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REMOTE DIAGNOSTICS OF AIRCRAFT GROUND SUPPORT EQUIPMENT

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Abstract

The paper stresses the importance of aircraft ground handling in the Armed Forces of the Republic of Poland. The most essential issues include high efficiency of the aircraft ground handling systems, experienced and qualified personnel and optimum use of resources. It is increasingly more difficult to achieve such state, due to inter alia more sophisticated and complicated equipment and its high operating costs. Thus, constant monitoring, checking and obtaining information about the ground handling equipment centres and actual and effective use of such centres in accordance with planned tasks becomes increasingly important. As of today, there is no remote diagnostic system of the aircraft ground support equipment, which could provide information about its technical condition and location. The paper presents a proposal of such a system, its basic parameters and standard windows of the computer-based GSE diagnostic system. The basic parameters acquired from the equipment, as well as methods of recording and saving them in the system is shown. The most important advantages, expansion potential and future prospects for the system are indicated.

Keywords: *aircraft ground support equipment, GSE diagnostics*

1. Introduction

In the era of fast development of aviation technology marked by appearance of new technical possibilities, refined designs of aircraft, modern power plant system, avionics, weapon systems have made the aircraft servicing and keeping them airworthy a very complicated task which directly affects the accomplishment of missions, reliability and flight safety.

Today, the standard is an efficient aircraft ground handling system based on experienced, well-trained personnel equipped with modern devices to support this process and ensure reliable operation of the aircraft.

During the servicing, the aircraft ground support equipment (GSE) is in most cases connected directly to the airframe systems and installations such as electrical and electronic system, hydraulics, air, oxygen and nitrogen installations. Consequently, these devices must be of high quality and reliability, commensurate with the quality of integral systems installed on the aircraft.

In comparison with the civil aviation, the logistics in the military aircraft operation system is a much broader process, resulting from fulfilment of combat missions. The services performed in the military system have to ensure the operational requirements, airworthiness and readiness of the aircraft in the global system of national security.

Currently, the Polish Airforce has a variety of aircraft, which entails the need to obtain specialist equipment for ground handling. Servicing planes of various types and use, helicopters or pilotless aircraft purchased from various Polish and foreign suppliers are a complicated process, which requires support by means of different modern devices.

A very important aspect in the handling system is to create an adequate, comprehensive system, which on the basis of acquired information will efficiently carry out tasks resulting from the aforementioned needs. One of the most important elements of such system are technical resources ensuring operation of a combat aircraft which can be divided into aircraft ground support resources (GSE) and airfield-hangar resources.

Constant monitoring, checking and acquiring information about the ground handling resources ensure their relatively optimal use according to the planned tasks.

In order to acquire such information it is necessary to build a central remote GSE diagnostic system to collect diagnostic data, which include not only monitoring of current operating parameters but also the failure codes and current location of equipment.

The users of GSE operated in the Polish Armed Forces do not have such possibility now – the equipment is monitored „manually". The statistics, e.g. number of person-hours used, fuel consumption, etc., necessary for planning of materiel resources, technical maintenance or the analysis of failures, are very time-consuming and sometimes difficult to generate.

Such a system is also very important during aircraft combat missions abroad, e.g. peacekeeping missions. Monitoring of the GSE redeployed to service aircraft in other parts of the world from the Poland-based centre will be of considerable importance.

2. GSE remote diagnostic system

In an attempt to these problems, the only GSE manufacturer in Poland – WCBKT S.A. – Central Military Bureau of Design and Technology – developed a concept of the model and launched the test version of the Remote Diagnostic System for the GSE of their manufacture. The system was tested on the TAURUS Ground Power Unit dedicated to handling civilian aircraft at the Warsaw Chopin Airport.

Generally, the GSE Remote Diagnostic System collects the diagnostic data from the GSE. The data are used for current analysis of functioning of the monitored equipment. It is the main task of the system – for analysis of equipment operation. The collected data are also used to generate statistics, such as number of man hours used, fuel consumption, technical condition of the equipment, etc., using standard statistical and probabilistic relationships. The determination of technical condition of a facility (equipment) requires that the following rule of inference be applied:

$$\forall i \in (1,2,...,n)\ WS = \left[x_i, \frac{dx_i}{dt} \right] \in WT \Rightarrow Facilityinoder\ , \tag{1}$$

where:

n – number of analysed parameters,

WS – vector of technical condition of the equipment,

x_i – i*th* equipment diagnostic parameter,

WT – technical condition specified by the Manufacturer.

Therefore, the main task of the current version of the system is to collect diagnostic data from all RSE items connected to it.

The users of the GSE Remote Diagnostic System:

- Administrator status users: system developer with access to all elements of the system,
- Standard status users: limited authorization for system administration which involves adding new equipment, adding user accounts, logging to the system database, or performing the programming works,

– External status users: future option.

The security model for system access from a computer network is based on standard security mechanisms, i.e. unique login and password for each system user and the mechanism, which makes access, by users to the specific system resources dependable on the type of their account.

The data acquired by the GSE Remote Diagnostic System are directly related to the features of the equipment. For this purpose, a measurement system with a dedicated communication protocol was installed and programmed on the equipment, allowing transmitting chosen equipment operation parameters, depending on the intended use of a given equipment.

The GSE Remote Diagnostic System acquires the following data from the equipment:

– **Measured parameters**: current operational parameters, e.g. output voltage, fuel consumption, equipment information, engine type, software version, etc. Currently, it is from 20 to about 40 parameters, depending on the model (see Fig. 1). The data are acquired from the database at 3-second intervals,

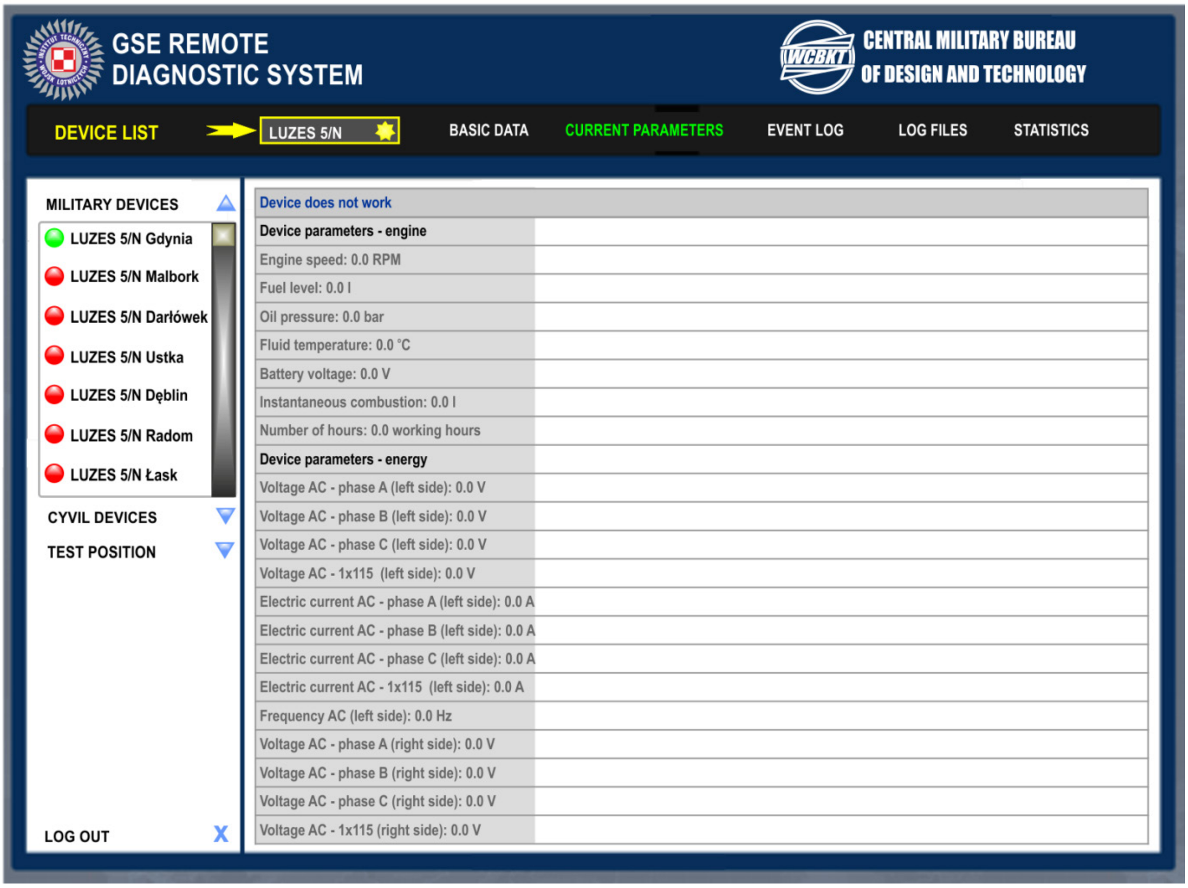

Fig. 1. Window – measured parameters

– **Event Log**: This is a summary report from the equipment operation generated on the user's request. After being transmitted, the generated report is saved in the GSE database and made available to the user via WWW. The system acquires the log in the UDT format, then converts it to the Excel format and saves in the database (Fig. 2),

– **Log files**: These are cumulated data in the form of files, acquired cyclically from the equipment and then saved on the GSE Diagnostics Server. The data are acquired in the UDT format, then converted to the CSV format (Fig. 3),

– **RSE location**: The system collects the data from the GSM module located in the communication module. Last 10 saved equipment locations are shown on the map (Fig. 4).

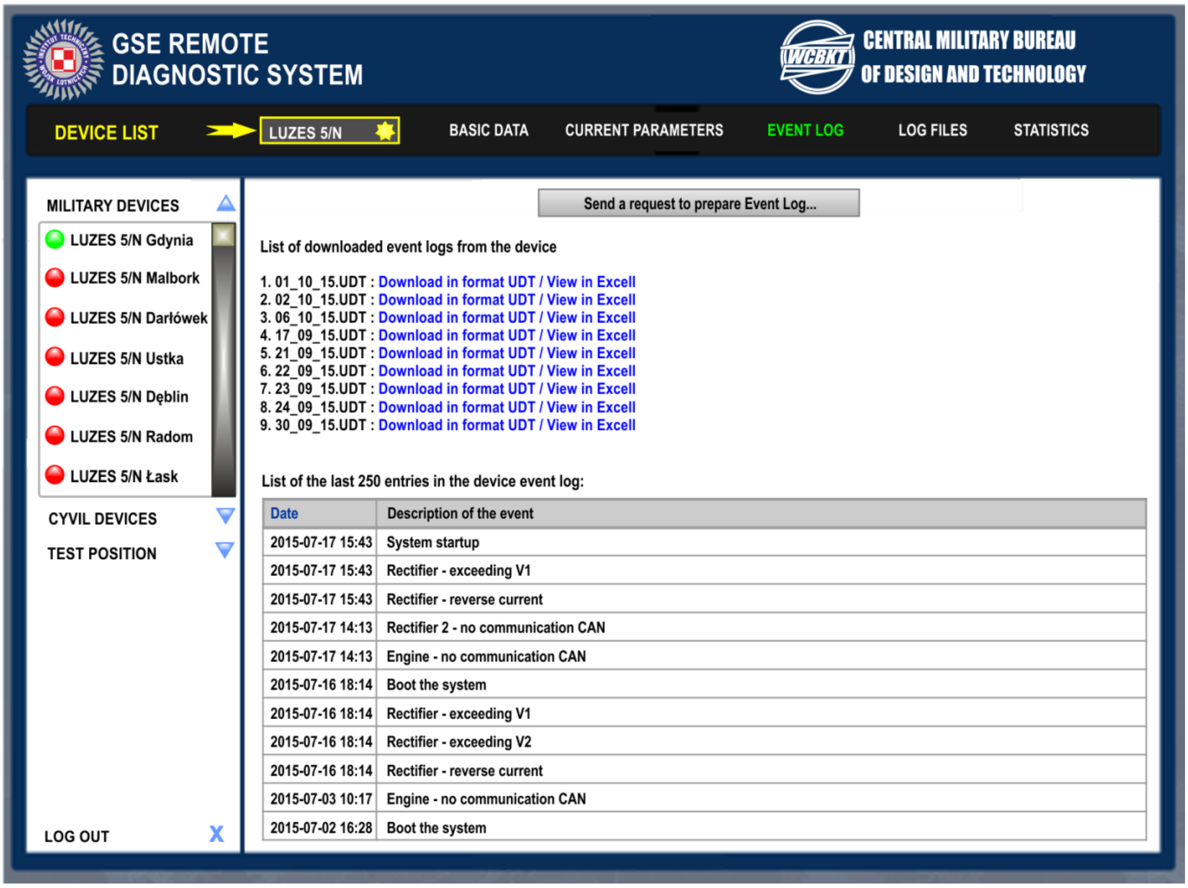

Fig. 2. Window – event log

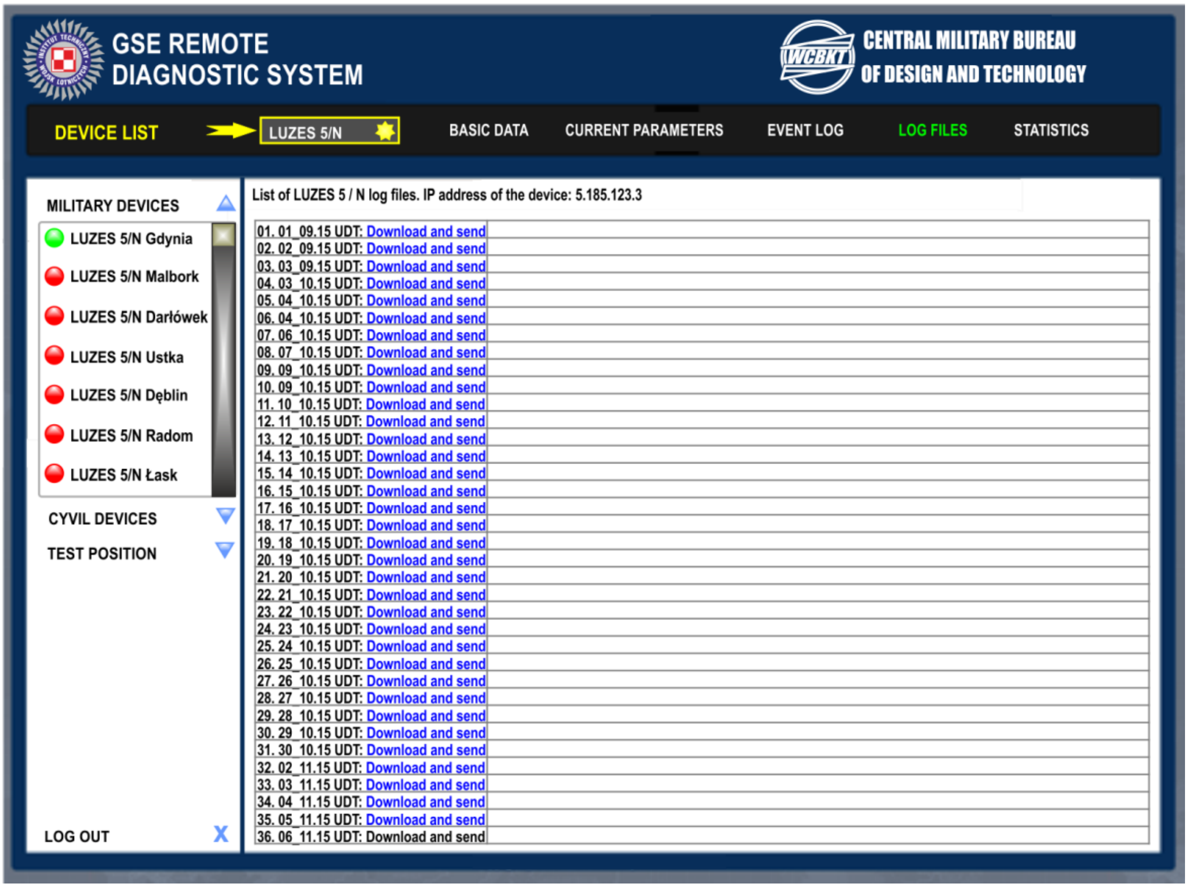

Fig. 3. Window – log files

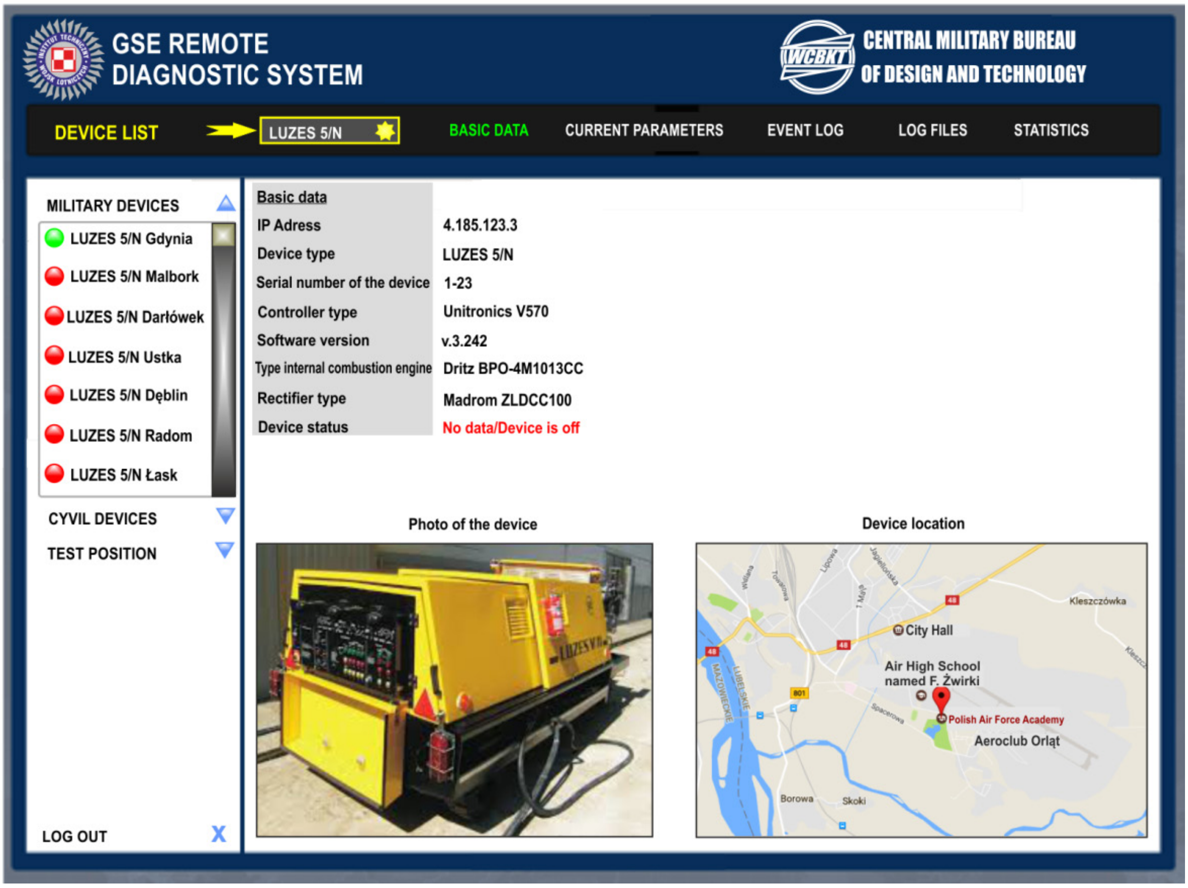

Fig. 4. Equipment information window with map presenting last 10 locations

