International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 7 (2017) pp. 1216-1221

Structures, Functions and Means of Access to Remote Resources

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Abstract

This paper looks into ways to get remote access to localized resources of complex installations. It gives the reasons for choosing such a way, variants, structures, what functions they will have, common fragments and how to go about it. The information in this article is aimed at working out promising systems with the use of remote access to expensive and complex research, technological and laboratory installations.

Keywords: remote access, Internet, video stream, video capture, remote control, server-retransmitter, and electron beam microscope.

INTRODUCTION

Now the constantly growing network infrastructure and network services offered have already turned into a significant factor in the development of society. Most likely, their role will only increase in the future.

Along with this there are and will continue to be systems with such computer control that access to them is limited by where they are located. Such localization is done for a whole number of reasons—economic and judicial requirements, insuring security and also the desire to limit or lower the complexity and time of working out new systems.

Subsequent exploitation of such systems often reveals a need for remote access to them. This is due to the desire to make their often unique resources available to a great number of different kinds of users, a desire which begins to outweigh the importance of the reasons for the localization given above.

We will set out the main ways for the network integration of such resources. For this we will look into their internal organization.

GENERALIZED STRUCTURES AND CERTAIN FEATURES OF LOCALIZED RESOURCES

The complex installations of various applied fields, for instance medicine, physical research and industrial technologies, allow making the required observations, measurements and manipulations with the objects under study with high mechanical and other accuracy within a wide diapason of time, frequencies and power intervals. A characteristic feature of such installations is the big volume of data received which must be mathematically processed, presented to the user in obvious form and saved for further work. The presentation includes graphics, a text and also various formats of audio and video.

The central component of any such installation is the executive unit with the sensors and executive devices which make it possible to measure and manipulate the objects. The sensors of the executive unit are the sources of the observed values of the data of various nature and forms—continuous, discrete, and transformed, as a rule in voltages and currents of different frequencies. The executive devices make it possible to act on the objects in all sorts of ways—from mechanical shifting and electrochemical pressure to electromagnetic radiation.

To control the installation, and also for processing, accumulating and presenting the data received to the user, a data gathering and processing system (DGPS) is used. Considering the huge volume of data, the DGPS must possess significant computing resources. Though a specially developed computer can be used as such a system, nowadays standard widely available IBM PC compatible personal computers (PC) are usually used. The resources of modern PCs are sufficient to do whatever is necessary to process and accumulate various kinds of data. It is surely advantageous that it is possible to use the wide-spread operational systems of the Windows and Linux families with graphic user interface. These operational systems have well worked out means of I/O and there is software for processing the data and presenting the information. Moreover, standard packages of applied programs are available for them that permit doing additional processing of the data gathered immediately after receiving it.

That significantly simplifies and makes the creation of the installation cheaper as well as making learning to work with it faster and easier.

The linking up of the executive unit with the system unit of the DGPS is done, as a rule, through the interface of the controllers (adapters) that join the output of the various sensors and input of the executive devices with the standard interfaces of the PC—the USB, COM, PCI etc.

The interaction between the installation itself and the DGPS is usually provided through closed protocols. This is due to

International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 7 (2017) pp. 1216-1221

the high specificity of the sensors and the executive devices and to the necessity to preserve the finely coordinated diagrams of their interaction and the cycles of processing the flows of data as well as trying to safeguard the system from incompetent users' interference that could lead to irreversible disruption of its work. These circumstances are reflected in the licensing and guaranty agreements in some or other form.

An installation that has high power elements, means of vacuum/pressure or temperature control, sources of radiation and other such high responsibility or potentially dangerous components can also be supplied with an autonomous real time control system (RTCS) that works independently from the DGPS. The autonomous RTCS insures adequate uninterrupted work of the installation for a long period of time if it has been necessary to stop and service the DGPS and also during emergency stops of the system in case of dangerous failures in the work of the installation.

The scheme of the localized interaction between the components of the installation and the user is shown in Fig.1. For simplicity, the autonomous RTCS is not visibly indicated in it and the following figures.

Figure 1: The scheme of the localized interaction between the components and the user of the installation

When remote access to an installation is made possible, a second type of user of the DGPS appears. They have access to its localized resources due to the services of the Internet or local network (Fig.2).

