BUILDING MANAGEMENT SYSTEMS
Introduction to Building Management Systems

The Building Management System is used for all the functions carried out by the building including energy services security monitoring, fire and smoke detection, alarm, maintenance scheduling, status reporting and communications.

The systems provides in a modern building are to create and to maintain an environment that is appropriate to the processes taking place.

- For an office building, this environment must suit the requirements of people in their working situation.
- For a residential building, the requirements will be for comport of people, but the systems adopted will be rather different.
- For building in which industrial processes take place, the requirements may be very different indeed.

The engineering systems for environment control need to be monitored *to ensure that they perform their functions correctly and meet environmental standards. Monitoring also provides the means of maintaining systems in good running order, capable of continuing to performing their functions.* The correct operations of the systems installed to maintain the environmental conditions outside the building i.e *the temperature, humidity and weather conditions*

Other functions relating to the building itself must be monitored and controlled in order to ensure it can be managed properly. Factors such as economy of energy use, security and safety.

The control of energy usage involves closed-loop control of the settings and operating schedules of heating and ventilating systems and of boiler and refrigeration plant.

The management of safety may involve expert systems, for example, to determine optimum exit routes in the case of fire, using measured information about the positions of the fire and smoke-filled areas.

Expert-system software may also be used to optimize the functions and setting of the controllers which determine the operating settings requires to minimize energy usage.

Building management Systems (BMS) can carry out all of these monitoring and closed-loop control functions. They will utilize the processing power of central computers as it first developed.

We shall look at the components used in BMS. Which are Sensors, Outstations and the Central Station? The way that these are interconnected is shown schematically in Figure 1.

Figure 1: Schematic Layout of Typical Building Management Systems

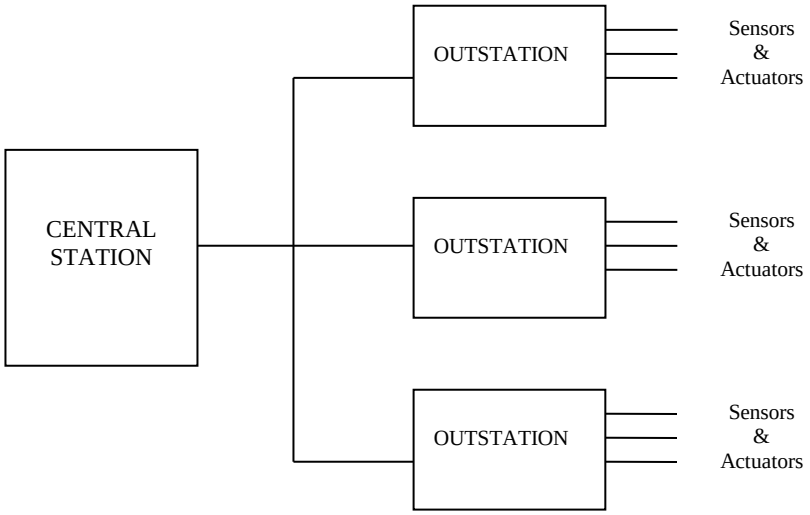
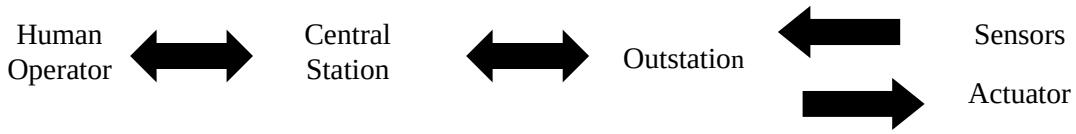


Figure 2. Data Flow in Typical Building Management Systems



1. SENSORS

In order a Building Management System (BMS) to function, it will need to obtain information from the building services plant as well as the building environment. In some cases this information will simply be the *status* of an item of plant while in others it will be a *measured value* such as temperature.

In order to provide information about continuously variable quantities like temperatures, sensors which generate an analog output are needed.

