

# Demo: BACChat: A Building Automation Control Client for Sensor Data Collection

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**Abstract**—Nowadays, many buildings are equipped with a building management system (BMS), which plays a key role in maintaining the operation, energy efficiency, and safety of a building. With the rising concerns in energy conservation and the fact that buildings are major energy consumers, there is an increasing interest in studies on building management systems in computing society. One key difficulty we found in BMS research is that a BMS system is very complex, and there is very few tools for researchers to flexibly the interaction with a BMS system.

We developed Building Automation Control Chat (BACChat) for a BMS system. The BACChat is the client side of BMS, which can interact with the sensing devices of a BMS system. Such operation was not possible because all the BMS operation software are developed by private vendors. We released BACChat as an open source. It can be used for many research problems. For example, we plan to redesign part of the BMS system using wireless sensors; so as to reduce deployment effort and costs. As such, our BACChat is an indispensable component for our system. We also found that data loss occurs when we are using existing software; but we are short of tools to diagnose the problem, therefore, BACChat is useful in such situation.

In this demo, we will help our audience from the computing field to better understand the existing BMS system. We will show how BACChat can be used for research studies.

## I. INTRODUCTION

We are in the age where people are paying increasing attention to energy conservation around the world. In 2004, commercial and residential buildings have accounted for 38% of the total energy usage in the United States while the rest goes to transportation and industry [1]. In some regions like Hong Kong, where the industrial sector is relatively small, the impact of commercial and residential buildings in energy consumption is even higher (in Hong Kong 2008, the figure is 65% [2]). As such, there has been an increasing interest in the computing field in applying the sensor networks and other computing technologies in the development of smart green buildings.

Building management system (BMS) is used for the operation of many high-end buildings. There are many sensing devices data in BMS to record, such as Heating, Ventilating and Air Conditioning (HVAC) equipment. These sensing devices are connected by the direct digital controllers (DDCs), which form the hardware back-bone of BMS. A key element of the software framework of BMS is the Building Automation Control Network (BACnet), standardized by the American Society of Heating, Refrigerating and Air-Conditioning En-

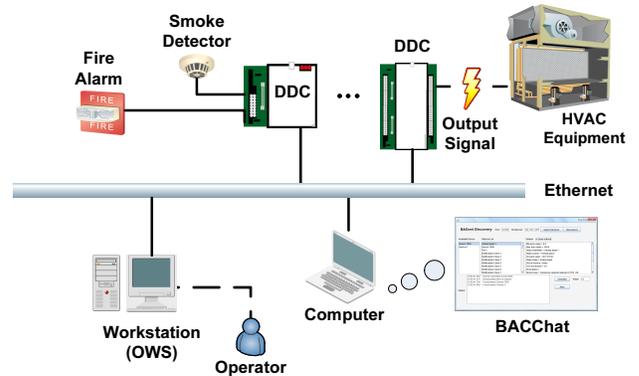


Fig. 1. A common architecture of a Building Management System

gineers (ASHRAE). BACnet is a protocol that bridges the communication gaps of DDCs between vendors.

Though the BACnet is an open standard and free to use, the client side software of BACnet is still developed by a few commercial companies (e.g. Johnson Controls, Siemens and Honeywell). As such, it lacks the flexibility to control and monitor the data streamed from the DDCs directly. For instance, we often found data loss when we are collecting the log data of the DDCs in the BMS software, however, it is difficult to carry out any diagnosis since the functions and interfaces provided by the BMS vendors are limited.

We developed an open source BACChat, available in [4], which is able to communicate directly with the DDCs through BACnet. It helps to develop applications using BACChat. For example, we are currently conducting a study on converting the DDCs components from wired into wireless sensor networks. BACChat will become an indispensable part of our system.

