# A Distributed, Extensible and Accessible Sensory Control and Data Acquisition System

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*Abstract*—
**The Sensory Control and Data Acquisition - Total Environment Management System (SCADA-TEMS) is a distributed multi-access computer controlled data acquisition and control system. The system is composed of multiple sensory and control modules that perform task ranging from controlling equipment to collecting, multiplexing and manipulating data. The SCADA-TEMS main control module performs the necessary buffering, latching and multiplexing of the multiple input and output hardware modules connected to the system. This module is in turn interfaced to the SCADA-TEMS server. The team developed a FTP-like TCP/IP protocol called Simple Access and Control Protocol (SACP) in which the SCADA-TEMS server can be accessed using a PHP web-based interface, Java client interface, SMS-to-SACP gateway or raw socket connection to port 6543. Multiple SCADA-TEMS servers can be controlled by a central SACP client to provide distributed access. New modules can be utilized by attaching them to the SCADA-TEMS main control module and loading the appropriate shared object. These and other features allow the SCADA-TEMS to become a critical tool in providing a complete environmental management solution.**

*Keywords*— **Sensory Control and Data Acquisition, Computer Interfacing**

## I. Introduction

In this modern world, there has been a drastic increase in connectivity. It is now possible to keep in touch around the world via global roaming mobile network or via satellite-based communications methods. It is even possible to transact business, make purchases and surf the web on a cellular phone. It is possible to purchase everything from books, clothes and other items on the vast ocean of the Internet. At the middle of this digital world is convergence to the Internet Protocol(IP).

Distributed Systems in volatile or remote environments are costly and difficult to maintain. In environments such as power plants, factories and other similar facilities, they would have to deploy a large number of sensory devices to monitor the status of the entire system. In research and development facilities, it would be a tedious, costly and even dangerous endeavor to perform all the monitoring manually. In order to reduce manpower costs, improve safety condition and provide just in time monitoring, Sensory Control And Data Acquisition (SCADA) systems have been deployed.

With all this advances in Information and Communication Technology and the SCADA technology, we now have the necessary tools to provide a complete, distributed and multi-access computer controlled data acquisition and control system. This we call the Sensory Control and Data Acquisition - Total Environment Management System (SCADA-TEMS).

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## II. SCADA-TEMS

The Sensory Control and Data Acquisition - Total Environment Management System (SCADA-TEMS) is a comprehensive software and hardware solution for interfacing data acquisition and control devices. The system also provides access to these devices via the Simple Access and Control Protocol (SACP). This protocol is to server as a presentation layer protocol for accessing the SCADA-TEMS Server.

The system is composed of a number of basic elements:

⋆ SCADA-TEMS Server - provides access to the entire system via SACP. The server listens at port 6543 for incoming TCP/IP socket connections. It servers as the connection point of the system to the outside world.

⋆ SCADA-TEMS Main Control Module - is a hardware component connected to the SCADA-TEMS Server via an Enhanced Communications Port (ECP). This module connects the different data acquisition and control devices.

⋆ Sensors and Data Acquisition Devices - are hardware components that are deployed to obtains certain environmental variables such as temperature, light levels and others.

⋆ Control Devices - are hardware interfaces to the different hardware components of the system such as lights, air condition systems and others.

The SCADA-TEMS team has build a prototype system that controls the lights, temperature and music of a room. The prototype SCADA-TEMS also supports other value added features such as audio playback, mixer adjustment and mood settings. A diagram of the prototype SCADA-TEMS can be seen in Figure 1.

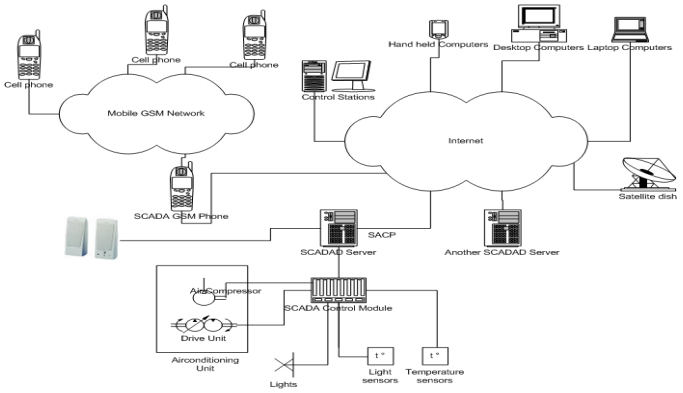


Fig. 1. Prototype SCADA-TEMS

A number of SACP clients have also been written to provide access to the prototype SCADA-TEMS. These clients include a cross platform java client, web-based PHP client and SMS-to-SACP gateway. A screen shot of the SACP PHP client can be seen in Figure 2.

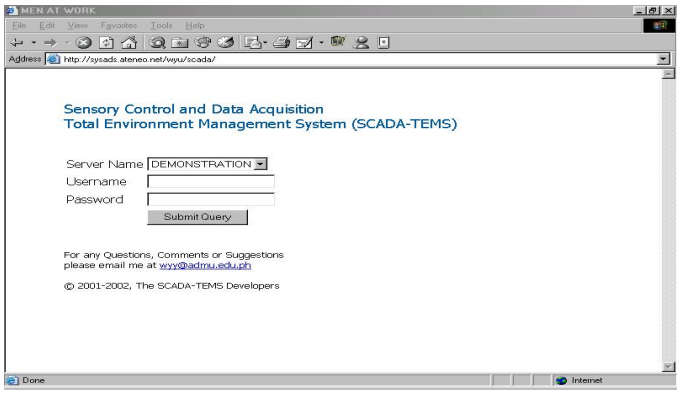


Fig. 2. Screen shot of the web-based PHP SACP client

This prototype SCADA-TEMS is intended to show the systems ability to be deployed in a variety of environments as the simplest of which is our own laboratory. The system can also be extended to control other environments.

## III. Benefits

The system provides a number of benefits to systems integrators over other SCADA systems. These systems tend to specific for a given environment and would be difficult to retool for a different one. SCADA-TEMS has three important benefits that give it an edge.

### *A. Distributed Control*

Like any other SCADA system, this is the main feature. This allows system manager to deploy a wide range of data acquisition devices in different locations which being able to maintain control over them. The devices can be deployed from a simple single location system to a regional or even national scale deployment. System managers can benefit by being able to limit the number of personal on the remote deployment site and still be able to full monitor and control the entire system.

### *B. Modularity and Extensibility*

Most systems are tailor made for a given environment and client. The SCADA-TEMS is no different. However, a major difference is the modularity of the design. Hardware-wise a central control module with a uniform interface enables system integrators to attach multiple sensing devices to a single control module. This allows the system to scale by being able to attach a large number of devices to a single SCADA-TEMS control module. This is because the SCADA-TEMS control module was designed to be able to multiplex the available parallel port lines in order to accommodate a large number of sensors and control units. In the SCADA-TEMS server, dynamically loadable system modules allow the systems integrators write a SCADA-TEMS software module and dynamically load into the system without having to recompile or restart the system. The system integrators do not need to know about the internals of the SCADA-TEMS server to be able to integrate their hardware. It is just a matter of writing the function for the SCADA-TEMS software module in the proper format.

### *C. Virtual Coverage*

This is the ability to access the system in a large number of way such that at any given time there is always a means for connecting to the SCADA-TEMS. The key to this is the Simple Access and Control Protocol (SACP). It is a protocol allows the SCADA-TEMS to be access by any SACP-enabled client. SACP is a TCP/IP based protocol and is a OSI presentation layer protocol. Client programs can be written to utilize SACP in manipulating the SCADA-TEMS server or synchronizing multiple SCADA-TEMS servers. The team has provided a number of SACP clients: a cross platform Java client, a web-based PHP client and a SMS-to-SACP gateway. With these Java client, the system integrators can run this SACP client in any platform with a Java Virtual Machine. With the PHP client, they can access the SCADA-TEMS via the Hyper text Transport Protocol (HTTP) through the World Wide Web (WWW) or Corporate Local Area Network (LAN). The SMS-to-SACP gateway allows the users to interact with the SCADA-TEMS by sending SMS message through their mobile phones.

With these three benefits, system managers and integrators are now provided with a tool that could enable them to have distributed control of their system. They can easily add software and hardware modules to the system. They can also access the system through a large number of different means the SACP clients written for the project are only a few of possible other clients.

## IV. Conclusion

The digital world in converging and new ways of doing old things are emerging. This is only one of them. SCADA system has been the target of various studies especially in the field of power distribution. Distributed control is the essence of any SCADA system. For it provides a cost effect way of monitoring and control multiple remote sites.

As the world converges, diverse systems also begin to converge. In the past, it would seem absurd to mix the telephone and a computer network, but now is an idea that is making high ground in the telecommunications sector. Extensibility, therefore, is also an important feature as it provides the flexibility to extend and retool the system for different uses.

With the availability of the Internet, mobile networks and others, there exists new means of providing greater access to SCADA systems. The SCADA-TEMS SACP is able to provide a simple interface for allowing the different networks to communicate to the SCADA-TEMS. The mobile GSM network and Internet are only examples of the many networks that can be linked to the SCADA-TEMS.