The types of sensors which are used as follows:-

i ***Status or Pulse Sensors***

These sensors provide an on/off, i.e. binary, output and will typically comprise a pair of electrical contacts on a relay operated in parallel with the state being monitored. Note that the voltage levels at the BMS input stage will be only a few words and the BMS will not to design to withstand the hundred of volts used in power circuits.

ii ***Temperature Sensors***

Temperature is one of the most commonly measured quantities in building services applications and a variety of different forms of sensors have been developed. These take advantage of the variation with the temperature of particular materials properties. Those are:

- ***Expansion Devices***
  Solids and liquids expand on heating in a known and repeatable way. The expansion of liquid is used in the familiar liquid-in-glass thermometer and the difference in the expansion of dissimilar metals is used in the bi-metallic strip.

- ***Thermocouple***
  A thermocouple comprises a closed circuit made from two different metals. If the two junctions between the metals are at different temperatures then a voltage between the junctions can be measured. Accuracy depends on one of the junctions being held at a known temperature while the other assumes the temperature to be measured.

iii ***Humidity Sensors***

The *Psychrometer* provides an indirect means of determining the humidity. This device simultaneously measures the dry and wet temperatures of the air. From these data the humidity can be calculated. Building Management System used the devices that can utilize an electrical property that varies with humidity. Sensors that operate as capacitors have been developed. As moisture is absorbed by the dielectric in the capacitor, the capacitance changed. This sensor also incorporate the electronic circuit needed to generate a voltage output proportional to the change in capacitance.

iv ***Pressure Sensors***

To measure pressure devices such as bellows, diaphragms or Bourdon tubes are used. These all depend on the physical movement associated with a change in pressure. This movement can then be measured using capacitive device.

2. OUTSTATION OPERATION

Function

The signal from the sensors provides the data the BMS needs to perform its function. Data will be gathered and bring all of these data back to one central point of processing. The complete system is disabled if fault occurs at the central processor and data will be lost if connection to the centre is interrupted.

Therefore an intervening tier is used by means of the *outstation.* The outstation *receives* and *stores* sensor data and will perform many of the processing functions. An outstation located in a plant room could, for example, control all of the local plant. A microprocessor within the outstation will have the 'intelligence' to achieve this without reference to the central processor. Then, if communication with the central is lost for any reason the plant can continue to operate correctly. In a typical BMS there will be many outstations, each having the required intelligence to perform its local functions. This idea of distributed intelligence is set to continue to develop with intelligence being devolved down to individual sensors and control units mounted on individual items of plant.

3. DATA ACQUISITION

One of the most important functions of any Building management System is the '*gathering*' of continuous measurement data, at regular time intervals from large numbers of individual measurements sensors, and 'discrete' state date from sensors such as smoke alarms. This requires real-time techniques not found in other systems, and this in turn necessitates chips unique to BMS for the sampling of sensors in strict rotation. Measured data are generated continuously by individual sensors; if many measurements are to be 'read' by the computing system, each must be *sampled* at regular intervals, in rotation, and the measurement reconstructed in the system from these samples.

- ***Data-Sampling Strategies***
  Frequency of sampling must reflect the way in which measured values themselves change with time. A rapidly changing measured value will have to be sampled much more frequently than a slowly changing value, in order to reconstruct its true nature from the samples.

4. CENTRAL STATION OPERATION

The sensors and actuators interfacing with the building at its services; and the outstations gathering data from the sensors and instructing the actuators. In most buildings there will be a number of outstations and, though they can operate locally with degree of autonomy, their operation needs some form of central, co-coordinating supervision. This supervision is performed by the Central Station which also forms the interface with the human building operator.

The Central Station comprises a microcomputer or personal computer (PC). This machine is microprocessor-based like the outstation but will incorporate a much larger memory, a monitor and a keyboard.

The Central Station will hold a lot of software associated with the management of the BMS and the operator interface. The software used to create these graphics can utilize the information from CAD software used in the original building services design.

