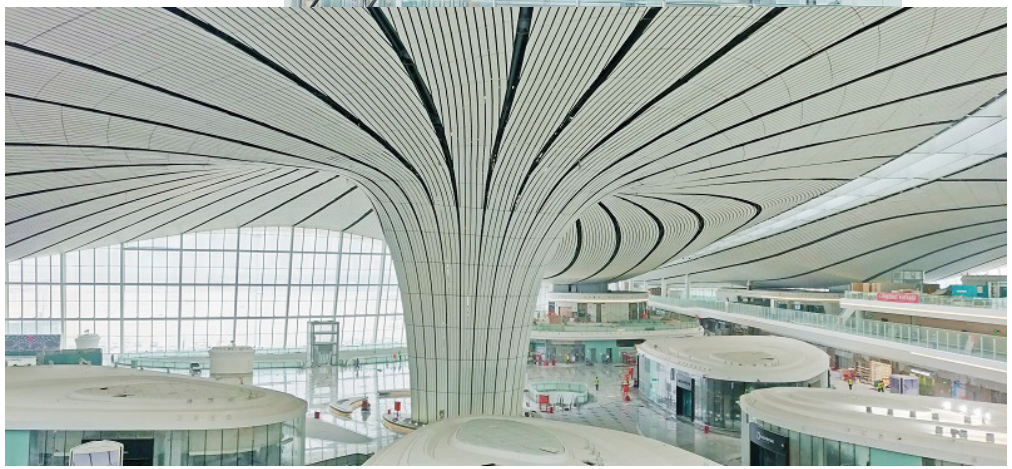
Beijing Daxing Int'l Airport

- Lighting requirements included:
  - Daylight detection
  - Flexible adjustment of lighting levels
  - Remote control of luminaires
  - Simple maintenance

- Tridonic DALI LED drivers with intelligent lighting control
  - Integrated into KNX building control system

- Luminaires controlled remotely, in real time
- Flexible regrouping as required
- Automatic reporting of operating status for drivers & luminaires
  - Enables predictive maintenance





Source: Tridonic (Link)

DALI for energy efficiency

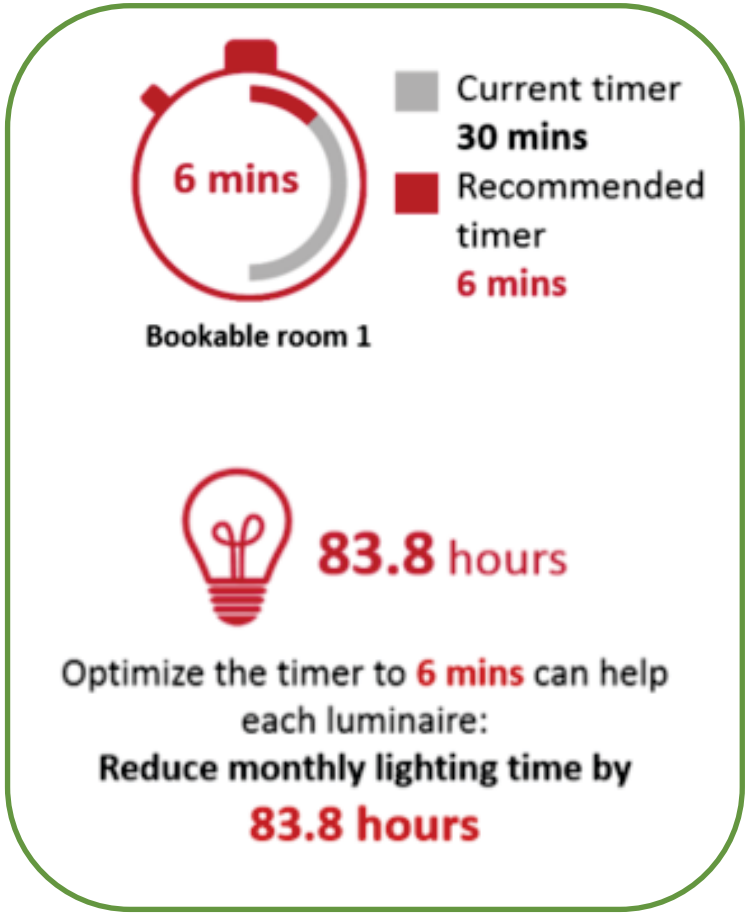
- DALI builds on energy efficiency gains achieved by using LEDs and basic lighting control (switches, dimmers)