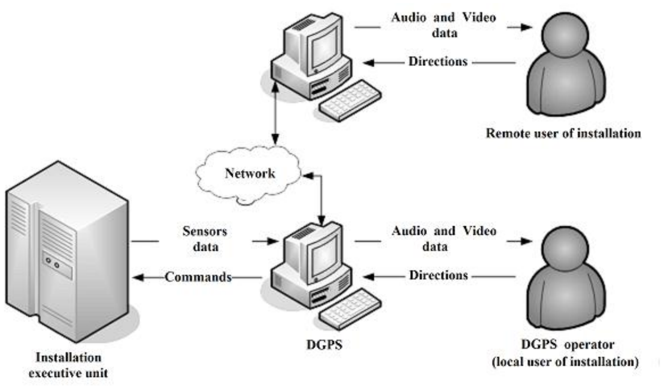

Figure 2: The scheme of the interaction between the components and two types of users of the installation

If for systems requiring only observations just a one-way flow of audio-visual information is typical, then in the systems of the common kind of user not only is such a flow, which is usually simply a video flow, received, but directions (flow of control) are generated, Fig.3.

It is clear that simplex systems are easier to do and can find application, for example, in education, in particular in review lectures and demonstration classes in the broadcast regime. It is also clear that using systems having a two way connection allowing a dialogue for such goals, Fig. 3, makes it possible to provide many more different types of classes and the effectiveness of forming the skills for working with the installation is increased. Maintaining the appropriate phases in the relations between both flows in order to ensure the semantic stability of such systems in the framework of the practical limits takes a bit of effort. Examples of the structural solutions and carrying them out will be described below.

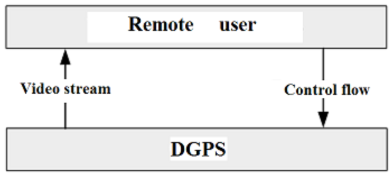

Figure 3: The interaction between the remote user and the DGPS

When a remote user is working with an installation and there is an intermediate medium for the exchange of data (Figs. 2 and 3), this brings with it certain features:

- The video stream generated by the DGPS can make significant demands on the characteristics of this medium. In practice one often has to make a compromise and lower the quality of the video series to a certain degree. The parameters of the audio component are of much less weight considering its much lower information significance.
- The reactivity of the user interface may fall due to the insufficient speed of the transfer of the data and delays whose length depends on the load on the medium of the data exchange.
- The potential dangers in the medium of the data exchange (criminals, viruses) demand taking special safety measures. Such measures can show up both in the architecture of the system of remote access and also in the proportions of the hardware and program component of its implementation.
- Interaction at a distance and the limitedness of localized resources of an installation require the creation of a system for access. Such a system could have a corresponding data base, passwords subsystem, a

schedule, records of activity subsystems and the like, thus requiring additional resources of the DGPS.

SUPPORTING THE CONTROL OF REMOTE RESOURCES

Analysis of the flows described and supporting their distributed [1], [2] and localized processing [3], [4], [5] makes it possible to formulate the following structurally simple approaches to getting control of remote resources [6]:

1. Intervention in the interaction between the DGPS and the specific hardware of the installation. It is necessary to read the data from the hardware interfaces and get control with one's own additional hardware means (1, Fig. 4).
2. Getting control through software means at the level of the drivers of the specialized devices of the installation. In essence, it is a matter of creating one's own SW control system of the complex with the added function of remote access through the Internet (2, Fig.4) or integrating the means of remote control into a regular controlling SW.
3. Using software means of remote control of the PC (3, Fig.4). Such means differ, they are worked out and perfected over many years [7], [8]. One should keep in mind that the hardware of the installation may interact with the DGPS at a functional level that is inaccessible (too low) for such software means. So part of the localized data of the user remains inaccessible to those programs and therefore to the remote user. As a result, it can require the support of additional localized hardware.
4. Use of hardware means of remote control of a PC—Keyboard Video Mouse (KVM) Remote Control or IP KVM Switch (4, Fig.4). Such means are a hardware realization of the function subset of software means of remote control. The module KVM is hooked up with the standard input-output interfaces of the PC—the keyboard and mouse ports, the DVI/VGA video output and the USB interface—for transfer of data, and independently carrying out the functions of transmitting flows of video, control and user's data via the network.