5. OPTIMISATION

Optimisation is *an energy-saving technique applicable when a building is not continually occupied.* Outside of the hours of occupation the building services plant is switched off allowing the building's internal conditions to depart from the design values.

Before the start of the working day the plant will have o either pre-heat or pre-cool building to ensure that required conditions are achieved by the time that the building is pre-occupied. Each day the *optimum start* feature seeks to start the plant as late as possible consistent with achieving the required conditions in time.

At the end of the working day it is possible to stop the plant before the building is vacated and allow the internal conditions to reach the minimum acceptable level at the end of the working day. The *optimum stop* feature seeks to stop the plant as early as possible.

6. NIGHT PURGE

Night purge technique reduces the energy used to cool air, under summer or tropical conditions, in air-conditioned buildings. The plant is shut down when occupancy ceases in the late afternoon or early evening. Just around dawn, the outside air is often much cooler than the inside air. Hence it is often advantageous to stat up the ventilation fans alone load on the refrigeration plant by enabling the optimum-start sub-system to delay the operation of the refrigeration plant.

If at dawn, the outside air has air higher humidity than inside air, the BMS will calculate relative energy penalties, on the one hand, of neglecting to use the cooler outside air to purge and, on the other hand, of using it to purge and thus increasing the start-up load on the dehumidifying plant. This is depending on the level of carbon dioxide measured by sensors inside the building.

7. ENERGY AND CONDITION MONITORING

The BMS can use to control the building services plant by gathering a large amount of data from many sensors. The data gathered also enable the building operator to monitor how the building and its plant are performing overall.

- *Energy Monitoring*
  The BMS can gather and summate the energy consumption data if the meters with pulse outputs are installed in the building. These data can be used to assess the relative energy efficiencies of different parts the building and in many cases to identify where the inefficiencies occur.

  Equally other utilities can be monitored and if these data are collected for individual parts of a multi-occupancy building then the occupants can be individually billed.

- *Condition Monitoring*
  Maintenance of individual items of building services plant is to be planned on a calendar basis, e.g. a particular item will be checked monthly. In reality maintenance interval needs will depend on the time that the plant has been in use. If a sensor detecting the running status is installed then the BMS can keep a log of the ‘hours run’ and flag up the appropriate time for routine maintenance.

8. OCCUPANCYMONITORING

Sensors are available which can detect the presence of people in a room or work area. These sensors use multiple infra-red light beams to cover the area; whenever any of these beams is interrupted, the presence of somebody, usually a person, is indicated. These detectors were developed primarily for security purposes, but can be used to monitor occupation of a room or work area. In doing this, the BMS seeks frequent interruptions of at least one of the beams – even someone sitting at a desk will make movements sufficient to satisfy this requirement.

The monitoring of occupancy enables the BMS to reduce or turn off both heating and lighting in rooms or areas which are not occupied, provided the systems have been designed to facilitate the monitoring occupancy device.

Using occupancy sensors, the lighting can be automatically turned off when occupancy has not been detected for a short period. If in addition, illumination levels are monitored in strategic positions, artificial lighting can be reduced by selective switching at times when natural daylight makes such reduction possible without inconvenience. These techniques can readily be operated automatically by the BMS and can save considerable amounts of energy.

Turning to security, both occupancy sensors and sensors applied to doors and windows effectively used to warn of break-ins. The BMS can monitor attempts to gain unauthorized access to secure areas, and at night the system can be connected direct to the local police station.

BMS can be used to enhance safety in the event of fire or other disaster. Smoke and fire detectors inform the BMS of the location of the hazard, and fire-exit direction signs can be made to indicate the best escape routes from different parts of building. This will depend on numerous factors including: the type and extent of the hazard, the escape routes that it cuts off or makes potentially unsafe; and the occupancy distribution.

A Building Management System (BMS) can make a contribution to safety that cannot be provided by other means.