- Reduced energy consumption via:
  - Daylight harvesting
  - Matching light levels to space utilization

- Example: University of Bristol, UK
  - Courtesy of Helvar

TIMER OPTIMISATION

ENERGY CUSTOMISATION *(LIGHT ON-TIME)*



Source: Helvar

DALI for future proofing

DALI-2 certified products:

- An ecosystem of interoperable devices from multiple vendors
- Based on global standards
- Avoids reliance on single suppliers and proprietary products

→ Confidence in future availability of compatible devices

Socketed systems:

- Easy to add or upgrade sensors and/or communication nodes to luminaires
- e.g. Zhaga-D4i joint certification; Plug-and-play interoperability

→ Future-proof luminaires that can keep pace with rapid developments in digital networking and sensing technology.

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

Addressing	DALI devices are individually addressable
Data exchange	Data exchange is inherent in DALI, due to bi-directional communication
Connectivity	Multiple current & emerging options, including wireless

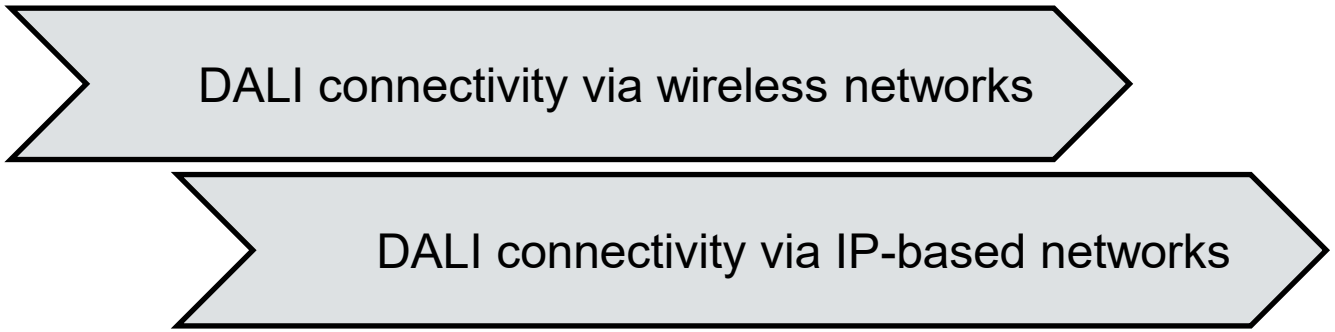
DALI is already positioned to participate in the Internet of Things

DALI in an IoT world – Connectivity

Current DALI capabilities:

- Multiple DALI subnets can be networked together, for building-wide control
- DALI subnets can connect with other networks via non-standardized gateways
  - e.g. Gateways with building-management systems (BMS), such as DALI-to-KNX
- D4i facilitates addition of wireless nodes (network lighting controllers) to luminaires
  - Standalone luminaires can participate in remote lighting-control networks
  - D4i or Zhaga-D4i luminaires are “IoT ready”

Emerging DALI capabilities:



DALI in a wireless world

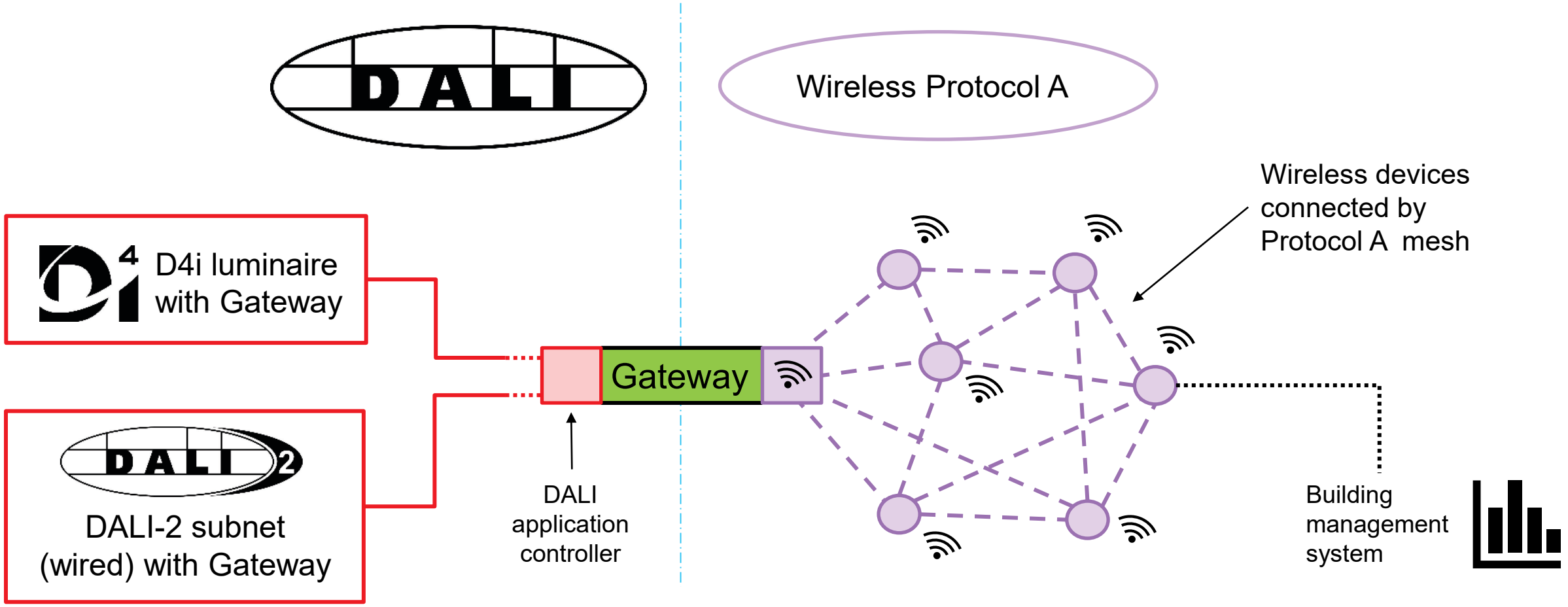
Combining DALI lighting control with wireless networking

- DiiA is working to standardize several different options, with partners. Goals are to:
  - Create or adapt specifications
  - Develop test procedures to enable certification

DALI Over Wireless	Native DALI commands are transported over a wireless carrier	Ecosystem partnerships: Bluetooth®, THREAD GROUP
Wireless Gateways	DALI-to-wireless Gateway translates between DALI and a wireless protocol	Ecosystem partnerships: Bluetooth®, zigbee alliance

