SIP APPLICATION TO MULTIMEDIA TELECONTROL OF POWER SYSTEMS

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ABSTRACT

At present, in our project we are researching about the viability of the enhancement of the basic telecontrol information supplied by SCADA systems by adding multimedia content.
SIP is a simple and light protocol, with client-server architecture, which allows to achieve voice and video communications through a data IP network, in similar way as the well-known and widespread HTTP protocol works.
So, we consider SIP a good choice to integrate multimedia in telecontrol operation.

KEYWORDS: SIP, telecontrol, multimedia, expertmedia, power systems

1. INTRODUCTION

Traditionally, telecontrol of power system has been accomplished by using SCADA/HMI systems which supply a basic and schematic graphic environment, faraway of natural visual and auditory perception of human being. See *Figure 1*.

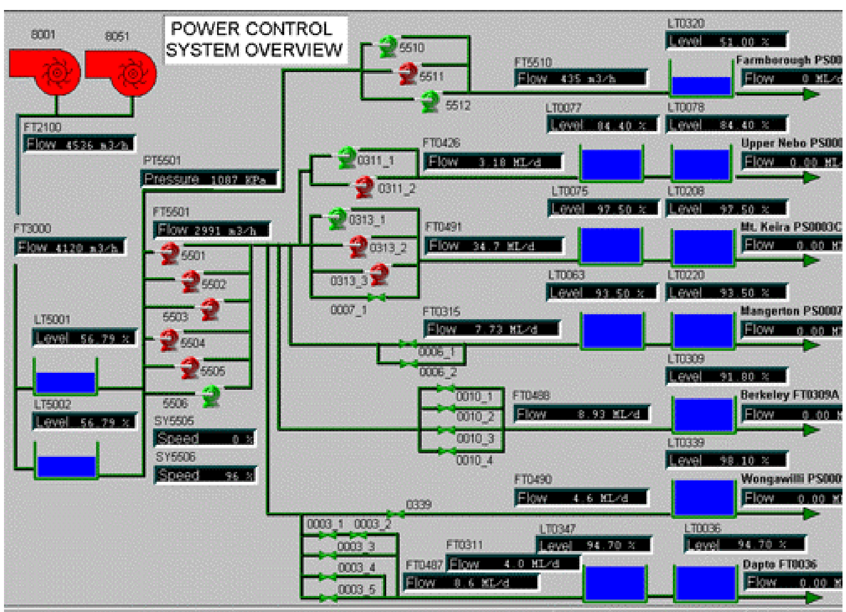

Figure 1. Typical SCADA/HMI System

SCADA/HMI systems have limited the display scope of status information and alarms logs to simple text characters [1].

This was mainly caused by the status of hardware technology at that time:

- systems were proprietary ones as there were not widespread hardware or software platforms
- the early stage of development of the networking technologies
- video and audio compression techniques weren't efficient enough to be used on systems other than scientific mainframes

Proprietary systems meant there was a strong dependence between the software and hardware parts, so only those who built the hardware systems had the knowledge to develop software applications that could be executed over those systems. That leaded to expensive and incompatible platforms where the original manufacturer could only do any improvement.

The relatively low processing power of those systems, together with the low bandwidth offered by the custom network technologies, prevented SCADA/HMI systems from using audiovisual information. Video and, to a lesser extent, audio information needed too much bandwidth to be transmitted over the existing networks, and even if that was the case, it would end up being too expensive to be used.

Throughout the last two decades, at a greater or lesser level, all these technologies (computer hardware and software, networking and audiovisual processing and analysis) have steadily been improved, while the cost of acquiring them has decreased.

1) The hardware side has benefited from a raising level of semiconductors integration, which has lead, among other improvements, to more powerful processors and faster and larger memory subsystems. Now, thanks to the new standard hardware architectures that have arisen, and along with new cost-effective widespread software platforms, we have at our disposal interoperable and hardware-independent systems.

2) Networking has also evolved over the years, and as a result from this, we can make use of many different transmission technologies, both affordable and powerful.

