Computerized Central Control and Monitoring System for Queen Elizabeth Hospital

Ir. Dr. K M LEUNG
Senior Electrical and Mechanical Engineer
Electrical and Mechanical Services Department

Summary

The application of computerized Central Control and Monitoring System (c-CCMS) is one of the major productivity improvement initiative of the Health Sector Division of Electrical and Mechanical Services Department. Upon full implementation of the scheme at Queen Elizabeth Hospital, all alarms and operational status from the engineering plants of the hospital complex and remote clinic venues in the vicinity will be fed back to the central control centres and the manpower strength of shift-duty team in the hospital and remote venues can then be reviewed.

This paper describes the computerized Central Control and Monitoring System (c-CCMS) installed at Queen Elizabeth Hospital (QEH), which was highly regarded as the initial step forward to fulfilling the productivity achievement target. The c-CCMS network comprises dual redundant servers with self-diagnostic routine for changeover through software arbitration mechanism in case of failure. The network is interlinked through Gigabit Ethernet Local Area Network with special features including auto-dialling through Short Message Services (SMS), remote dial-up to c-CCMS, digital video management through Closed Circuit Television (CCTV) images, interface with Queen Elizabeth Hospital (QEH) Intranet and accessibility through Web. The c-CCMS also includes a comprehensive real-time database incorporating data from analogue, digital and pulse inputs as well as analogue and digital outputs. The database is configurable with trending and alarm reporting capability allowing real-time, historical or archived data to be displayed in different formats to facilitate operation and maintenance. In addition, c-CCMS also processes an energy management module, which can oversee the overall energy consumption profile of individual building of Queen Elizabeth Hospital and formulate appropriate energy management plan.

1. *Introduction*

The application of computerised and integrated central control and monitoring system was well recognised as one of the possible ways to achieve productivity improvement for operation and maintenance activities and to update the technological know-how of in-house staff of the Health Sector Division of Electrical and Mechanical Services Department (EMSD). In mid 1998, the Health Sector Division decided to engage the latest state-of-the-art technology in relation to computerized Central Control and Monitoring System (c-CCMS) for centralising fault call management as well as monitoring and control of the E&M plant and equipment over several major acute hospitals together with its nearby clinical venues.