Each GSE connected to the Remote Diagnostic System has the following set of modules (Fig. 5).

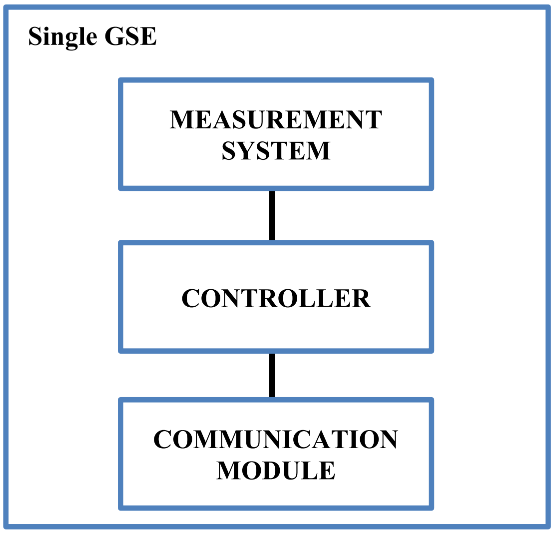

Fig. 5. Block diagram of the system on a single GSE

- **Measurement systems** – collect chosen equipment operating parameters;
- **Equipment controller** – a modified controller with added function of data acquisition and transmission
- **Communication module** – used to transmit the collected and acquired data to the GSE Remote

Diagnostic System Server (Fig. 6).

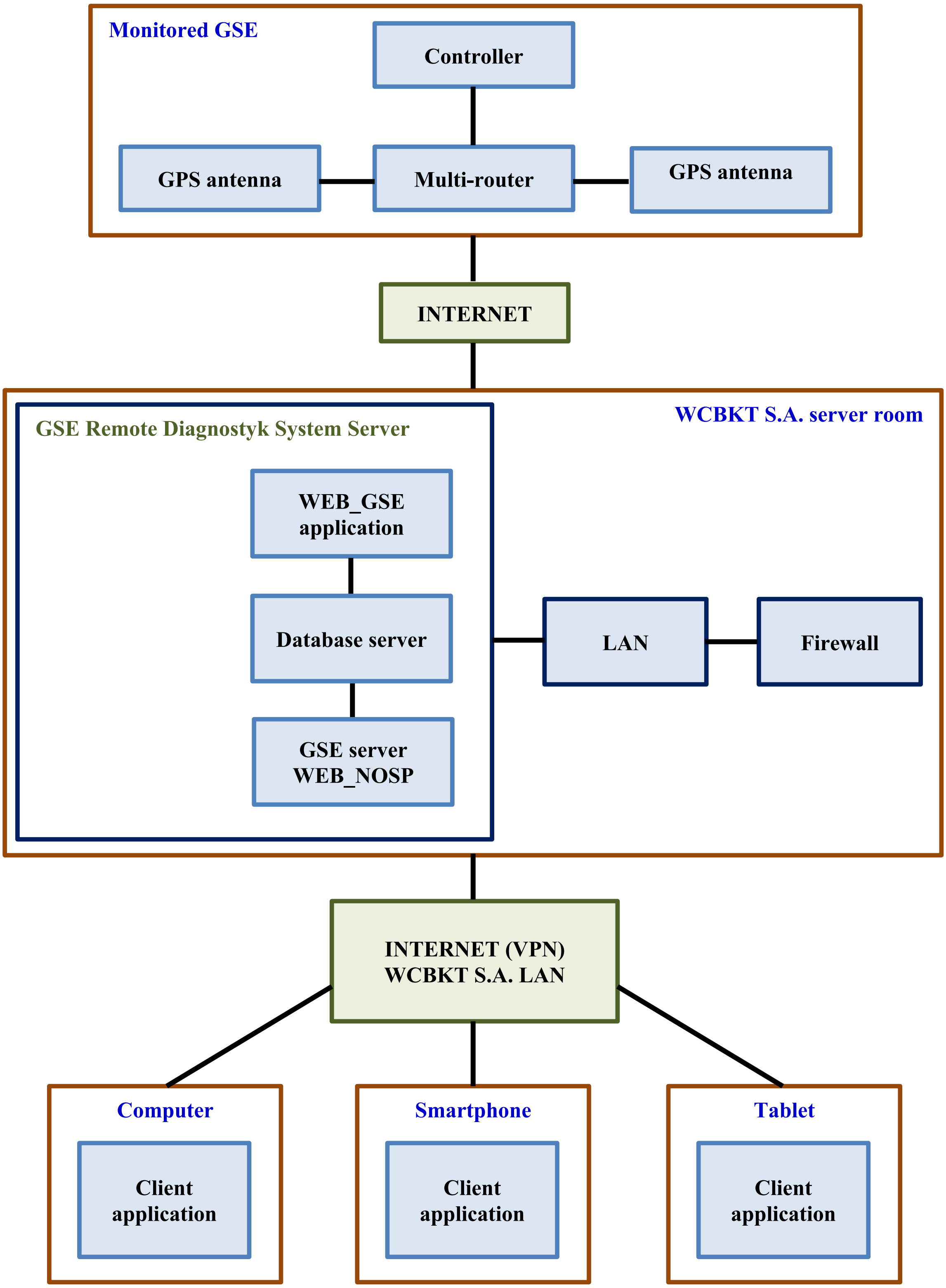

Fig. 6. Block diagram of system elements for a single GSE

The GSE Remote Diagnostic System Server allows simultaneous communication with many equipment items. The server comprises the following modules (Fig. 7):

