Laboratory SCADA – System for Control on Railway Traffic

Emiliya Dimitrova[1]

Abstract – **Supervisory Control and Data Acquisition systems (SCADA) in some important industry sectors, such as production and distribution of electricity, transport management, etc., are crucial for their correct and reliable functioning. The purpose of these systems is centralized data acquisition for remote geographical sites, information processing and generation of managerial impacts.**

Keywords – **SCADA - -systems, Railway traffic control.**

I. INTRODUCTION

Scientific and technical revolution, especially in the last two decades, has led to fast development and improvement of technological processes in all sectors of the economy, transport, energy, education etc.

Efficiency of technological processes in industry, transport, energy and communications cannot be achieved without the use of appropriate methods and systems for its control, which are also developing and growing at an exponential pace.

The technical literature is full with reports of specialized automated operational dispatch control on complex objects, and lately with reports of applications of the most modern SCADA – systems [1].

The fast industrial progress set up higher requirements of education quality. The power engineering and the transport are attractive areas for Bulgarian and foreign investment for progress, modernization and expert education. The training under the Bachelor and Master programmes in Telecommunications and Signaling at the Todor Kableshkov University of Transport (VTU) prepares highly qualified experts in telecommunications and signaling in railway and underground transport. A special place is given on the study of remote monitoring and control systems in transport. The VTU's lecturers realize the necessity to train skilled workers for transport needs. A modern laboratory simulator representing SCADA - system will be built.

II. PURPOSE AND NATURE OF SCADA - SYSTEMS

Automated systems of control and SCADA - systems have the same purpose, namely to remotely control on technological objects without or with as little as possible human involvement. Although somewhat SCADA – systems appears to be a natural development of automated systems of control, there is a significant difference between these two types of systems.

As a rule, both kinds of systems are a product of engineering activity. They are configurable technical software project complexes and have a unique character for each case of application. This difference is in the way of implementation of the management process. In automated systems, the attention of the designers is directed to the technical part – selection of the most appropriate technical devices. However, SCADA - systems appear when the abundance and diversity of electronic computing on the market is rich and the design is only reduced to selecting technical devices, which satisfy the amount of memory, performance and other technical parameters according to the specific requirements of the process. Here the attention of designers is drawn to the creation of the maximal operator's comfort, so that he/she will not think of what to do at the same point but how to deal better with the situation.

III. STRUCTURE OF SCADA - SYSTEMS

Each SCADA - system consists of three formal levels:
- Dispatching (upper) level;
- Communication level;
- Object (lower) level.

A SCADA – system is implemented for dispatching and control on the train traffic in the Sofia underground. A simplified structural scheme of this SCADA – system DISIM-V is shown in Fig. 1. The object level covers only one object such as one underground station. Dispatching and communication levels are the same regardless of the number of stations on the object level.

The system is a complex structure of technical, software and organizational resources related to certain rules, providing control and operating on the train traffic process. In general, the control is performed automatically, while operating is done either automatically or through operator commands submitted by the train dispatcher of the Central Dispatcher Post (CDP).

The connection between CDP and the underground station is realized by a programmable logic controller (PLC) situated in the object level. It has a modular structure that allows easy configuration and reconfiguration if necessary (e.g. when there are changes at the object). The PLC is connected to the electrical interlocking devices. The data on the track circuits state and the current status of the station are translated by the PLC to the CDP. The main controlled elements are points, traffic lights, track circuits and general alarm and signaling.

Normally trains run on automatic locomotive signaling indications for automatic speed regulation (ALS-ASR) in the

[1] Emiliya Dimitrova is with Faculty of Communications and Electrical Equipment at the Todor Kableshkov University of Transport-Sofia, 158 Geo Milev Str., Sofia1574, Bulgaria,
E-mail: edimitrova@bitex.bg, web page: http://vtu.bg.