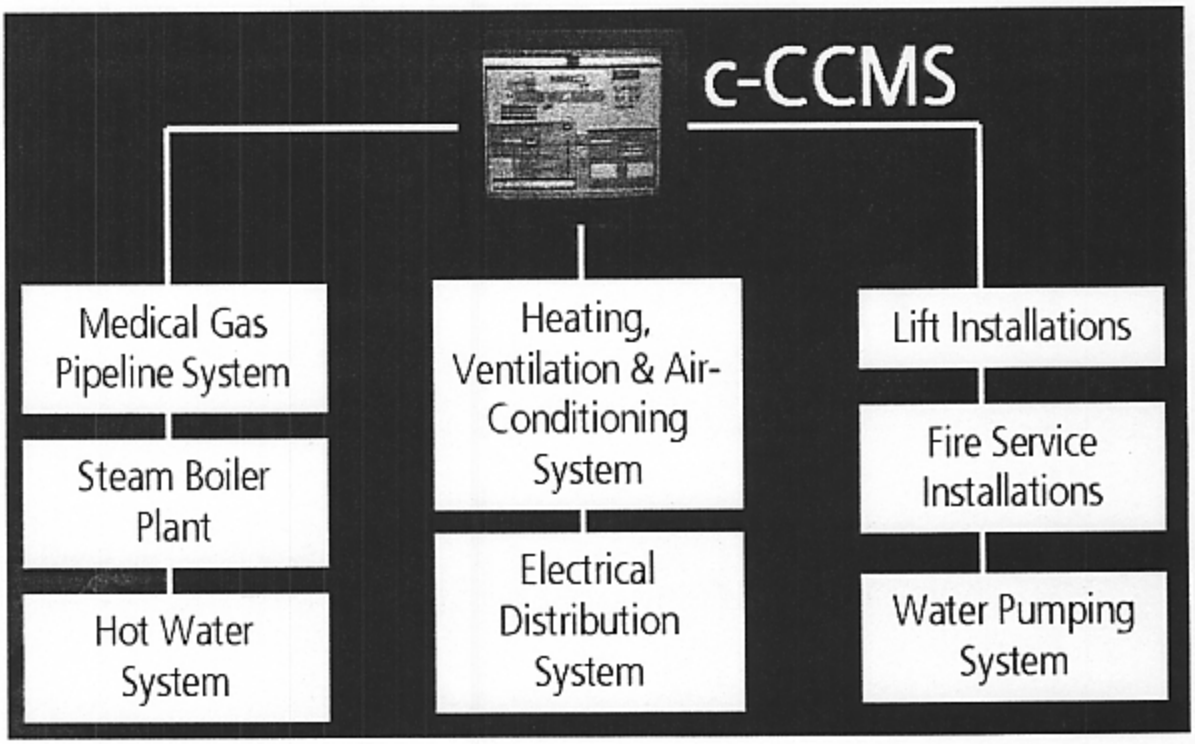

Figure 1: Engineering plants controlled/monitored by c-CCMS

This idea had been incorporated as one of the major productivity gain initiatives in 1998/1999 business plan. An in-house study was then carried out to look into the shortfall in the daily operation of the already installed CCMS in the hospitals and to

formulate appropriate integration and upgrading strategies.

There were a total of over 20 nos. of CCMS installed at different hospitals by different vendors using their own proprietary software, all running individually without exchange of information or data with each other. Having reviewed all the concerned areas, a preliminary study report was produced in March 1998 which set out several positive directions to effectively utilize c-CCMS to improve operational efficiency. These included upgrading to web-based systems and integrating different CCMSs into a Local Area Network and eventually to Wide Area Network (WAN).

The c-CCMS installation at the Queen Elizabeth Hospital was targeted as the first step forward to fulfill productivity achievement target.

