

## Project Draft

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### Overall understanding

Many components are related with an intelligent building. A group of topics have to be stated to show the overall understanding of intelligent buildings.

When come to intelligent buildings, the topics needed to consider include building systems, applied building types, objectives, related people, what are being controlled and how to make a building intelligent. But the most important question is what an intelligent building is. To my understanding, the 'intelligence' here means the ability to automatically deal with problems or maintain current conditions in buildings based on the previous data and human commands to achieve the objectives of saving energy and comfort indoor environmental quality. The way to make a building intelligent to run the building under control and communication system, widely called Building Automation System (BAC), or Energy Management and Control System (EMCS) by ASHRAE. According to ASHRAE definition, *EMCS is a computer/processor based hardware and software system with sensors, control devices and all the necessary components that perform some or all of the following functions: 1 Measures (energy related); 2. Monitors and/or controls; 3 Reports status, information about buildings environment, energy efficiency, and HVAC system maintenance.*

From the technology point of view, the control and communication are key parts in an intelligent building. The control strategies include proportional control, two position control, and modern control technologies such optimal control, fuzzy logic control and neural network. The optimization of building system is achieved when the appropriate strategies are used. The communication network is also necessary to build up based on the growing information technology. Basically, there are three levels in communication system architecture. The highest level is Intranet and TCP/IP network system with human interface such as computers. The second level is peer-to-peer controller local area network and the third level is a polling or managed secondary controller network. In order to ensure communications among different devices under different levels, the communication protocols come to play. Closed protocols and open protocols are developed by manufacturers which are different from one to another. The standard protocols (BACNET) are developed by organizations like ASHRAE to improve the system standardization. Some problems are existing in control and communication systems which will be described latter on.

Once the EMCS are built up, all building systems will be under control. The major building systems include heating, ventilating, and air conditioning (HVAC), lighting system, fire protection, safety and security, hydraulic and drainage, and vertical transportation system.

During the design, management, operation and maintenance of an intelligent building, many people are involved in. the contractors and owner are in charge of building and managing. The indoor conditions will be adjusted based on users' requirements. Basically, the satisfied indoor environmental quality is obtained by monitoring and controlling indoor temperature, relative humidity, indoor air pollutant and luminosity. Adjusting these parameters is not only for residential purpose, but also for commercial and industrial processes such as cargo storage and manufacturing process.

### **General problems in building systems**

Several problems exist in today's building. Mainly, these problems can be described in the aspects including design, construction, operation, occupants and modification.

The building comes from design. It is related to many types of people such as designer, contractor, owner and user. Traditionally, the designer designs the building according to their ideas. The contractors may change the design in some extent to meet their needs. When the construction begins, the on-site construction engineers may change the design again based on their experience. Finally, the owner and users might not be satisfied with some detailed design or even the whole design. This is the lack of communications among these people. Moreover, the designers are also lack of ideas of intelligentizing the building. Normally, there is no communication network for automation control. It is better to install sensors, controllers and their wire system together with the electrical system when the building is under construction.

Some problems existing in a building have to do with the construction. Cracking, spalling, and rain penetration happen sometimes due to the construction technique problems, including lack of the joints and barriers. Evaluation and retrofit should be taken to solve these problems.

Sometimes, the operation is not performed as expected. It might be too hot or too cold in the interior zone. Therefore, the occupants are not satisfied with the indoor conditions such moisture, thermal comfort and indoor air quality. A smart fault-detection on HVAC and MEP systems are required.

All the problems above could be solved by modification which should target on making the building more intelligent. The modification could be hard because of the lack of the future consideration in the initial construction. A new construction or destruction may be

needed to install sensors, controllers and wires. Cost is also a consideration of the modification.

Cost is always a consideration when building intelligence. The control and communication devices are expensive, but the intelligent building can save the operation cost. So attention should be paid to balance the initial cost and operation cost.

### **Problems in control and communication**

The problems in control and communication are specified in this project. Basically, the problems in this field exist in control, communication, detection and data collection. There are always 'dead' bands for controlled devices, meaning that in a certain range the device is non-controllable. For example, the damper position in a VAV terminal unit is not controllable at low flow (under 5% open). In this case, the damper will just switch between fully close and partial open. Big noise will be made and the ventilation requirement cannot be met. The control strategies also play a very important role.

Another big problem is the communication between devices. It is hard for devices 'talk' to each other if they are made by different manufacturers who develop their own protocols. It could be solved by using gateways but problems are always with setting up the gateways. Therefore, using the standard protocols such as BACNET by ASHRAE is the best solution here.

Other problems refer to wiring sensors, supplying power for wireless sensors and acquainting data locally.

DDC: Direct/Distributed Digital Control

BMS: Building Management System

BAS: Building Automation System

ASHRAE Standard: