Multimedia in the operation of large industrial networks

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Abstract - **This paper describe the main features of the IDOLO system. This system uses multimedia technology in the operation and maintenance of large industrial networks (electricity, telecommunications, water, gas, ...). The four functions of the system are: a) network operation (real time)), providing a real-time presentation of images and sounds from distant installations together with classical remote control information; b) network operation (extended real time), offering the network operator complementary multimedia information for consultation; c) network maintenance, including the multimedia information needed to carry out suitable preventive and corrective maintenance of the network equipment and installations; d) operator training, allowing to use both real-time multimedia information, and multimedia information stored in the system to improve the training of operators that telecontrol the network.**

I. INTRODUCTION

The maintenance and operation of large industrial networks involve the performance of many inspection, surveillance, and control operations to guarantee the safe and reliable operation of the network and allow the detection of anomalies in the equipment, connections, and installations. The rapid detection of these anomalies is important to avoid the appearance of failures that would imply service interruptions and the resulting use of complex equipment and qualified personnel to restore service. Moreover, an operating error could also lead to service cuts.

At the present time, maintenance jobs are carried out by brigades that must cover the different installations in frequent, periodic inspections, which means that personnel must travel even under adverse meteorological conditions. Moreover, when a failure or anomalous operating conditions are detected, personnel must go and identify the failure and eventually send specialized personnel to carry out inspections and operations such as finding the precise location of the failure.

Regarding the control and supervision tasks of industrial processes, we must point out that the instruction and training of network operators are usually the responsibility of an expert operator who acts as tutor. After a period of time, the new operator is considered an expert operator. As a result, the operator learns to handle the network in normal situations because he rarely comes up against difficult or emergency situations, which are infrequent in today's industrial networks. Although they are infrequent, it does not mean that these situations do not appear. Therefore, occasionally, the operator will need to carry out maneuvers that he has never carried out under the same conditions, producing errors that, although sporadic, have such serious effects that they should be avoided where possible. Due to this, it becomes ever more important to train the operators adequately for all types of situations.

The availability of images and sounds in real time from remote installations for the control of certain operations related to the operation of an industrial network, breakdown prevention, and the improved training of operators and maintenance technicians make this system attractive for electrical, water, and telecommunications companies and, in general, for all activities that cover large surfaces and need telecontrol [1].

The control of large networks is presently carried out from centers which, equipped with work stations with terminals for different operators, visualize in one form or another the information sent by the transducers placed all along the network to be controlled. The presentation of this information appears in different windows on the screen as process diagrams, measurement values, and network state values. The fault reporting alerts the operator about critical situations that must be solved by following seriousness criteria that are assigned based on information from the field. In existing control centers, this information is usually binary (failure/non-failure of equipment), and based on it, the operator, or expert system that the control system might have, classifies the alarm according to its seriousness and takes the proper actions. The use of multimedia technology as the medium for this field information is not present in the control centers of existing industrial networks, so the business opportunity is high because there is no competition in this field [2].

The application of multimedia technology is becoming ever more important for automating those processes in which man intervenes. This boom has been aided by the advent of high-powered computers at ever more competitive prices, the development of high-resolution image and sound sensors, and the improvement of data transmission media.

Until now, the application of these technologies has been limited to industrial processes carried out in small spaces. However, the supervisory control and data acquisition (SCADA) of facilities that are very spread out geographically, such as electric power grids and major telecommunications networks, have not taken advantage of the new forms of visualization, electronic documentation, and videoconferencing that the use of multimedia would suppose [3].

II. MULTIMEDIA CHARACTERISTICS

Recently a new trend has emerged in distributed systems, namely multimedia computing. The need for multimedia has stemmed from a need for more flexible collaborative working environments. Traditional text/graphics based systems go only part of the way to facilitating activities such as group interaction and scientific colaboration. Applications such as these have now identified the need to use media such as voice, video and moving graphics.

Before going into any details, it is necessary to examine the nature of multimedia services and their characteristics which will influence the design of new mechanism to handle multimedia. The addition of multimedia also has important implications for the overall architecture of distributed systems.

With the emergence of multimedia computing, it is important that distributed system architectures consider the particular requirements of the various media type. Firstly, however, it is necessary to examine the characteristics of multimedia that impact on traditional approaches to distributed system design.

The most obvious and important characteristic multimedia is the need to support continuous media types such as video, voice and moving raster images. Use of such media types implies that continuous data transfer is required for relatively long periods of time.

Traditionally, quality of service has not been a major issue in distributed systems. For most services, users, will tolerate a wide variance in performance. However, the addition of multimedia into distributed systems has brought quality of service to the forefront of the design process. Some media types such as voice and video place real time constraints on systems especially if they are used in an interactive environments. For example, a delay in a receipt of a video soundtrack will mean that some subsequent lip synchronisation is incorrect.

Multimedia systems also require the ability to express synchronisation constraints across different media types. Two different types of synchronisation can be identified in the multimedia domain. Firstly, it is possible to have continuous synchronisation across two or more media types whereby the two data types are transmitted/displayed in step. Lip synchronisation between a video and audio signal is a good example of this style of synchronisation. A second approach is to have more asynchronous event based synchronisation between types. Note that the two styles of synchronisation are often complementary in nature.

The key to coping with multimedia in a distributed environments is the flexibility. This flexibility is necessary in order to cope with the many similar but subtly different services that will now exist and also to maintain the open, heterogeneous nature of such architecture.

III. IDOLO FUNCTIONS

The IDOLO system is meant to make use of the advantages of multimedia information presentation to improve the operation and maintenance of large industrial networks, such as power distribution systems, telecommunications networks, or water grids. With this goal in mind, its functionality can be detailed as follows (Fig. 1):

A. Network operation (real time)

The IDOLO system integrates into the control system of the corresponding network (SCADA-type systems), providing a real-time presentation of images and sounds from distant installations together with classical remote control information. To accomplish this, pertinent high-speed broadband transmission channels is used. This functionality can be used to guard against intrusion or to supervise equipment, systems, and installations (plants, stations, etc.).

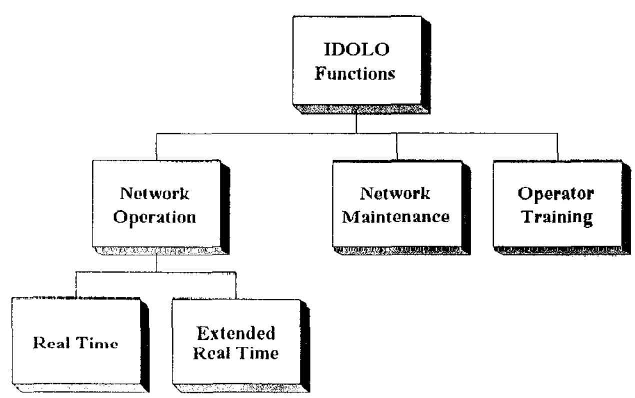

Fig. 1. IDOLO Functions.

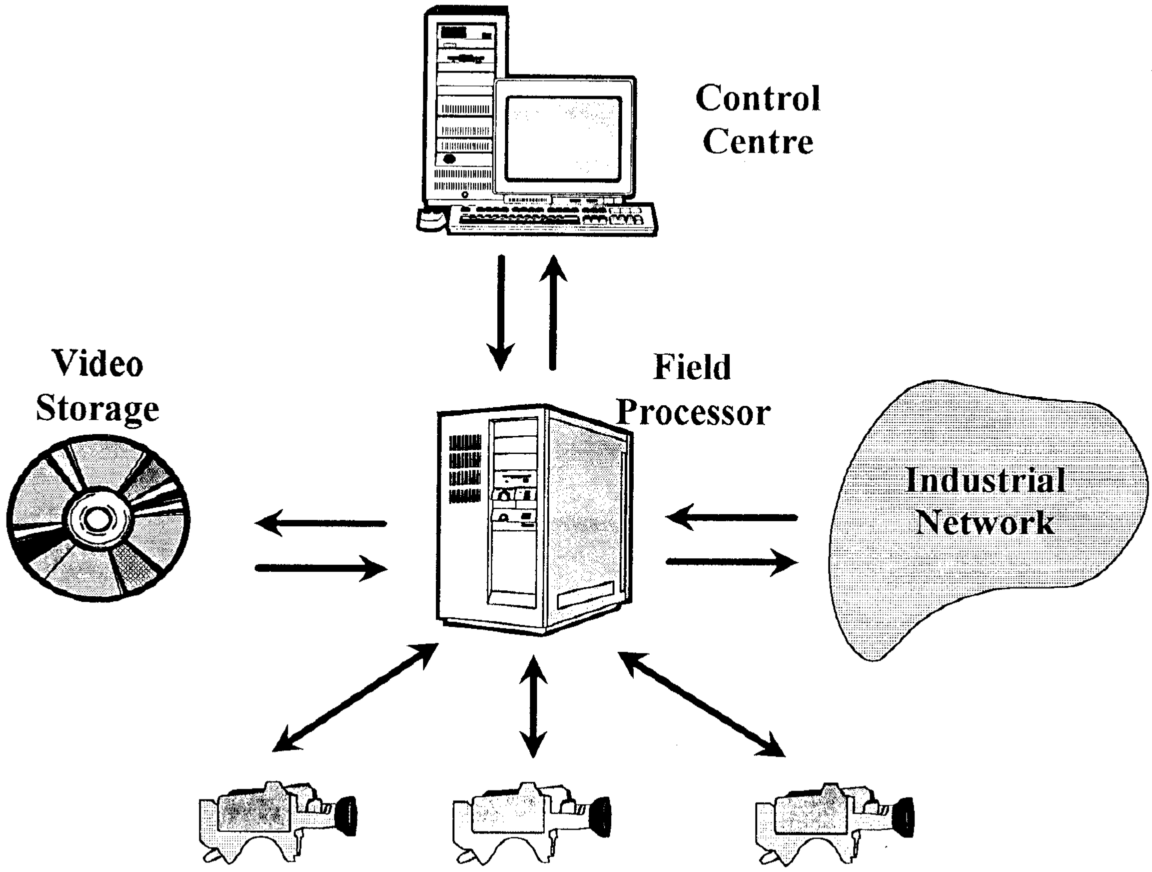

Fig. 2. IDOLO Architecture.

B. Network operation (extended real time)

The IDOLO system can offer the network operator complementary multimedia information for consultation. This information may include ample data with different degrees of detail on network equipment, installations, and operating procedures. This allows the operator to make any query and receive an answer in extended real time with visual and audible media. The multimedia information is linked to the current state of the network received in real time at the control center.

C. Network maintenace

The IDOLO system includes the multimedia information needed to carry out suitable preventive and corrective maintenance of the network equipment and installations. In this way, the maintenance of a given element may be carried out by nonspecialized personnel. This maintenance information is also linked with the troubleshooting systems that are present in many SCADA systems.

D. Operator training

The IDOLO system allows us to use both real-time multimedia information, and multimedia information stored in the system to improve the training of operators that telecontrol the network.

The goal of improving the operation and maintenance of large industrial networks can be measured by different parameters such as:

- Service availability
- Customer service quality (voltage, water pressure, bit error rate, etc.)
- Network operating cost, etc.

IV. SOLUTION ADOPTED

The solution provided by the IDOLO system is based on a distributed network of high-powered computers (Fig. 2) that are able to generate, process, store, and transmit large volumes of information [4]. These computers carry out one or another function depending on whether the units are situated in the field or in the control centers.

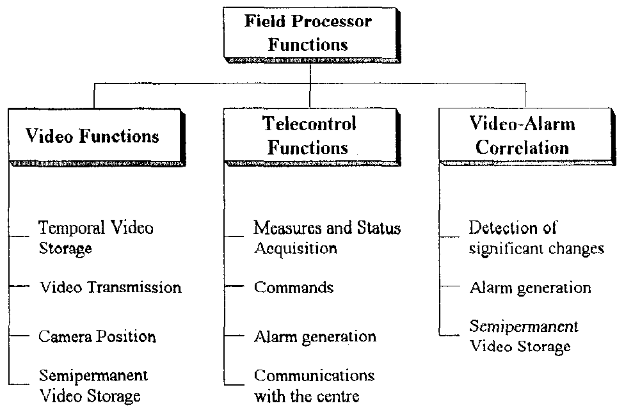

Fig. 3. Field Processor Functions.