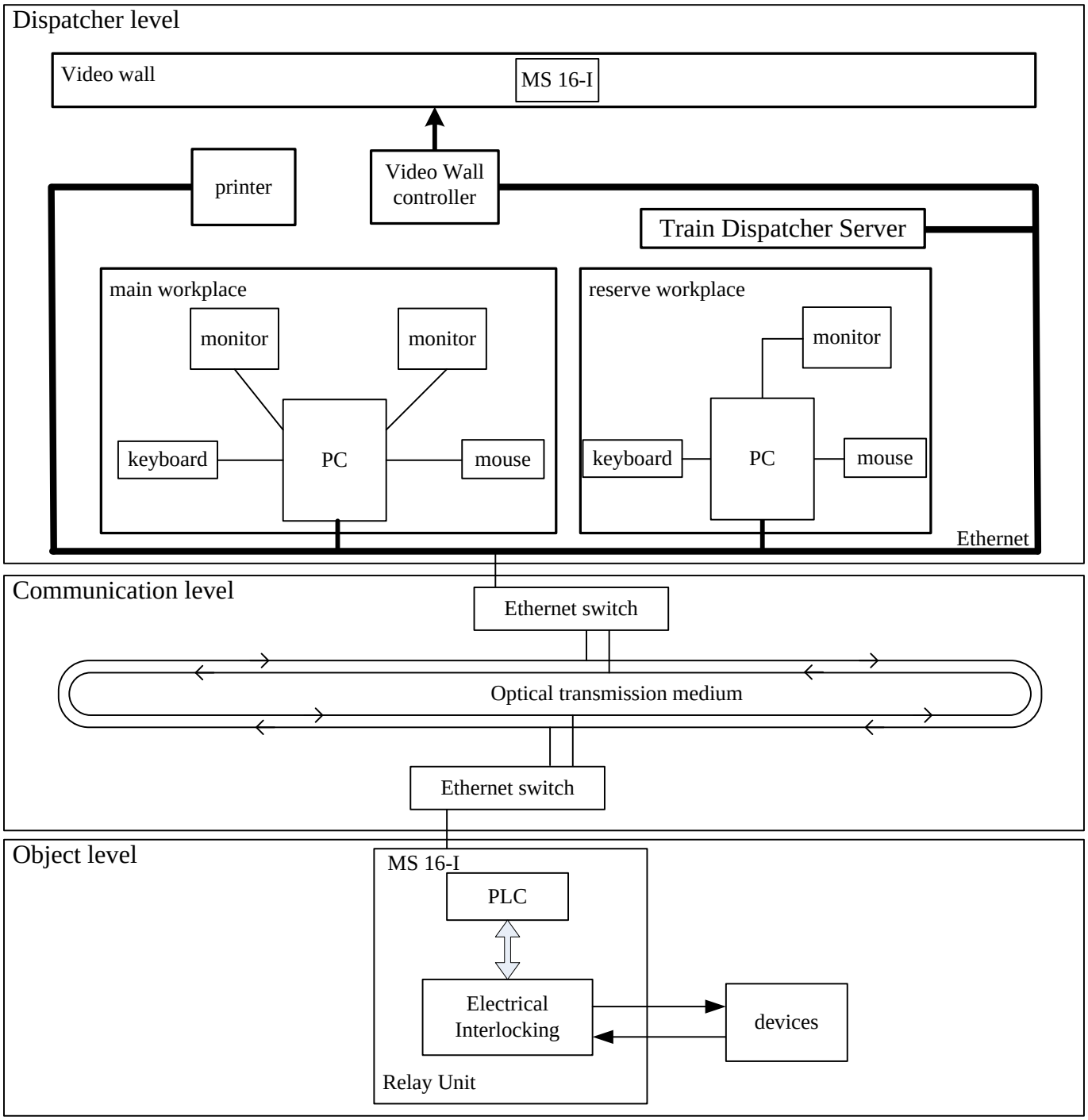

Fig. 1. SCADA - system DISIM-V

cab. In case of failure of one of the elements of ALS-ASR trains run on automatic block system signals.

The communication level realizes the connection between object level PLC and computers situated in the CDP. Ethernet network of the CDP is also part of this level.

The data received from the object enter in "Train Dispatcher Server" where according to the system algorithm their treatment is carried out. This process includes functions of displaying the information and human-system dialogue.

The main components of this SCADA - system are PCs and specialized and custom-developed software. The system works in a Linux environment. All menus in the system, as well as event logs and printed reports are in Bulgarian language, in line with the industry-accepted terminology. The system provides a comfortable and simple dialogue and an opportunity for easy manipulation. Dialogue with the system is in Bulgarian and performed via keyboard and mouse – standard peripherals of computers. DISIM is running under control of a complex program structure, which consists of

high standard software package and applications developed by the company DISSI - LTD. The standard software used in the system is:

- OS LINUX;
- Graphics upgrade X-Window System;
- X.org server;
- Package management windows - Metacity;
- Software to work with a video wall controller;
- Software for use with a programmable controllers' object level;
- Standard Java Virtual Machine;
- Implementation of the CORBA specification TAO / ACE, omniORB;
- Management System database - PostgreSQL.

IV. Functions of SCADA - systems

SCADA - systems perform basic technological functions (monitoring functions and process control functions), system functions and additional functions.

A. Technological functions

The functions of monitoring on the technological processes ensure:

- Permanently and automatically collecting of data about the current state of equipment in the area;
- Continuously automatically sending of the collected data to the CDP;
- Analysis and processing of the data received in the CDP;
- Visualization of the received information on the system screens and on the video wall (with the existing subway system);
- Printing the current information or different pieces of the past tense, if necessary, by a command of the operator;
- Automatic backup in chronological order of the events that occurred.

The functions of control on the technological processes must provide:

- Reliable sending of operator's dispatching commands to the objects and their implementation;
- Reliable protection and prevention against improper and wrong manipulation (password, incorrectly set command, nonexistent command, inability to execute the command, etc.).

