Home and Building Automation Systems:

- Building automation systems control various components within a building's structure, such as heating, ventilation, air conditioning (HVAC).

- HVAC system performance and sustainability is key for today's building operation.

- The primary goal of this type of infrastructure is to improve system efficiency, reduce costs and increase safety.

- A centralized building management platform brings all of these parts together, but this description is a simplification of what's really going on behind the scenes.

Main Components of a BAS :

- Building Automation Systems can be implemented either during initial construction or through a retrofitting process for an existing structure.
- It uses five component categories to provide a smart building environment.

i. Sensors:

These devices track temperature, humidity, the number of people in a room, the lighting level and other values. The sensors transmit this information to centralized controllers.

ii. Controller:

This component acts as the "brain" of the BAS. It collects data from the sensors and then sends commands to heating, ventilation, air conditioning (HVAC) units, lighting systems, security alarms and other connected parts.

iii. Output devices:

- Once the controller sends out a command, actuators and relays go into action to follow the requirements.

- For example, they can reduce or increase the heating in a particular part of the building, dim lights in unused offices, or turn on the air conditioning before people come to work.

iv. Communication protocols:

The BAS uses a specific language that's understood by the system's individual components. BACnet and Modbus are the most commonly used options.

v. Terminal interface:

Users can interact with the BAS through this interface. It presents information so that users can monitor the condition of the building or choose to override settings manually.

Smart appliances

1. Touch-Screen Refrigerator
2. Microwave With Voice Control
3. High-Speed Smart Toasters
4. Multifunctional Digital Air Fryer
5. Smart Oven
6. Smart light
7. Electric glass

BACnet, developed by the American Heating Refrigerating and Air Conditioning Engineers (ASHRAE), is a building automation and control networking protocol, designed specifically to meet the communication needs of building automation and control systems for applications such as heating, ventilating, and air-conditioning control; fire and other life safety and security systems; energy management; lighting control; physical access control; and elevator monitoring systems.

The BACnet protocol provides mechanisms for computerized building automation devices to exchange information, regardless of the particular building service they perform.

The BACnet protocol provides mechanisms by which computerized equipment of arbitrary function may exchange information, regardless of the particular building service it performs. As a result, the BACnet protocol may be used by mobile and cloud-hosted devices, head-end computers, general-purpose direct digital controllers, and application-specific or unitary controllers with equal effect.

This protocol provides a comprehensive set of messages for conveying encoded building automation data between devices including, but not limited to

(a) hardware binary input and output values,

(b) hardware analog input and output values,

(c) software data values,

(d) schedule information,

(e) alarm and event information,

(f) trend and event logs,

(g) files,

(h) control logic,

(i) application specific data for a large range of building services, and

(j) network configuration including security.

Modbus is a data communications protocol originally published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs).

Modbus is now a commonly available means of connecting industrial electronic devices.

Modbus is popular in industrial environments because it is openly published and royalty-free.

It was developed for industrial applications, is relatively easy to deploy and maintain compared to other standards, and places few restrictions on the format of the data to be transmitted.

The Modbus protocol uses character serial communication lines, Ethernet, or the Internet protocol suite as a transport layer.

Modbus supports communication to and from multiple devices connected to the same cable or Ethernet network. For example, there can be a device that measures temperature and another device to measure humidity connected to the same cable, both communicating measurements to the same computer.

Importance of User Interfaces:

- The terminal interface is an important part of an effective building automation system.
- Organizations need a way to access the data produced by the sensors, discover whether problems need troubleshooting, and look for areas of ineffciency they can address.
- A poorly designed user interface may not provide the necessary access or analysis to understand its BAS performance levels.

Functions of a BAS:

- The primary function of a BAS is to provide control over heating, cooling, ventilation, lighting and other critical building systems.

- However, building automation systems also monitor their individual components to alert building managers about detected problems.

- Depending on the issue, the system may attempt to automatically resolve a problem before getting a human involved.

- The system's continually monitors and optimizes its own performance, although the building manager can make adjustments as needed.