3) Audio and video processing has also been dramatically improved. Standard compression technologies such as MP3 and MPEG-4 enable the compression of a huge amount of information in a relative small space.

4) New multimedia communications protocols have been developed. Standard communications protocols related to multimedia such as SIP [2] and H.323 [3] allow integrating multimedia applications with other kind of applications.

In a few words: we now have systems capable of processing huge amounts of audiovisual information and transmitting it to remote locations, all at an affordable cost.

In the case of SCADA systems, they have progressively adopted these new technologies, but, due to their special characteristics, at a slower rate. SCADA systems are typically huge systems, so the cost of upgrading them is greater than other typical systems.

They are targeted to supervise critical processes. In such processes, fails on the system could have adverse side effects, so only those technologies that have been tested enough are taken into consideration.

2. TRADITIONAL SCADA SYSTEM ARCHITECTURE

2.1. Physical and Data Link Layers on SCADA systems

Although classic SCADA systems were centralized systems, modern SCADA systems are distributed ones. That means different nodes do the processing, instead of performing it in a single, centralized machine.

The taxonomy of the existing buses on a SCADA system differs depending on the author. Nevertheless, it is widely accepted there are at least three different types of them, in function of their temporal requirements [4].

Data coming from the sensors and data being sent to the actuators, due to the special temporal requirements needed, are transmitted over the so-called **field buses**. These are buses where operation is done in real time, and are designed to support a high traffic of limited messages in the form of commands and status data. They are buses with low transmission rate and short cable length.

These buses are typically proprietary ones, but in the last years some open buses have been developed. The most used are CAN Open, DeviceNet and AS-i.

The communication between process control devices and/or between personal computers with SCADA/HMI applications is usually performed over another type of bus, known as **control bus**.

Control buses have higher transmission rates and more relaxed temporal restrictions than field buses; the network reach is also wider than on field buses. In example, ControlNet reaches 5 Mbps and allows links with a length of up to 30 Km if optical fiber is used. A segment of a Modbus Plus bus has a maximum length of 500 meters while transmitting at up to 122 Mbps.

The rise of personal computers (PCs) introduced the need of interconnecting a set of PCs in the same subnet, so they could share information. These systems work on environments less tough than the former ones, whilst at the same time they need to deal with a greater data load. These buses are known as **information buses**. See *Figure 2*.

Internet and the TCP/IP protocol have imposed a fact standard, Ethernet, which is widely used on this type of buses.

We have focused on studying the topology of the electrical distribution networks. These networks are usually wider than those used on industrial applications.

From this study, the following considerations can be taken into account [5]:

- Remote stations can be located at far distances from the control center
- Transmission between remote stations and the Control Center(s) is performed over medium voltage electrical lines or using radio signals, at slow rates.
- Only new stations have usually another type of physical links, usually fiber optic.
- Equipment within the remote stations are exposed to strong electromagnetic inetrferences.
- The bandwidth offered by the typical field buses is not enough to room audiovisual information with a decent quality. It shouldn't be forgotten that the information must be accurate detailed enough to give extra details that couldn't be obtained with the usual text displays.

Depending on the links available on the control and information buses (if existing), it will be more or less likely that multimedia information can be transmitted over them.

Information buses are designed to support a high load of information, but control buses are more sensitive to such floods of data, as status and control messages arrival can't be delayed too much.

It's recommended not to share the physical medium between the audiovisual information and the SCADA real-time information, but in the event it is, multimedia data should be transmitted on different channels than those used by supervision information so it does not interfere with the latter.

2.1. SCADA systems operation

The SCADA system in a control center always displays power network elements status. So, when a problem happens in a remote element, the SCADA system may show a text message, display a color change on the graphical representation of that element and perform any other action configured by the operator.

Then, expert operators can apply their expertise o eliminate the problem which aused the alarm firing. Actual SCADA systems provide some tools which help to make right decisions in real time, although, it usually requires a previous training. Therefore, it is desirable for the expert operators to have all possible acquisition mechanisms that may complete the basic textual and graphic representation.