A. Field stations

A set of steerable video-audio cameras allow the visualization of the units of this installation. The information from the cameras is gathered by a processor at each installation, which carry out the following functions (Figures 3 and 4):

- Storage of the signal for a certain length of time (typically 10 minutes). After this time, the information is replaced by new information.
- At the request of the control center, the remote unit sends the video-audio signal in real time through a broadband communications channel. Similarly, the control center is able to request the transmission of some of the stored signals.
- Camera position control, either through local algorithms or at the request of the control center.
- Semipermanent storage of the information during alarm situations indicated by the control center, by other processors located at the station, or even by field sensors read directly by the processor.
- Real-time processing of the video-audio information and the detection of significant changes (alarms, intrusion, etc.), activating semipermanent storage mechanisms and informing the control center.

B. Control center

The control center is equipped with classical telecontrol computers, which are complemented with multimedia consisting in:

- Monitors for showing the video-audio information.
- Modules for selecting the camera and its position.
- Electronic multimedia documentation generators with information on the stations and equipment; these generators are used in extended real time and for maintenance.
- Inquiry modules for the electronic information generated.

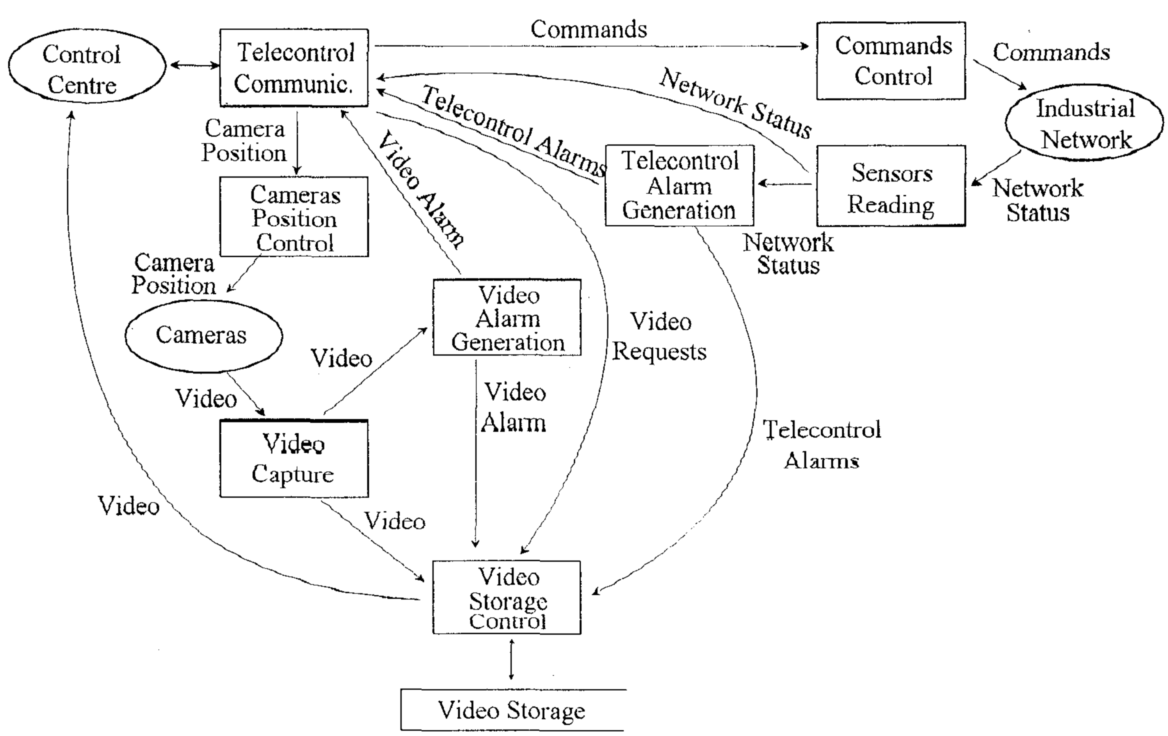

Fig. 4. Field Processor Data Flow Diagram.

V. CONCLUSIONS

The application of multimedia technologies to the operation and maintenance of industrial networks in the terms described in this proposal will allow the company to improve significantly the quality of service it offers to its clients. This improvement in quality will be obtained due to three main factors:

- Speed and safety when carrying out operations.
- Lower cost of the operation.
- Optimization of maintenance resources.

The importance that the availability of water, electricity, and means of communication have in the daily lives of citizens from industrialized countries means that the interruption of any one of these services has social costs that are much higher than the losses that the utility companies would incur. Therefore, all the actions leading to an improvement in the supply quality of these services should be valued positively.

VI. REFERENCES

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