Types of Data a BAS Collects and Its Applications:

A BAS has access to a wide range of sensor data, depending on the smart systems installed in the building and the needs of the business.

Temperature is one of the most common data points tracked, as this information is critical for proper climate control.

The indoor air quality is monitored to ensure the correct mix of external and internal air, and this method is often used to control the humidity in the structure, as well.

Pressure and chemical sensors help the system troubleshoot problems with air quality or discover issues with mechanical aspects of the building.

The security system relays data that can indicate potential intruders, such as motion in supposedly empty buildings.

Alarms can come from many parts of a building, such as power supplies, elevators or electronic doors. The data gets passed along to the user interface (UI) when it meets certain requirements, such as when a data center's power has gone out and it's switched to an uninterruptible supply.

Building automation systems

A building automation system (BAS) consists of a system installed in buildings that controls and monitors building services responsible for heating, cooling, ventilation, air conditioning, lighting, shading, life safety, alarm security systems, and many more.

A BAS aims at automating tasks in technologically-enabled environments, coordinating a number of electrical and mechanical devices interconnected in a distributed manner by means of underlying control networks.

These systems may be deployed in industrial infrastructures such as factories, in enterprise buildings and malls, or even in the domestic domain.

Building automation has been receiving greater attention due to its potential for reducing energy consumption and facilitating building operation, monitoring and maintenance, while improving occupants' satisfaction.

These systems achieve such potential by employing a wide range of sensors (e.g., for sensing temperature, zone airflow, daylight levels, occupancy levels), which provide information that enables decision-making regarding how the building equipment will be controlled, aiming at reducing expenses while maintaining occupant comfort.

Level architecture:

A BAS is a distributed system oriented to the computerized control and management of building services, also referred to as building automation and control system (BACS).

The architecture of this distributed system can be organized into three layers:

(i) The lowest layer is known as the Field Layer where the interaction with field devices (sensors, actuators) happens,

(ii) The middle layer is the Automation Layer, where measurements are processed, control loops are executed and alarms are activated,

(iii) The top layer is the Management Layer, where activities like system data presentation, forwarding, trending, logging, and archival take place.

Communication networks:

The backbone of the field level is the field bus, a digital data bus that allows communication between devices at the field level such as controllers, sensors, and actuators.

A field bus aims at improving communication quality in comparison to previous analog communication buses, and at reducing installation costs by cutting down on the required wiring, since devices connected through field bus only communicate digitally.

Devices connected to a field bus network are expected to have some computational power, and may even replace several analog devices simultaneously, further contributing to decreasing installation costs.

Actuators, sensors and controllers:

The setup of a BAS comprises actuators, sensors and hardware modules.

Actuators react to signals closing circuits or varying the intensity of electric loads, which are physical devices such as a window blind or a ceiling lamp. Sensors are devices that convert a physical reality into a signal that can be measured.

Although, some devices fit in both groups due to their sensing and actuating capabilities, for simplicity they may be perceived as two different virtual devices: one device capable of sensing and another one capable of actuating.

Actuators and sensors are attached to I/O ports of hardware modules that produce electric signals according to digital output commands and create readings from input signals.

The interaction between devices must be carried out through some type of control logic. Such logic lies in components known as controllers.

In building control systems, a controller usually consists of an application-specific hardware with embedded software that continually controls physical actuators (such as lights, blinds, among others) depending on the feedback given by monitored inputs (such as light or occupation sensors) or by receiving commands from the system.

Fig. 1 illustrates this situation, where physical devices are connected to I/O ports of a hardware module (acting as a hardware device driver) capable of providing an interface that abstracts these connections. Such an interface is then used to connect the hardware module (and thus connecting the physical devices) to a network.