B. System functions

The system functions include the control function, internal control and diagnostics of the system and all its facilities, including software. The system functions provide also interconnection to all other systems in the SCADA - complex, including:

- Maintenance the system time and date;
- Internal automatic control and diagnostics of the successful operation of the system individual devices;
- Exchange of information with other SCADA - systems in a common computer network;
- Monitoring on the successful operation of communication between stations and the control center;
- Location of place and type of the damage;
- Monitoring and diagnostics of the software.

C. Additional functions

The additional functions are related to data archiving events, data analysis, generating various types of reports, including:

- Record of events;
- List of executed and outstanding commands;
- Data records and lists storing for time that is set by the operator;
- providing an opportunity to review the data in reports and lists and printing if necessary;
- printing the current information or stored information about various pieces in the past;
- testing the equipment for control on the video wall;
- testing hardware and application software at all levels of the system;
- testing the condition of communication channels.

V. Laboratory SCADA - system

A. Description

A simplified structural scheme of the laboratory SCADA - system is shown in Fig. 2. The object level will be presented by special software. The train traffic will be simulated by the lecturer. The communication level consists of only Ethernet network. The students will be able to watch train traffic in one or more stations as well as the status of the points, traffic lights, track circuits and general alarm and signaling. The train traffic schedule will also be displayed.

The main window of the laboratory SCADA - system will act as a control panel. This will be a group of buttons that run separate software modules with the following meaning: Stations, Schedule, Train number, Track circuits out of dispatcher monitoring, Records, etc. The menu for selecting the station will be displayed by pressing the button of Stations. The status of the selected station will be displayed on the monitor and all status changes could be monitored in real time. The student – Dispatcher could control on the electrical interlocking devices by the mouse. Two stations could be displayed simultaneously on the two monitors.

Information for registered alarms and messages, as well as the actions of the dispatcher for a specified period of time could be made by pressing the button of Records.

B. Benefit to the students training

The uniqueness of each SCADA - system makes the access to the information about the system very difficult, simply because if such information is available, it is primarily commercial and advertising. On the other hand, a contemporary, modern and efficient SCADA - system is in operation in the underground and covers all the technological

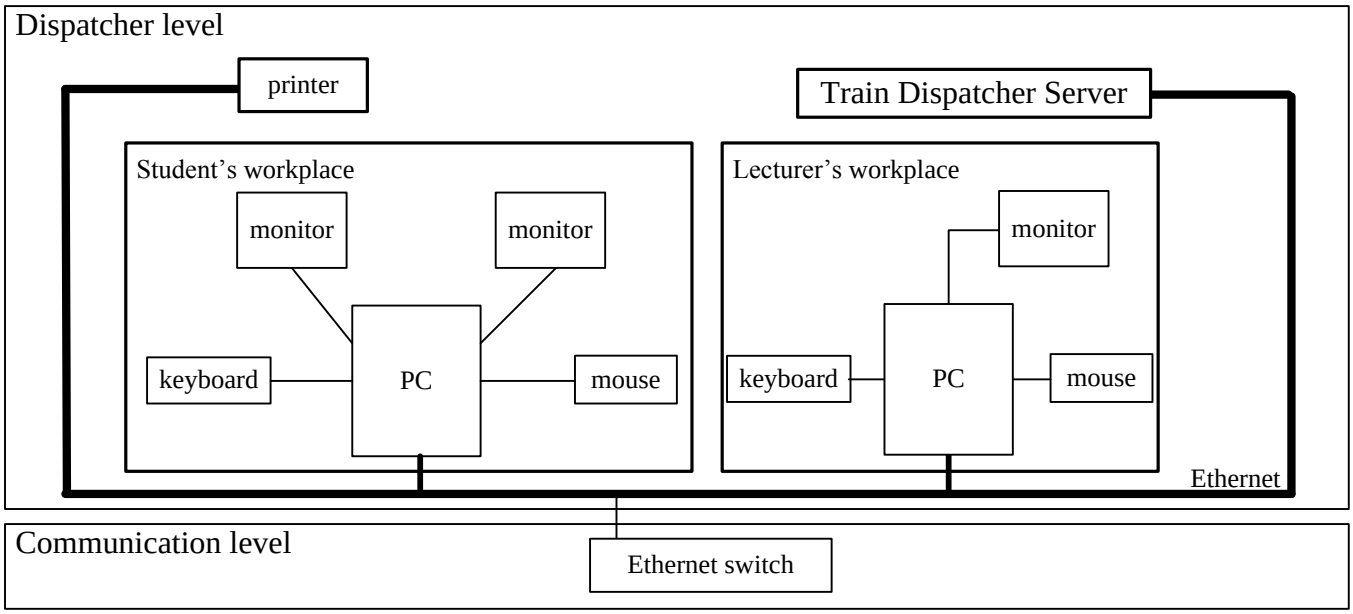

Fig. 2. Laboratory SCADA - system

processes. Its extensive study is not possible due to the special mode and permission of access. Therefore, the presence of upgraded laboratory models of SCADA - system in the Todor Kableshkov University of Transport will be extremely useful for students in the learning process and will enable them to deepen their knowledge in the core of modern SCADA - technology.

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