Multimedia information supplies data which content is richer to human perception. Also using this type of information enables its automated analysis applying well known digital image processing techniques.

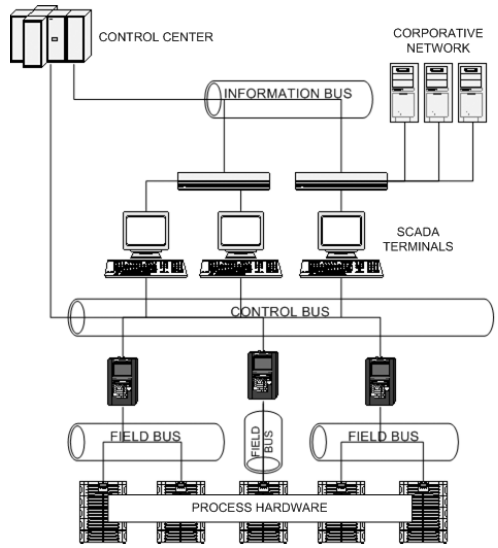

Figure 2. Typical buses on SCADA systems

3. SCADA SYSTEMS ARCHITECTURE WITH MULTIMEDIA SUPPORT

3.1. What is SIP?

The IETF Multiparty Multimedia Session Control Working Group (MMUSIC WG) has defined a control architecture for telephony features over wide area Internet that integrates stored and conference multimedia. The main component is the Session Initiation Protocol (SIP), which was specified by the MMUSIC WG as a proposed standard in 1999 as IETF RFC 2543. At present, RFC 2543 is obsolete by RFC 3261 [2][6].

SIP is an application-layer control (signaling) protocol for creating, modifying, and terminating sessions with one or more participants. These sessions include Internet telephone calls, multimedia distribution, and multimedia conferences [6].

There are two components within SIP: the SIP User Agent and the SIP Network Server.

The User Agent is effectively the end system component for the call and the SIP Server is the network device that handles the signaling associated with multiple calls.

Each User Agent contains a client element, the User Agent Client (UAC), and a server element, the User Agent Server (UAS). UAC is the part of the user agent that sends requests and receives responses. UAS is the part of the user agent that receives requests and sends responses. This enables peer-to-peer calls to be made using a client-server protocol.

User Agents usually, but not necessarily, reside on a user's computer in form of an application. Although this is currently the most widely used approach, User Agents can be also cellular phones, PSTN gateways, PDAs, automated IVR systems and so on.

3.2. SCADA systems and SIP

Using multimedia information provides a more complete and intuitive support for the operation and prevention of failures in a power system network element. Multimedia information transmission makes possible displaying the most important power network elements and an easy communication via videoconference between control center operators and field operators. See *Figure 3*.

Taking advantage of SIP functionality, flexibility and simplicity, one of the possibilities that we are researching is the deployment of a host in the substation, responsible of collecting visual and audio field information. A SIP UAC is installed on that host, and a SIP UAS is integrated in the control center SCADA. The host performs an expert analysis of the captured image and audio data from the substation. When some kind of alarm is detected, the host instructs the UAC to initiate a communication automatically with the UAS of the control center. When the connection is established, the UAC sends the audio and video information to the UAS and it is played in the control center.

So, it is possible having a UAS in the control center which multiples UACs of different substations can set connection with, and performing a multimedia telecontrol of the network. See *Figure 4*.