– **database** – collects and stores all data and files acquired from the equipment items. The Microsoft's SQL Server was chosen as the database server (Fig. 8),

– **GSE server** – an application that acquires data and saves them in the database. The application can run as a system service or in the view mode showing actions currently performed by the server,
– **WEB_GSE** – a WWW client allowing access to the data by the GSE System users (data presentation).

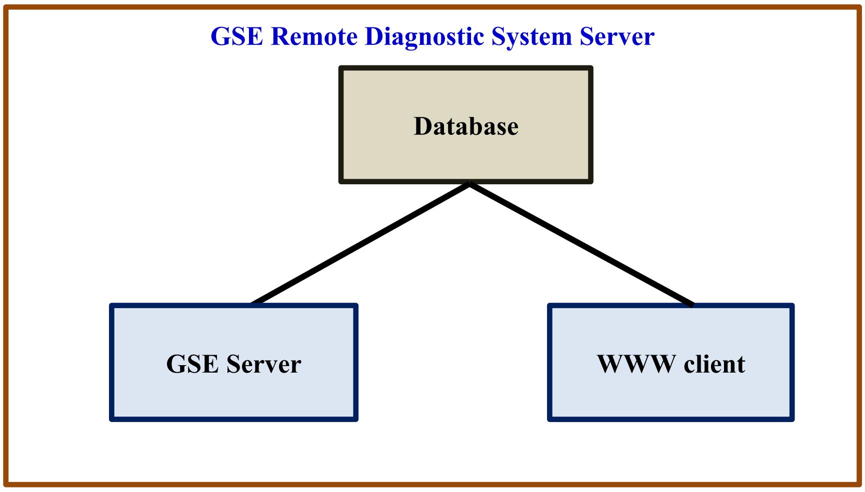

Fig. 7. Block diagram of the GSE Remote Diagnostic System Server

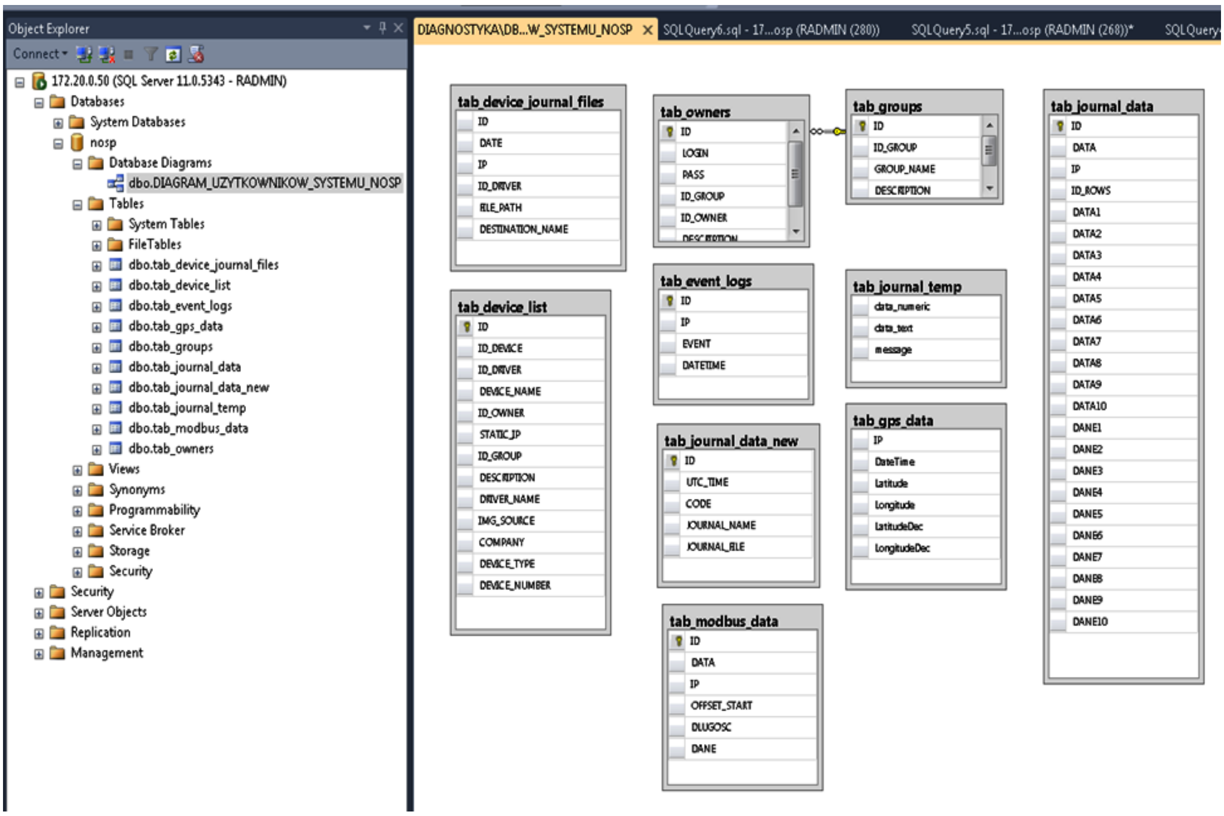

Fig. 8. Diagram with database tables of the GSE Remote Diagnostic System

As a result of using the state-of-the art solutions, the system allows operation of many equipment items and access by many users (Fig. 9). The system was tested on three emulated TAURUS GPU's, three emulated LUZES V/N's, emulator of the PORTOS equipment, and the data collected from the GPU TAURUS manufactured by WCBKT S.A.

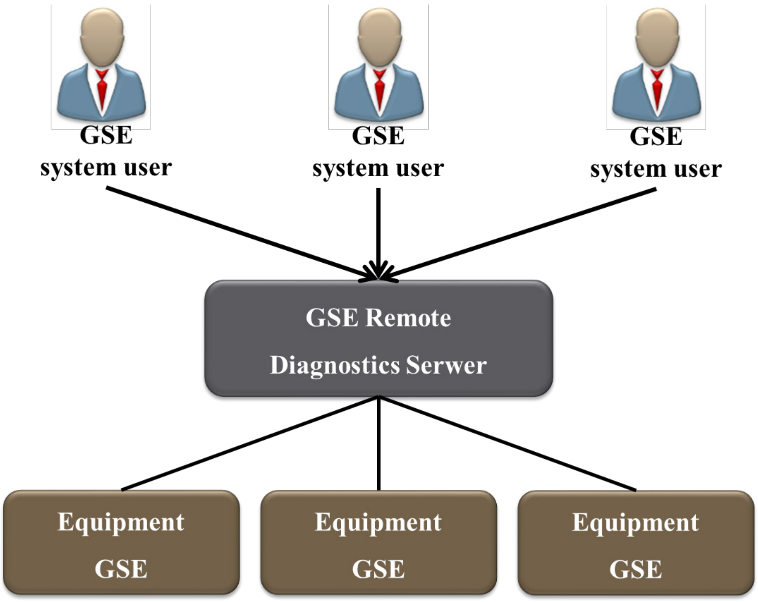

Fig. 9. Block diagram of the GSE Remote Diagnostic System

The current system capacity, with available electronics and internet connection, is up to maximum 20 GSE items. This number can be successively increased, by means of replacing the current computer hardware with hardware featuring better performance. Currently, the system can be used by 50 people simultaneously. This capacity also depends on the performance of the server on which the system runs.

3. Conclusions

It should be explicitly stated that the system passed the tests successfully which fully verified the assumptions. Of course, the system needs to be improved and supplemented, but it was confirmed that the concept of using the system in the operation and planning process is a step in the right direction.

The system can find a wide application in Polish Armed Forces, mainly as a support of central supervision of all GSE items used in the Airforce. Similarly, to many other support systems, the aircraft handling support system can significantly improve the logistic processes implemented by relevant technical services.

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