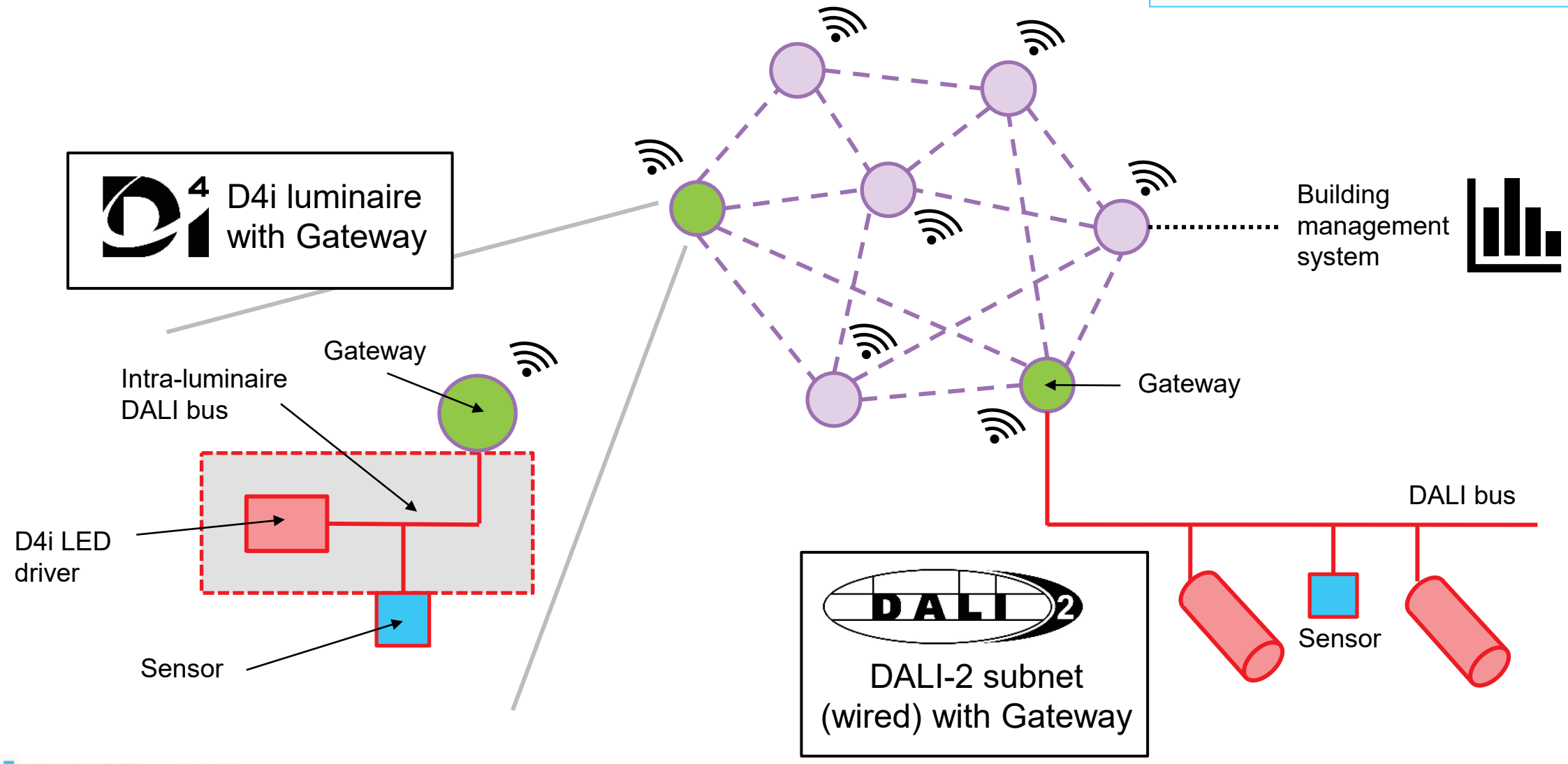
Wireless Gateways

Gateway translates between DALI and wireless protocol



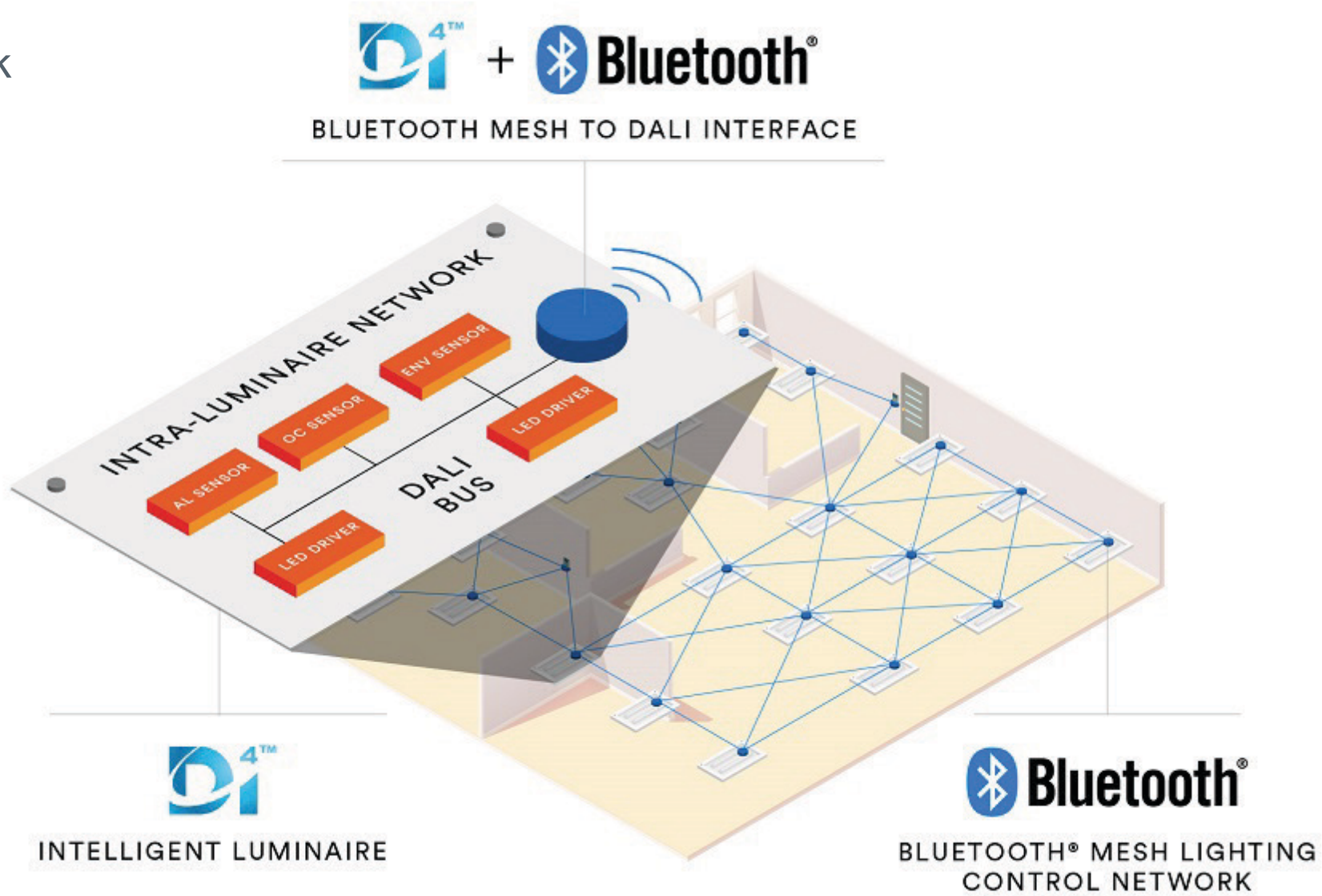
Wireless Gateways

Gateways currently in development:
- DALI to Zigbee