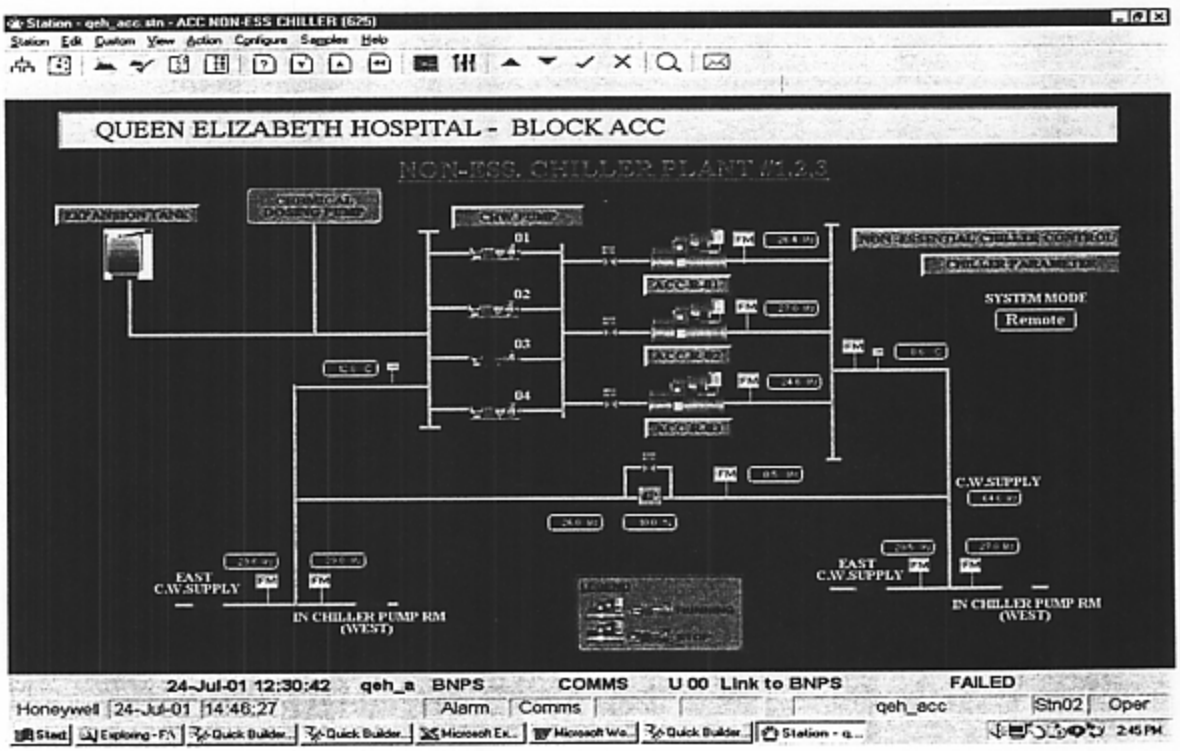

Figure 2: Chiller Plant at Ambulatory Care Centre of Queen Elizabeth Hospital at c-CCMS

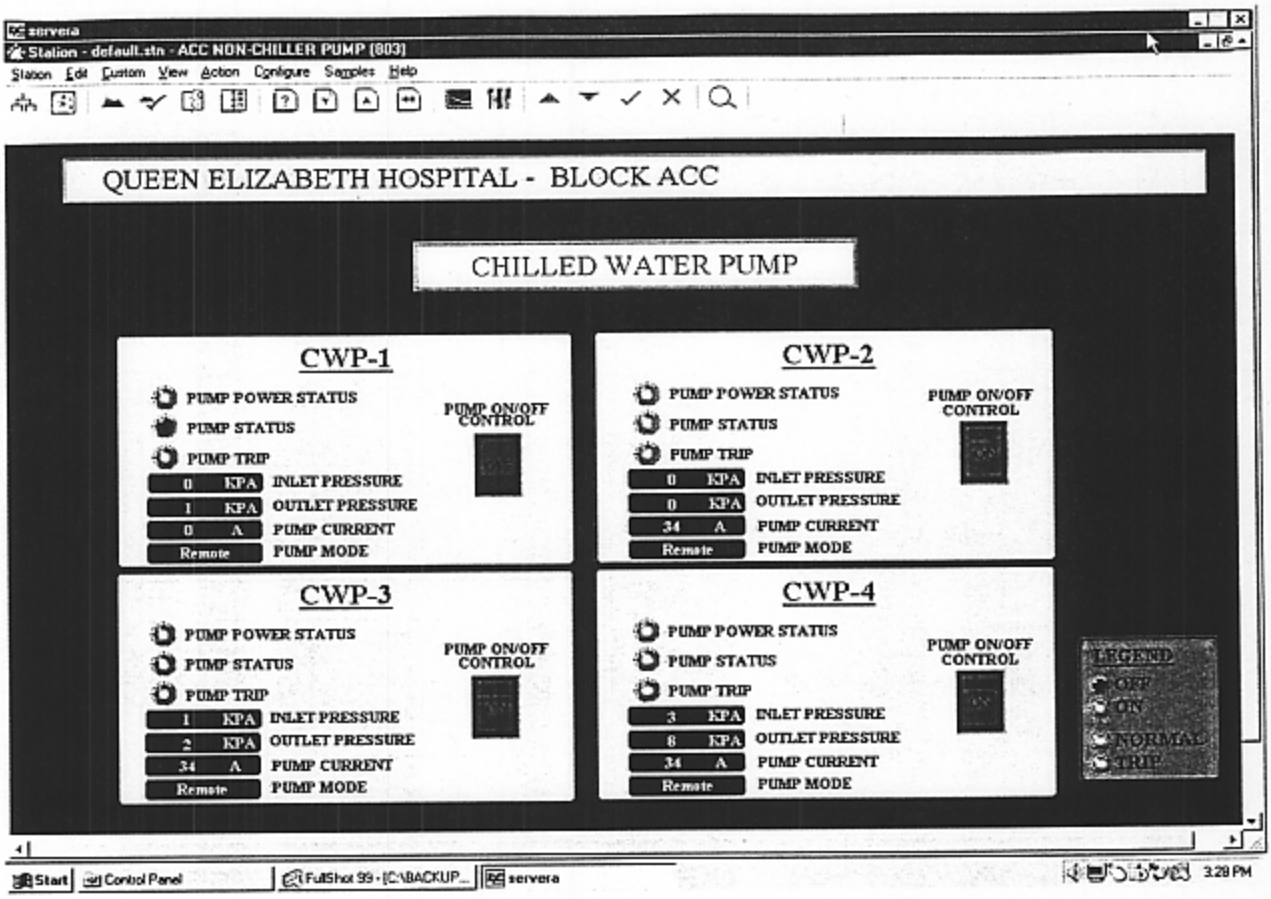

Figure 3: Chilled Water Pumps at Ambulatory Care Centre of Queen Elizabeth Hospital at c-CCMS