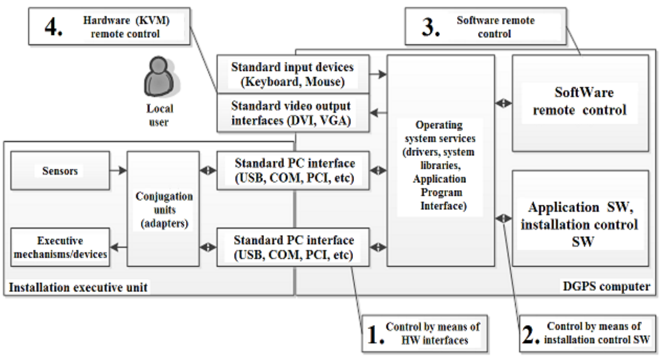

Figure 4: Possible embedding points of remote control functions of the installation

In practice, using the **first two** approaches is made difficult by the above mentioned closed nature of the protocols and the low level of the HW-SW of the installation. If control of the installation is done not only with the help of the DGPS software, but also with the help of specialized hardware means such as joysticks, control desks, etc., then partial carrying out of the functions of remote control by the first two approaches could be required. The difficulties that arise are either the necessity to correct the licensing agreement and limitations, or (in their absence) the labor-consuming task of finding out what is in those protocols with the use of specialized analyzers.

The means of the **third** group, software means of remote control of the PC, are distinguished by its high flexibility in fixing the settings and a wide choice of both for pay and for free means. The operating systems themselves also have built-in means of remote control—Remote Desktop (Windows), SSH (Linux), and Rlogin (UNIX). Such means are widely used for remote work by the user in the environment of a set operation system. A typical example of using such means is the remote control of servers when it is impossible to get physical access to the server. The merit of such means is the use of the access control services of the operational system itself, which simplifies control of the users and access to the system. Another merit is their great accessibility in comparison to the hardware of the KVM which we go into below.

A drawback is the functional limitedness of such means in regard to the support of devices that actively use hardware acceleration instead of the standard (and less effective) means of output of graphics of the operating system, for example, of some models of video cameras and other such devices. The use of such software means can also lead to problems of security and compatibility arising. There is potential susceptibility of the operating system to the attacks of criminals if the means of the remote control do not use protected protocols for the transfer of data and/or have weak spots in the program code.

The means of the **fourth** type, the hardware complexes of the IP KVM, don't have these shortcomings. They are independent from the targeted system and give access to a system at the level of the basic input-output system (BIOS), which makes it possible, for instance, to remotely control the parameters of the hardware of the PC and the parameters of the OS boot, to look over the results of the self-testing of the system, and to set up operational systems. In essence, the module of the KVM completely resembles the work of the local user of the PC with the usual keyboard, mouse and display in regards to the tasks mentioned.

The shortcomings here are manifested in not being able to use the means of the OS to control user access—it is necessary to make additional efforts in fixing the settings and controlling. Then there are also the well-known functional limitations—the choice of types of devices is relatively small. Moreover, so far they are mostly the costly and hard to get ones.

Software remote control stands out for its flexibility and variety. So let's look more closely at the means of that group.

PROGRAMS FOR REMOTE CONTROL

They are programs or functions of operating systems which make it possible to get remote access to a computer through the network and be able to control a remote computer in the regime of real time. The programs of remote control give practically full control over a remote computer: control over the desktop of the computer, the ability to work with the files, to execute applications, etc. There are many realizations of programs of remote control for different operating systems [8]. Such realizations differ in a number of parameters:

- User interface (graphic or console)
- The protocol used (RDP, VNC, X11, and also a number of other protocols, including closed ones)
- Methods of ciphering
- Methods of compressing the data transferred
- The support for transmitting video, sound and 3D-graphics
- The ability to transmit files
- The possibility of a number of users to all work at the same time (a multisession)
- Control of user access
- Licensing, the possibility to use it for both commercial and non-commercial goals free of charge

In a number of cases, the simplest and an entirely workable solution is just installing an appropriate system of remote control on the DGPS computer.

However, a hybrid solution is of much more interest [9]. Such solutions make it possible to avoid the shortcomings of the last two approaches while still keeping their positive aspects.

HYBRID MEANS

A structure that carries out functions like those of the hardware of the KVM while using an interim localized server-retransmitter is the basis for such solutions.

The video data of the DGPS's video interface is read by the usual video capture device and then shows up in full screen regime on the desktop of the server-retransmitter. Then the transmission of the video series to the remote user is completed by the program of remote control.