- DALI to Bluetooth mesh lighting



Wireless Gateways – D4i luminaires

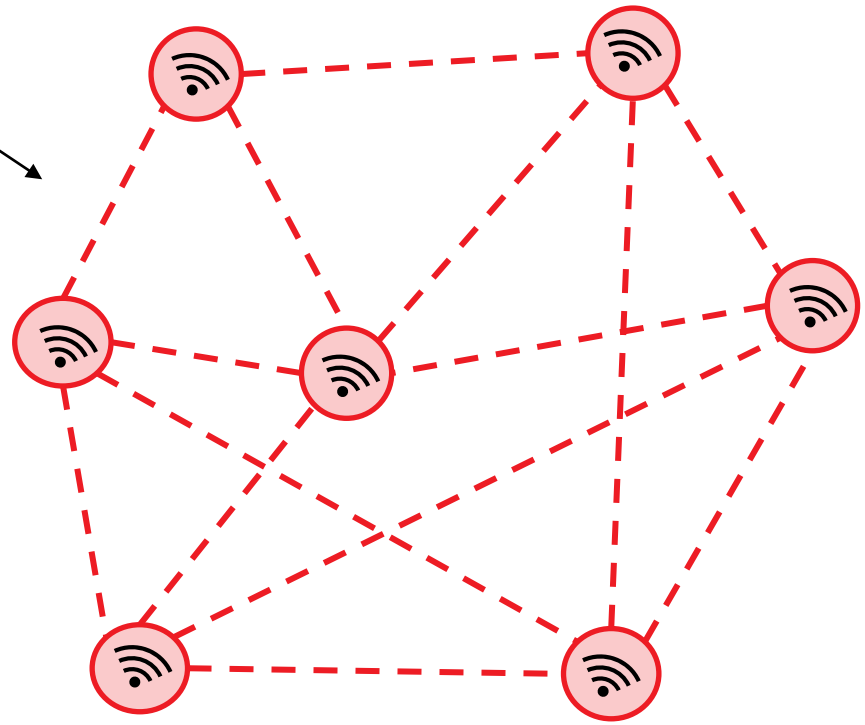
- Image shows wireless Bluetooth mesh network connecting multiple D4i luminaires
- One of several possible network architectures



