BUILDINGS THAT THINK FOR THEMSELVES

Field communication in smart buildings

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- Sensors
- Connectivity
- Security

BUILDINGS THAT THINK FOR THEMSELVES

Field communication in smart buildings

In contrast to the smart home, the term ‘smart building’ refers to the digitisation of an entire building rather than a residential space. It sums up the automation and control of the technical equipment as well as the processes within a building. The aim is to make working and living more comfortable and to counteract climate change through energy efficiency.

Smart buildings run on networked and remote-controllable devices and sensors (see the RS article, “Fresh air”), as well as automated processes. Their aim is to ensure operation from the outside too, and to ensure efficient use of energy for cost savings and a reduced CO_2 footprint. In the EU alone, buildings are responsible for 40% of energy consumption and 36% of CO_2 emissions. By 2050, the German government wants to reduce the energy demand of existing buildings by 80%. Domotik can play an important role here.

Market research company, iot-analytics, says an estimated 23.8 billion devices were connected worldwide in 2021; an increase of 10% compared to 2020 (21.6 billion devices). The market researchers expect to see the greatest growth in building automation. In 2018, 230 million devices were connected in buildings worldwide. By 2022, it is expected to be 483 million.

LIGHTHOUSE PROJECTS

Two of the most famous smart buildings in Europe are The Edge in Amsterdam and the ‘cube’ in Berlin.

The Edge (Fig. 1) has often been referred to as the smartest office building in the world. About 28,000 built-in sensors capture and analyse data on the building’s use and its condition. The systems can calculate the optimal energy requirement and adjust it in realtime. Building users are able to ‘interact’ with the building via an app, for example to change the lighting and temperature to their own needs. The Edge uses solar cells to produce more energy than it consumes.

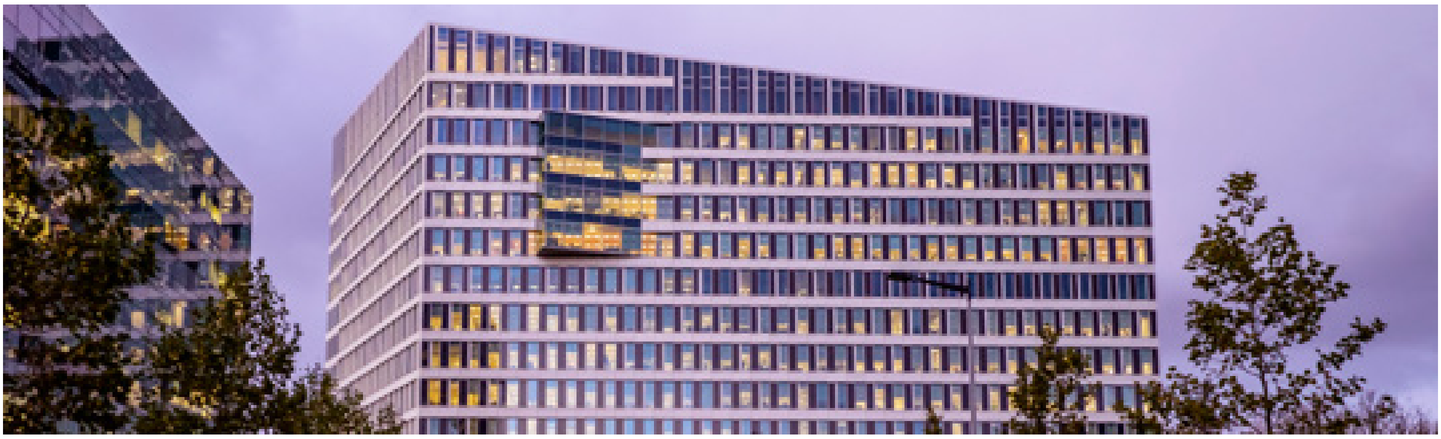

Fig. 1. The Edge has often been referred to as the smartest office building in the world. (Image: Ronald Tilleman of RS Website Copyright unclear)

In addition to energy efficiency, The Edge also focuses on applications such as how users can best enter internal and external parking spaces or employees making use of services on a needs-only basis, and ordering supply and cleaning services by external service providers accordingly.

Fig. 2. The 'cube berlin'. (Image: Duernsteiner pixabay)

The 'cube berlin' (Fig. 2) was opened in 2020. In this office building, 3,750 sensors, 750 beacons and 140 mobile radio antennas ensure the networking and collection of building data. In the central analysis and control centre 'brain', user behaviour and the building condition are analysed and evaluated by AI, with the aim of the building controlling and optimising itself. Similar to The Edge, building users can access functions of 'cube berlin' via an app and manage and adjust the lights, temperature and facility management, and more.