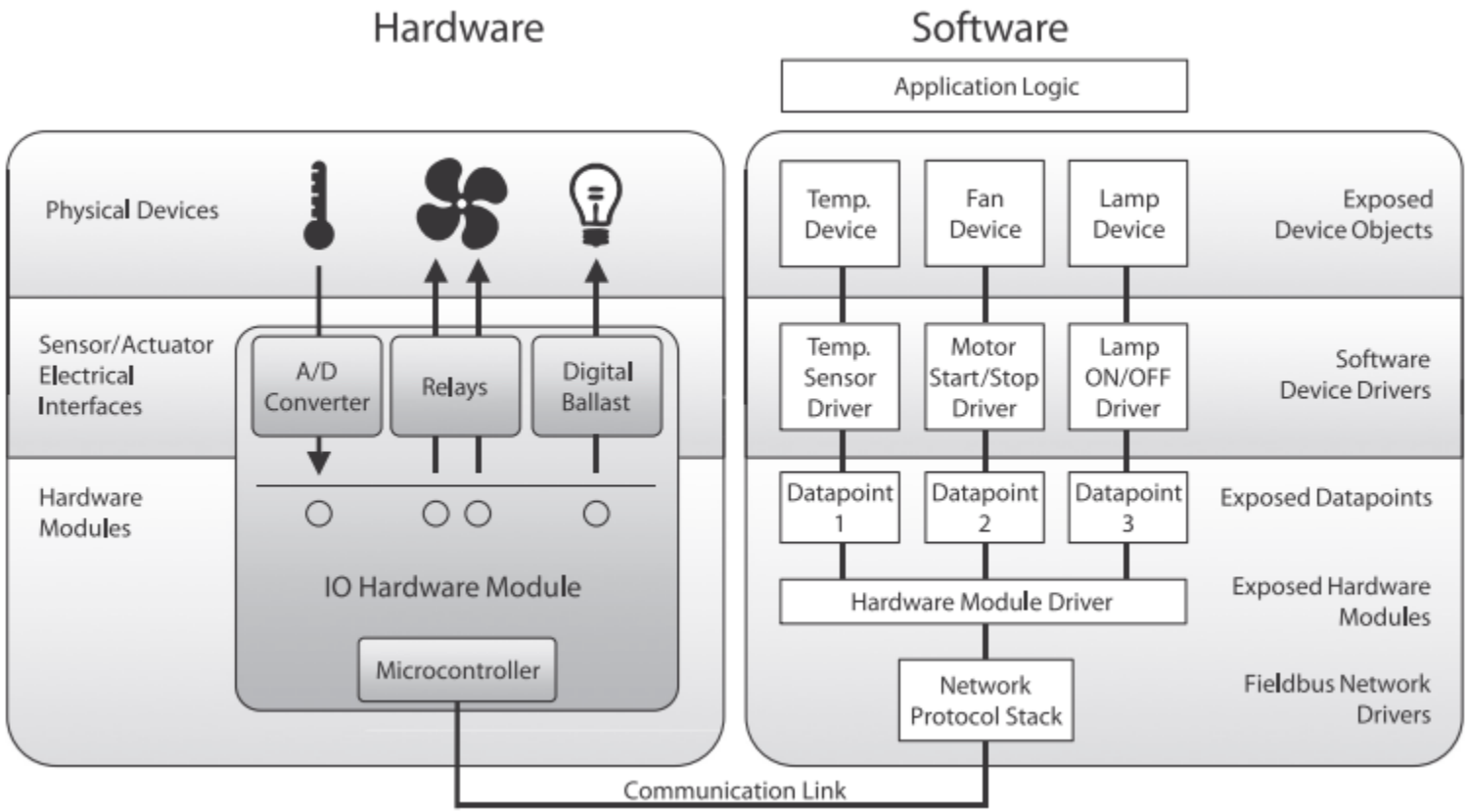
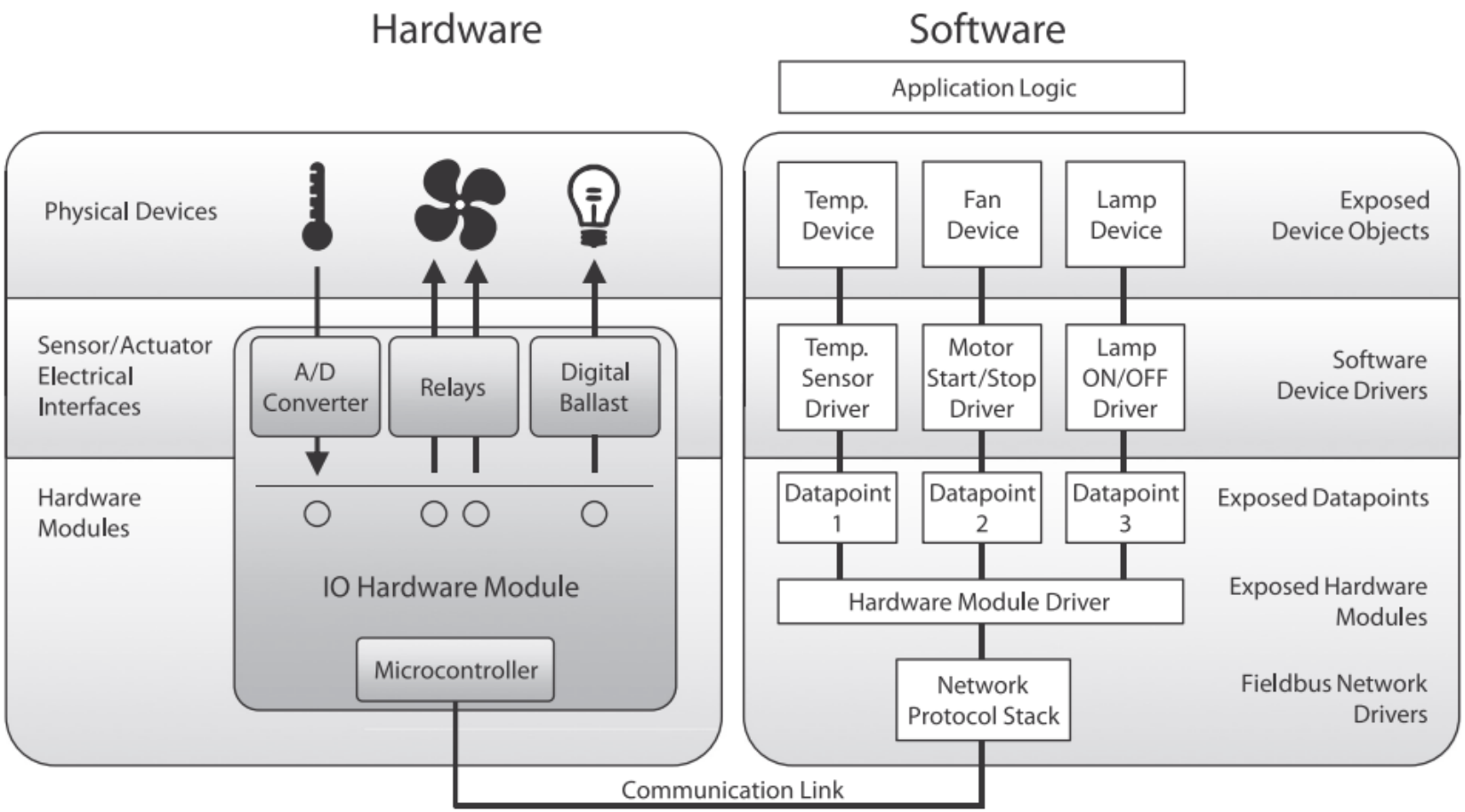


Fig. 1. Illustration of a Building Automation Hardware and software stack


Hardware
Software
Application Logic
Physical Devices
Sensor/Actuator Electrical Interfaces
Hardware Modules
A/D Converter
Relays
Digital Ballast
IO Hardware Module
Microcontroller
Temp. Device
Fan Device
Lamp Device
Exposed Device Objects
Temp. Sensor Driver
Motor Start/Stop Driver
Lamp ON/OFF Driver
Software Device Drivers
Datapoint 1
Datapoint 2
Datapoint 3
Exposed Datapoints
Hardware Module Driver
Exposed Hardware Modules
Network Protocol Stack
Fieldbus Network Drivers
Communication Link