DALI over Wireless

DALI commands transported by an underlying wireless carrier

Wireless DALI devices connected in mesh

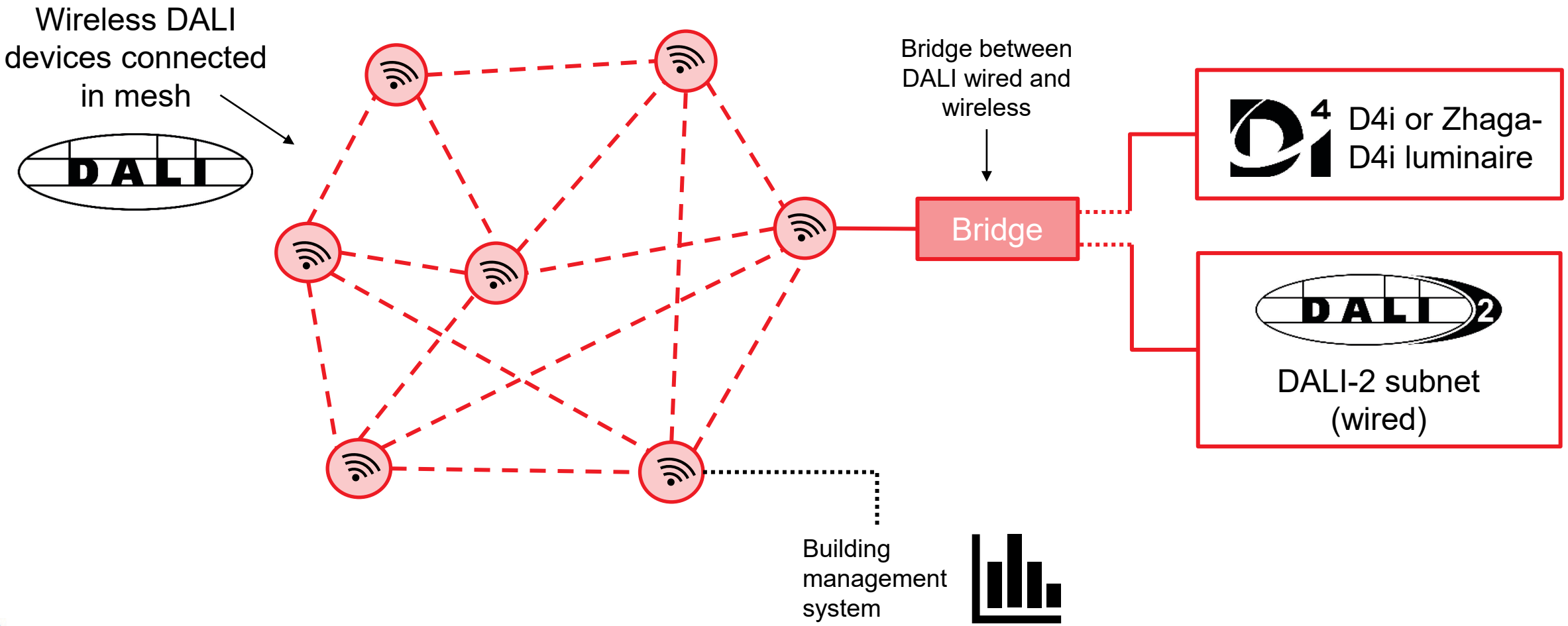


Currently in development:

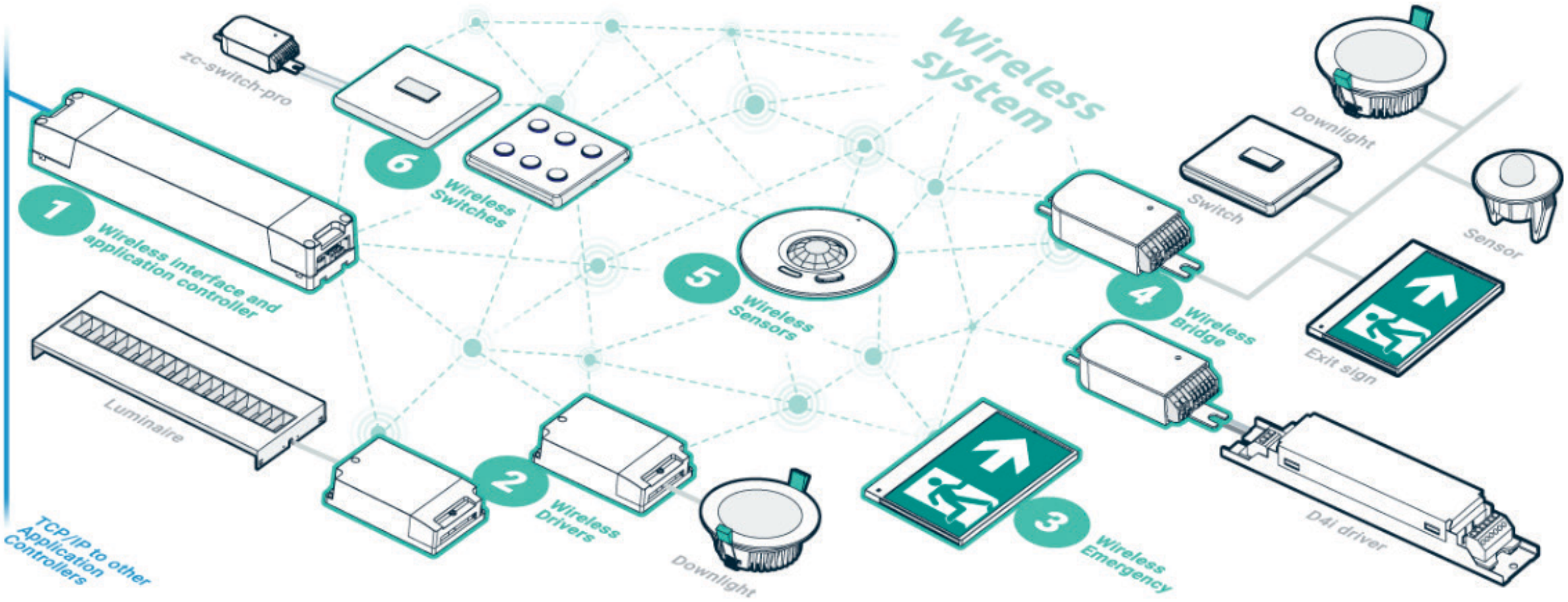
- DALI over Thread (IP-based)
- DALI over Bluetooth mesh

DALI over Wireless

DALI commands transported by an underlying wireless carrier



DALI over Wireless



Source: zencontrol (Link)

Conclusions

- DALI-2 makes a significant contribution to intelligent buildings:
  - Energy efficiency
  - Future-proofing
  - Wellbeing and comfort of occupants
  - Predictive maintenance

- DALI-2 certification increases confidence in cross-vendor interoperability

- Specifications in development will enable:
  - DALI over wireless and IP-based connectivity options
  - Gateways to other wireless ecosystems

Thank you! Any questions?

Email: info@digitalilluminationinterface.org

Website: www.dali2.org