Besides "The Edge" and 'cube berlin', there are several other advanced smart buildings, such as Karvesvingen 5 in Oslo as well as the Crystal and the Tottenham Hotspur Stadium in London. Berlin is home to an office complex called DSTRCT.Berlin, which links several office buildings to form a single, smart overall system.

THE NERVOUS SYSTEM OF A SMART BUILDING

Field, automation and management levels are the characteristic layers of a building automation system. The automation functions are becoming increasingly decentralised with ever more powerful digital systems, integrated into the field level. Edge processing would be an analogy from today's industrial automation technology.

Fig. 3. Field, automation and management levels are the characteristic layers of a building automation system.

At field level, the technical systems of the building are operated with the help of sensors and actuators. Sensors record information (e.g. motion detectors, sensor devices, brightness, temperature) and send it to the actuators as data telegrams via suitable bus systems – examples of which are listed below.

At automation level, the technical building systems are controlled and regulated on the basis of the data provided at field level. It also follows the specifications set out at management level.

The management level is responsible for the higher-level operation and monitoring of the automation processes.

OPEN OR PROPRIETARY FIELD COMMUNICATION?

An open system is characterised by the fact that it is supported by many manufacturers and corresponds to a standard. The more manufacturers participate in an (open) standard, the wider the range of devices on the market. An open system reduces dependencies on a particular manufacturer.

A proprietary system is vendor-specific. The use of such systems means dependence on a manufacturer for commissioning, maintenance and upgrades. If the products used are no longer available on the market, there is rarely a second source.

WIRED BUS SYSTEMS

The Digital Addressable Lighting Interface (DALI) is an established communication protocol for lighting in buildings and is used for communication between electronic ballasts, brightness sensors and presence detectors, among others. It is defined in IEC standard 62386. The data traffic takes place over two wires and allows 64 participants in 16 groups. 16 scenes are possible per DALI strand. The electronic ballast of the lights stores configuration data such as group memberships, light scene values, dimming speeds, emergency current light values, switch-on light settings when power returns (power-on-level). Line, tree, star or mixed structures are used as bus topologies. The cable lengths can reach up to 300m depending on the cable cross-section.

PRODUCTS

KNX has been on the market for more than 20 years (KNX is based on its predecessors EIB, EHS and BatiBUS). It is a worldwide standard for home and building system technology according to EN 50090 and ISO/IEC 14543. KNX is marked by its decentralised structure. Instead of a central unit, the functions are accommodated in the separate bus participants. The sensors, such as buttons or presence detectors, send control commands directly to lights, blinds, heating and ventilation systems. You can change and adjust the assignments and functions at any time. Up to 12,000 bus subscribers can be connected, with a transmission speed of 9.6 kBit/s.

KNX supports a wide variety of transmission media, such as two-wire cabling (KNX TP), ETHERNET (KNX IP), wireless (KNX RF) and powerline (KNX PL). KNX as a standard makes devices from different manufacturers inter-compatible. Since each device contains its own microcontroller, a control panel is not necessary.

PRODUCTS

BACnet was developed by the American Society of Heating, Refrigeration and Air Conditioning Engineers Inc. (ASHRAE). Published as an American standard in 1995, BACnet has been the ISO 16484-5 standard since 2003. BACnet offers open, interoperable building automation. It means we can add extensions and alter buildings manufacturer-independent and across systems.

The MODBUS protocol is based on the MODBUS protocol for programmable logic controllers, which has been widely known since 1979. The special advantage for the user is that MODBUS is a lean protocol ensuring fast data transmission via ETHERNET. Due to the manufacturer-neutral data structure, the communication exchange between devices from different manufacturers is problem-free. Modbus is a communication protocol that enables data exchange between a master and several slaves. In 1979, the Gould-Modicon protocol was developed to allow programmable logic controllers to communicate with each other. The open protocol connects computers with measurement and control systems. The Modbus TCP version is part of the IEC 61158 standard.

There are three operating modes for transmission:

- **Modbus TCP:** ETHERNET TCP/IP communication based on the Modbus RTU client/server model: asynchronous serial transmission via RS-232 or RS-485
- **Modbus RTU:** client/server model: asynchronous serial transmission via RS-232 or RS-485
- **Modbus ASCII:** similar to the RTU protocol with a different data format. Modbus ASCII is rarely used.

PRODUCTS

STANDARD MOTOR INTERFACE (SMI) is an electrical connection between roller shutter and sun protection drives. This uniform interface controls drives not only with switching commands, but with precision via telegrams. Depending on the application, up to 16 drives can be electrically controlled in parallel. The electronic controls and drives are connected by way of a five-wire cable with power supply and data transmission. SMI ensures the precision approach to intermediate positions, the query of current motor positions and feedback from the motor with diagnostic messages.