The flow of control from the remote user is first transferred to the server-retransmitter and only then to the DGPS computer. This last transmission uses a closed (reliable) local network and the software support of devices of interaction with a person (HID—a human interface device) such as the keyboard, the mouse, etc. (Fig.5). In such a scheme the control of the DGPS is separate from the dangerous network environment since it doesn't have direct access to the Internet.

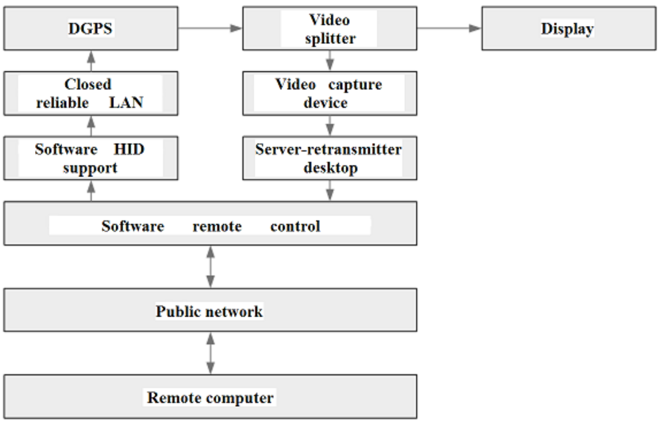

Figure 5: The structure of hybrid solutions

Here the local operator of the DGPS keeps full control over the actions of the remote user in contrast, for instance, to when using Windows Remote Desktop, as part of the simplest systems, allowing loss of such control.

SPECIFICS OF APPLICATION

Certain aspects of the tasks of application to be solved in the course of using remote resources demand extra attention. For example [10], for solving those very same tasks of training.

In our case one of the manifestations of the specificity looks like a contradiction between the usually group nature of teaching on one hand and, on the other hand, the singularity of the installation and indivisibility of its resources.

A simple way out of such a contradiction is the organization and support of the already mentioned simplex sessions of work with the installation in the regime of video series translation, including with the possibility of video recording—video-lessons are one of the modern ways of teaching.

The regime of teaching with the contemplated joint work of several operators of an installation is much more complicated. It demands thorough study of the scenarios of such work—both from the point of view of the methodology of presenting the teaching material and also from the purely technical point of view.

Here a number of problems have to be solved beginning with coordinating the network characteristics of the members of the group being taught—after all they could be geographically scattered—and ending with the problem of guaranteeing the installation is kept perfectly safe in the absence of extremely strict limits on the actions of the students. Evidently, such a regime would be unsuitable for most types of installations discussed here.

In practice, a multiplex (consecutive) regime of active interaction of the members of the group with the installation, namely when one of them, each in his turn, interacts with it and the others only observe, is quite applicable. Such a regime demands strict regulation of the regimes of access and also proper control by an experienced local user-operator of the DGPS.

The hybrid solutions described above make it possible to put the whole additional load that arises when giving remote access to the user on the server-retransmitter.

EXPERIMENTS

These solutions were used in creating means of support for access to remote resources of complex physical installations, namely the electronic microscope Raith 150-TWO [11] for educational and research goals.

The Raith 150-TWO can work in two main regimes:

- The raster electron beam scanning microscope of high resolution
- The electron beam lithographer

A number of experiments conducted confirmed the correctness of the main solutions we had come up with and made it possible not only to determine some important parameters that have an influence on the effectiveness of the components of the system but also to plan ways to further improve it. A detailed description of the experiments and their results will be given in the next article.

CONCLUSION

The development of the network infrastructure inevitably leads to integration of earlier isolated complex and costly resources into the environment of their joint use.

Such resources have highly developed computer control as part of them. It has components that are specialized and closed off from external interference as well as common personal computers.

The existing means of integration that rely on those common personal computers have their merits and shortcomings. The proposed hybrid variant makes it possible to preserve the pluses and get rid of the minuses of the means used. This was confirmed when checking such variants in experiments with a complicated installation.

The research was partially done within the framework of National Research Nuclear University MEPhI (Moscow Engineering Physics Institute) Academic Excellence Project (contract № 02.a03.21.0005) and was supported by the Ministry of Education and Science of RF in the frames of Competitiveness Growth Program of National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Agreement 02.A03.21.0005

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