2. *Integration Approach*

Over the years, the Hospital Authority (HA) has continued its efforts on rationalisation of services through explicit cluster-based service networking. In line with the Hospital Authority's cluster management, the Health Sector Division is also currently reviewing its c-CCMS networking to meet the cluster management concept.

The major benefit of clustering is that services and manpower resource belonging to an individual cluster can be effectively optimized and shared. In the context of c-CCMS network, a major acute hospital, e.g. Queen Elizabeth Hospital in this case, has become the core of the cluster while the remote venues are selectively linked to the c-CCMS network. The criteria to determine which venues should be connected to the c-CCMS network largely depended on the significance of function and impact severity

during major plant failures. For remote venues, only those occupying a standalone building with significant size and scale of engineering systems were selected.

In order to facilitate CCMSs integration, application of open protocol is inevitable. In reality, there are several industrial standards that claim they can provide open architecture and protocol for cross vendor integration. Such standards include BACnet, Lon Works, OPC and Modbus. Modbus is considered not appropriate for the c-CCMS network as the speed of transmission is confined to 19.2kbit/s and it is designed for factory level control rather than high level management level control. For BACnet and Lon Works, although they are standard protocols for building automation, they require gateway for integration. OPC at the present technological advancement standard can integrate systems each with its own information servers into a common client. Subsequent to detailed scrutiny, OPC and BACNet were selected as the most suitable open protocol for the c-CCMS application.

3. *System Architecture*

Dual Redundant Servers

The c-CCMS system comprises two Intel Pentium III Xeon 866MHz dual processor type central servers, each equipped with 40GB Ultra SCSI 160 hard disk and interlinked with the workstations and the Ethernet network core switch through an Gigabit optic fibre Ethernet Local Area network (LAN) to form a dual redundant hot standby computer configuration, allowing data from the primary on-line central server to be automatically transferred to the hot standby backup server. Whereas communication between the c-CCMS and the direct digital controllers (DDC) is processed through communication-bus protocol on twisted pair cables with data rates configured to 76.8

kbps, the hot standby function is being executed through the self-diagnostic routine of each server which audits the process of other servers continuously. In case of failure of the primary server, the self-diagnostic routine will initiate an automatic changeover using software arbitration mechanism to the backup server within 3 seconds. Further changeover will normally be inhibited until the operator re-activities the failed server.

The central servers also maintain high performance real-time database and give real-time information to the network-based operator workstations.

Standalone Servers and Workstations

There are 5 standalone servers and 5 workstations altogether. The five standalone servers are each processing data from the DDCs of a dedicated building within the hospital, while the five workstations are operator terminals. The industrial standard Ethernet LAN and the Ethernet network core switch enable data from the five on-line building standalone servers to be transferred to the two central servers.

System Network

The communication protocol used for optic fibre LAN interlinking the two central servers, five standalone servers, five workstations, Ethernet network core switch, CCTV server, web server, router, video wall, video servers, public switched telephone network (PSTN) modems and associated peripherals is called "Ethernet TCP/IP" (Transmission Control Protocol/Internet Protocol). Standard TCP/IP network topologies are adopted with LAN, WAN, serial and dial-up access. In order to minimise capital cost, apart from the optic fibre, 100M bps unshielded twisted pair (category 5) cables have also been used for data transfer linkage between servers and

Ethernet network core switch as well as the communication interface with PSTN modems and other network branch connections.

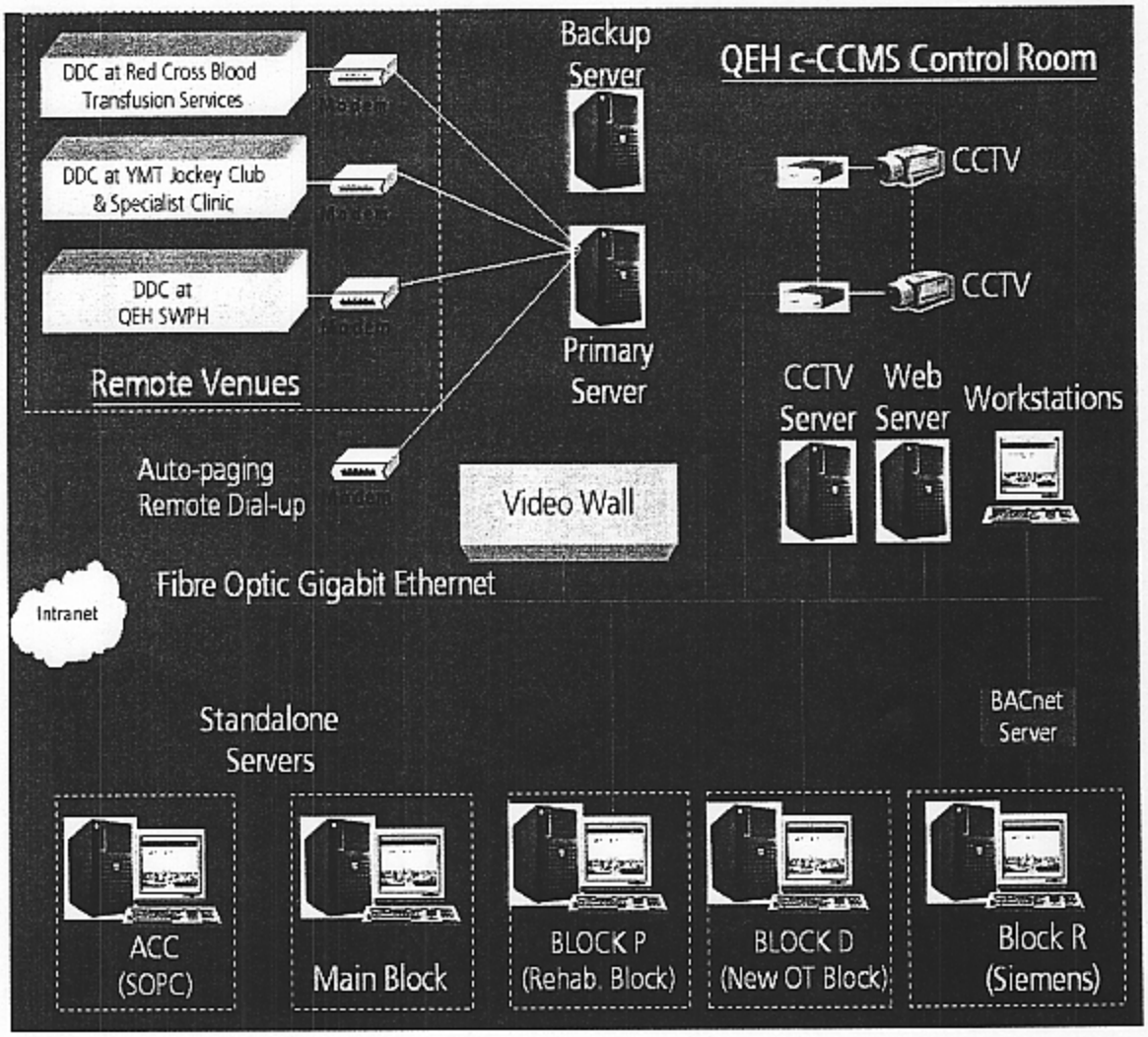

Figure 4: System Architecture of Queen Elizabeth Hospital c-CCMS Network

c-CCMS Software

The c-CCMS software is a proprietary software running on Microsoft Window 2000 operating system with industrial networking standards.

Data are retrieved from the field sensors through direct digital controllers and building servers to the central severs under the mechanism of "report by exception". Scanning

by the server is also performed to read the status and values of the input, output and memory locations of the direct digital controllers.

The real-time database supports the collection and storage of data with:

- analogue point structure for continuous values (such as temperature readings, station points for digital values)
- accumulator point structure (e.g. number of times a switch has been turned on)
- historical data structures
- event data structures

4. *Special Features of Regional c-CCMS Network*

In the design of the c-CCMS network, several special features were being incorporated to ensure that it will be a practical and effective O&M tool for inhouse staff. These include:

(1) <u>One Single Central Control Centre</u>

Fault alarm management and monitoring and control of engineering systems through the Queen Elizabeth Hospital complex and the nearby clinical venues are performed in one single central control room at 24 hours per day basis.

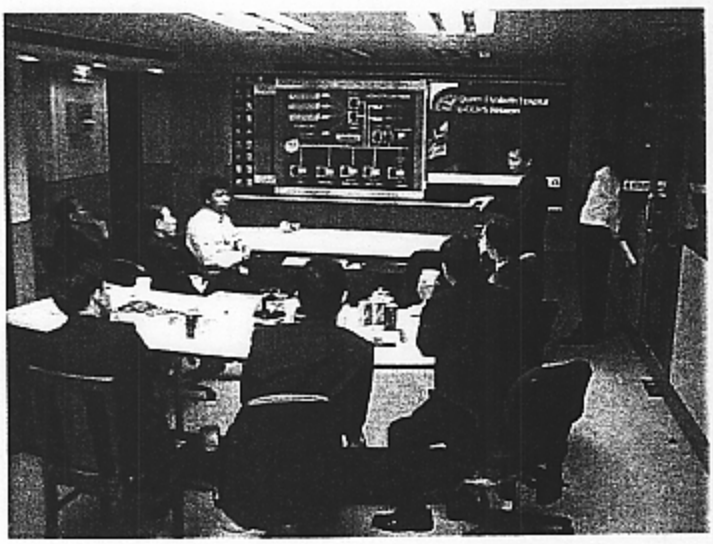

Figure 5: Queen Elizabeth Hospital c-CCMS Control Room

(2) Auto Dialling through SMS

When the c-CCMS receives an urgent fault message, it will automatically initiate the auto-dialling function. The relevant alarm message will be sent out from the c-CCMS network to the Short Message Services (SMS) centre of the telecommunication services provider and activate a ringing tone with alarm message displayed on the mobile phone of designated operators. From the alarm message received through the mobile phone, the operator will be able to know the time, location and description of the fault.

(3) Remote Dial-up to c-CCMS

Upon being alerted of an urgent fault through the mobile phone, the operator can then use his own notebook equipped with c-CCMS software, dial up through PSTN and gain access to c-CCMS network vide the c-CCMS central server and obtain immediate fault information on the E&M engineering plant and equipment.

(4) Digital Video Management through CCTV

CCTV cameras are positioned at strategic plant rooms to bring back real time digital video images through the c-CCMS network to the main control centre to allow operators to monitor the plant operation situation remotely and simultaneously.

(5) Interface with QEH Intranet

The c-CCMS network is connected to the Queen Elizabeth Hospital Intranet by means of router. With the setup of the Web server on the c-CCMS network, HA staff can access information on the status of E&M plant and equipment at their

own PC terminals by using Internet browser such as Netscape Navigator or Internet Explorer.

(6) Accessibility through Web

With the setup of the Web server and connection to Internet, plant equipment status can be monitored by O&M staff at any time anywhere around the world through the Internet by means of PDA equipped with wireless modem / mobile phone.

(7) Distributed Server Architecture

Apart from Gigabit Ethernet LAN for enhancement of the system throughput and capacity, the concept of "Distributed Server Architecture" is also being implemented in the c-CCMS network. There are five standalone servers, each processes data from its own DDCs installed in a dedicated block of Queen Elizabeth Hospital. Data from these five standalone servers are then distributed to the two central servers, thus enhancing the system reliability as well as the response time. Should the two central servers fail, the distributed servers will still work properly with data being stored within its own database. Data will be sent back to the two central servers, once the two central servers resume normal operation.

5. *Acknowledgement*

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