The abbreviation LON stands for Local Operating Network and refers to a fieldbus standard in building automation. As an open technology standardised according to ISO/IEC 14908, LonWorks is accessible to all market participants. A distinction is made between sensors, actuators and controllers. The data exchange is event-driven. Due to its high complexity, LonWorks is suitable for numerous applications in building automation, such as access control, HVAC systems, fire detectors, lighting or elevator controls.

LonWorks is a decentralised automation system in which the devices (nodes) communicate with each other via a bus using the LonTalk protocol. The communication protocol can be implemented in any hardware structure and, as an open standard, enables the interaction of different LonWorks products from different manufacturers.

The individual nodes each have their own intelligence system and can process different programs almost independently of each other, but also provide the respective data to devices in other areas.

MP bus (Multi Point) is used in the HVAC sector (heating, ventilation, air-conditioning) to control actuators for flaps, control valves and variable volume flow controllers. Devices with an MP bus connection are capable of communication via a bus with higher-level controllers. It is a bus that was developed by the Belimo Automation AG as a sensor-actuator bus especially for the building heating and ventilation sector. Using the three conductors of the MP bus, an MP master can group and control up to eight HVAC actuators as a bundled unit. Various manufacturers offer components with an MP bus interface.

M-Bus (Meter-Bus) is used for reading energy consumption data from electricity meters, heat meters, gas meters, water meters and various sensors and actuators from different manufacturers. As a measurement technology system for recording consumption data, M-Bus is often used in building management systems. A central master communicates via a two-wire cable with the bus participants (up to 250 slaves per segment), such as heat, water, electric and gas meters, as well as with all kinds of sensors and actuators.

DMX is used for lighting control. The Digital Multiplex protocol has its origins in stage and event technology where it is used to control lighting equipment and special effect devices. DMX is based on the RS-485 serial interface standard. Three-pin XLR connectors are usually used for cabling. This bus is finding use increasingly in commercial construction. The main applications here are RGB colour and light temperature controls. Light is a common design element and is used, for example, for effect and architectural lighting, façade lighting and to highlight special architectural features. LED technology is one of the most popular and is used in effect lighting due to its efficiency and variety of colours.

As this list shows, the field-level infrastructure in building technology can sometimes be highly fragmented due to all the different bus systems. The resulting data islands require gateways that complicate access to external device data. Eliminating these gateways could significantly reduce the cost and complexity of these facilities and we could altogether remove the data islands they create.

SPE (see the RS article “World on a wire”) can transport data at 10Mbps, 100Mbps and 1Gbps via two-wire copper cables while powering end devices via Power over Data Line (PoDL). Unlike Power over Ethernet (PoE), however, no extra cable pairs are required.

10BaseT1S is the ‘short-range’ version of the single-pair Ethernet variant and offers a particularly cost-effective networking scheme. This variant works in a half-duplex process and can be operated in both point-to-point and multidrop technology. The latter is defined with a bus length of 25m with 10cm long stub cables. Instead of a switch, this topology uses an arbitration scheme to ensure that there are no data collisions. The standard provides for eight stub cables, but the system can have many more than that.

The EnOcean wireless standard is designed for wireless sensors and wireless sensor networks with particularly low energy consumption. This also includes sensor networks that use energy harvesting technology (see the RS article "Batteries not included") to generate energy from the environment – for example from movement, light or temperature differences.

This principle enables electronic control systems that work independently of an external power supply. The EnOcean wireless standard (ISO/IEC 14543-3-1X) for the sub-1 GHz range is suitable for use in buildings thanks to its range of up to 30 metres.

PRODUCTS

One of the most important features of Bluetooth is the Bluetooth mesh topology, which lets multiple devices communicate and creates large-scale device networks. Mesh works with BLE and is available from Bluetooth Version 4.0 and up.

Unlike a point-to-point connection, a mesh network consists of devices that can communicate with all other devices on the network by exchanging messages. In the Bluetooth mesh protocol, each sensor and device acts as a node, transmitting messages between the hub and other sensors and devices. These can be temperature, light intensity or humidity sensors.

The nodes can also be used to track the condition of doors in a building, for example, or to control fans, air-conditioners and lamps or issue safety warnings. The system can be controlled locally via a smartphone that acts as a proxy node, or over the Internet via a proxy gateway. Messages are passed from one node to another (relays) so that messages can be exchanged between nodes that are not in each other's direct range. The messages are also transmitted to different devices.

The general advantage of mesh networks is that they provide greater fault tolerance to node failures in parts of the network. Starting with Bluetooth Version 5.1, a suitably configured network can also provide location services (indoor navigation, asset tracking).

PRODUCTS

Based on documentation from:
Infineon
German Association for the Digital Economy (BVDW)
WAGO
Bluetooth SIG
Baunetz Wissen