## II. AN OVERVIEW OF BACCHAT

Fig. 1 illustrates the architecture of a standard BMS. Nowadays, many DDCs use ethernet for data communication. The Operator Workstation (OWS) software provided by the vendors is used to monitor and control the building's equipment. The clients are passive and confined to the functions and performance of the workstation software. The software framework for BMS is shown in Fig. 2. BACnet supports several kinds of connection in the physical and data link layers. BACnet/IP is the most common one (i.e. the IEEE 802.2 over

BACnet Application Layer - e.g. BACChat					
BACnet Network Layer					
IEEE 802.2 Type 1		MS/TP	PTP	LonTalk	ZigBee
IEEE 802.3	ARCNET	EIA-485	EIA-232		

Fig. 2. The software framework of BACnet and BACChat

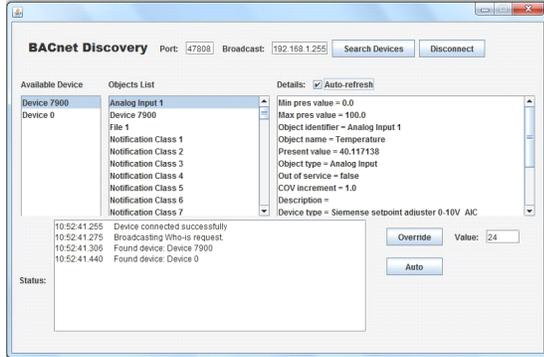


Fig. 3. The graphical user interface of BACChat

IEEE 802.3 Ethernet solution) due to the prevailing TCP/IP framework.

Our open source BACChat is built over BACnet. It can interact with different BACnet devices directly. BACChat aims at collecting sensors data from the BACnet network with the command functions. BACChat is written in Java and it provides a graphical user interface as shown in Fig. 3.

Since BACChat is built over BACnet/IP, it assumes the computer that runs BACChat has obtained a unique IP address, so that other neighboring devices can communicate with it through unicast or broadcast. Once BACChat is connected to the network, it broadcasts the BACnet Who-Is service to the whole network under the same subnet. When the other BACnet-compliant controllers hear the Who-Is service, they will reply with their object ID and list the services they support. All the devices found by the BACChat will be listed in the device list and the response time will be shown in the status box. The BMS operators can further read the objects list of the chosen device. For example, the operator may want to have the current temperature from the sensor of a room. BACChat enables the operator to select the requested point and obtain the live data by selecting the point name. Besides the BACnet devices discovery and property readings, BACChat also provides functions that can override the current setting of the DDCs. Such function is especially useful for research purposes.

Our BACChat is useful as it is the first open source BACnet client. As such, it assists the research communities for the initial design and testing of more advanced communication systems (e.g. BACnet over wireless 802.15.4 or 802.11), develops and diagnoses new Quality of Service applications (e.g. energy efficient, delay constrained) for a smarter, greener, and more intelligent building management system.

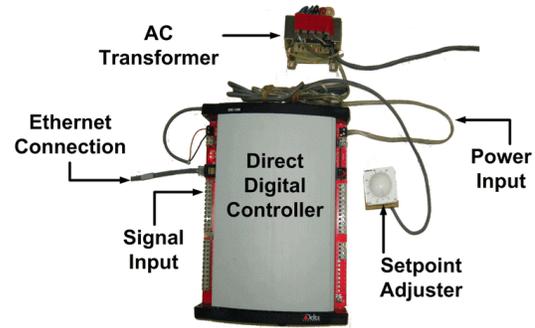


Fig. 4. The hardware used to demo BACChat

### III. DEMO DESCRIPTION

We will provide three levels of demos. 1) We will bring a DDC and show how it connects with different sensors and input signals to the controller. 2) We will use a standard BACnet workstation software to show the daily operations of BMS. 3) We will demonstrate how BACChat can discover and control the BACnet devices through the BACnet/IP.

In the first level, we will bring a DDC hardware shown in Fig. 4. Our DDC, Delta Controls DSC-1280, is a fully programmable BACnet Building Controller (B-BC). It is suitable for controlling equipment such as Air Handling Units (AHUs), chillers and other common HVAC equipment. It has also been verified by the official BACnet Testing Laboratory (BTL) as a native B-BC.

For our second and third level demos, we will simulate the signal inputs to the controller. We use Siemens BSF61, which is a setpoint adjuster (see Fig. 4) providing 0-10V DC output signal by adjusting the setting knob. A router will be used to form a LAN to the controller and we will use a laptop to run both OWS software and BACChat. We will first show the traditional BMS operations by using the Delta Controls OWS software ORCAView [3]. We will answer questions related to building management system.

We will then show BACChat, which simulates the functions of ORCAView. In our demo, we will show how to override the readings of the Siemens' setpoint adjuster from BACChat.

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