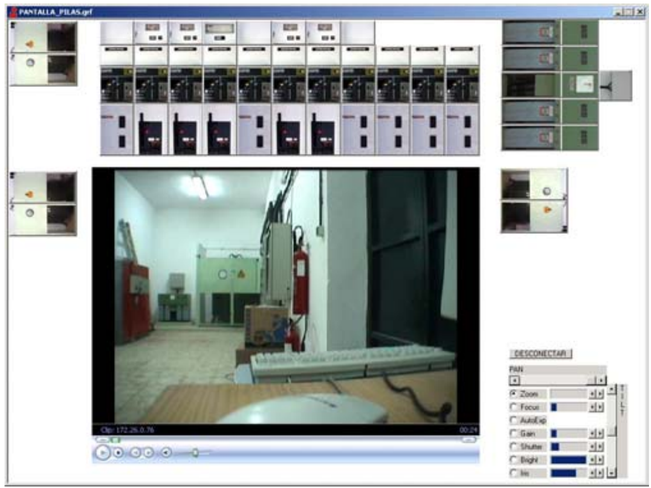

Figure 3. SCADA/HMI System using multimedia information

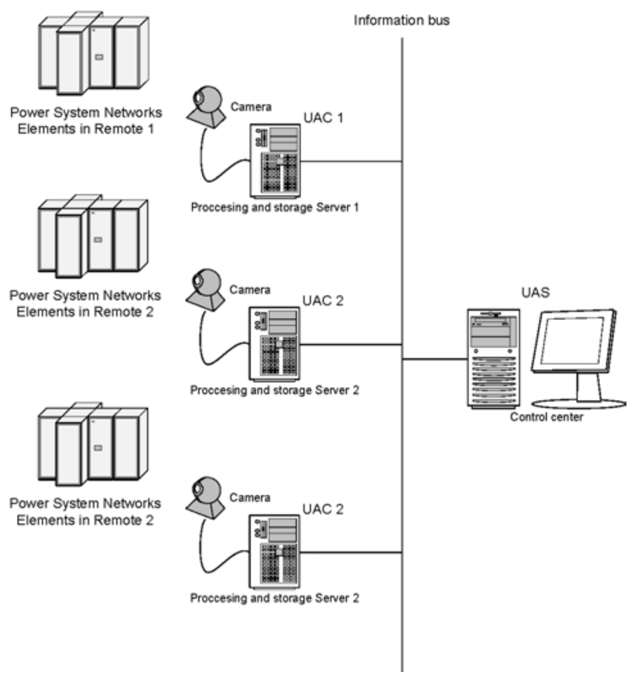

Figure 4. Using SIP in SCADA Systems

3.3. Integrating the multimedia system with SCADA/HMI suites

The integration of third-parties applications on SCADA software systems has historically been a difficult task.

Over the last years the effort of the developers of the most known SCADA/HMI suites (Intellution's iFIX, WonderWare's Factory Suite, etc.) have focused on adopting the latest software technologies.

Modern suites run over mass operating systems, such as Windows (usually only on professional, more stable versions such as Windows NT or 2000) and, to a lesser extent, Linux. In our research project, we have selected Intellution's iFIX as our testing platform, a SCADA/HMI suite that works on Windows 2000 and Windows XP Professional operating systems.

iFIX, as most latest SCADA suites, support the latest technologies developed by Microsoft. Apart from supporting Visual Basic for Applications, which allows the use of VB inside the HMI application, it's being built as an ActiveX container. This allows integrating third-parties applications designed as ActiveX controls.

As ActiveX controls can be built using most important programming languages, this opens the door to the use of many external APIs.

Therefore, we've designed the multimedia system as an ActiveX control that uses the Windows Media [7] multimedia suite to deal with multimedia data. This suite offers APIs for C++ and VisualBasic languages.

4. CONCLUSIONS

Now, integration of multimedia information in SCADA systems is closer to reality. More and more frequently, electric utilities are equipped with an underlying data network (usually one of optic fibre) whose bandwidth is suitable for video, audio and data transport. Also innovations on communications technologies like Power Line Communications and wireless networks are important factors to take into account for this integration.

From a technical approach, this integration is feasible, such as we have described in this paper, and we are still working on the implementation of a specific system and researching about transmission of multimedia and telecontrol information. From a functional approach, this integration greatly extends the functionality of SCADA system, so it enriches existing telecontrol functions adding new operation, maintenance support and operators training functions.

SIP is a multimedia communications protocol that allows integrating easily SCADA facilities and multimedia functions. Also, it enables using expert systems and video and audio analysis to help control center operator.

5. ACKNOWLEDGEMENTS

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