Software development network diagnostics industrial complexes

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Abstract. The article is devoted to the development of software for network diagnostics of industrial networks. The relevance of this topic is determined by the growing object of automated production. The reliability and effectiveness of their autonomous operation are directly related to the quality of remote monitoring and control of industrial complexes. The paper presents an assessment of the key parameters of the existing network diagnostics systems. Considered cross-platform, mobile technology used, the speed of reaction and the breadth of the functions implemented in the most common modern systems. A comparative analysis is given and the advantages of the software offered by the authors are shown.

1. Introduction

At present, the use of industrial networks has become widespread and continues to evolve. This is due to the fact that they meet important requirements for the industry: real-time operation, ensuring increased reliability of data transmission, support for communication between highly remote network nodes, strengthened mechanical design of equipment, as well as the ability to work on low-cost physical environments. Networks such as industrial automation require constant maintenance, of which technical diagnostics is an integral part. Solving the problems of technical diagnostics in the industry is now one of the primary tasks.

The rapid development of the industrial automation market provokes the creation of network diagnostics systems to perform this task, which in turn must be provided with software for their configuration and monitoring. The question of technologies used in these tools, today remains open. Some complexes have a mobile application as a diagnostic portal, others-desktop, being a portable computer, and the third – a web interface.

It is well known that the modern market of web technologies is full of various products, and the task to find not only the checked, but also the rational decision, is quite difficult. However, the world's desire for web technologies, the Internet of things, cannot be underestimated, and, therefore, this task should not be excluded from the account.

Summing up, it is possible to assert safely that questions of development of software of configuration and monitoring of industrial complexes of network diagnostics are actual.

2. The purpose of the work and the tasks necessary to resolve.

The above served as the basis for the work, the purpose of which was to develop a software configuration tool and monitoring of a complex diagnostics of networks (SCTaMCDN). The developed software product will find its application in the field of industrial network diagnostics, namely as a means of configuration and monitoring of network diagnostics systems used in enterprises specializing in automation of technological processes, as well as when accompanied by robotic lines, including assembly lines, at other enterprises using real-time critical equipment.

To achieve this goal it was necessary to solve the following main tasks:

- To search for existing analogues of the developed software and conduct a comparative analysis.
- Develop a prototype of the system.
- Choose the best web server to use as the base of the developed system.
- Implement a prototype-based software tool in the form of development of screen forms and configuration files.

Scientific novelty lies in the uniqueness of the combined application of technology in the development process and the features of the designed software.

The practical value of the work is justified by the fact that the integration of the web server into the embedded system using the web interface as a diagnostic portal is significant for industrial automation project. Currently, network systems provided with similar software are in demand, although the latter are not without drawbacks: dependence on the platform, a relatively low level of user comfort. The developed system abstracts from the usual shortcomings of its analogues.

The reliability of the results is provided by a comprehensive approach to solving problems, analysis of information from official electronic resources, as well as a comparison of the results with the data of such developments.

3. Comparison with existing software systems

Analogues of the development are the following software products:

a) Android-application AnCom RZA-Test is a mobile interface analyzer AnCom Rza-Test/GOOSE, designed to control the parameters of the transmission of GOOSE-messages during commissioning, troubleshooting and laboratory testing of digital substation equipment [1].
b) The OptiView Series III client is a dedicated desktop application implemented on the OptiView Series III integrated Network Analyzer laptop under the Windows operating system that provides network visibility and helps you deploy new applications, configure incoming devices, and protect your network from internal threats. [2]
c) DANEO 400 control PS is a diagnostic and at the same time configuration portal of a hybrid measuring system for recording and analyzing all typical signals and messages of the communication network at the substation [3].
d) The user interface of GOOSEMeter ONE is a software tool for managing a portable tool for analyzing GOOSE-messages and monitoring data arrays in the network being diagnosed [4].

The criteria by which a comparison of SCTaMCDN with analogues is made are the following: platform independence, portability of technology, amount of implemented functions, reaction speed.

3.1. Cross-platform

The task of cross-platform software product is quite important in the realities of the modern software market. The complexity of using some technology in the design of a software tool is directly proportional to the number of platforms satisfying this tool, i.e. the maximum complexity of execution is observed in a platform-independent product. However, given the development of the software language base, the problem is quite solvable [5].

In SCTaMCDN use a web interface that takes the developer from the task of creating a specialized desktop application. To access the interface SCTaMCDN need only a web browser, as well as in DANEO 400. GOOSEMeter ONE and AnCom RZA-Test do not have such a possibility, the second is

tied to Android, and OptiView Series III Integrated Network Analyzer has only reports and files of captured traffic through a web browser.

3.2. Mobility of technology

The web browser available on most mobile devices, therefore, the technology of SCTaMCDN and DANEO 400 is extremely mobile. In the case of AnCom RZA-Test the situation is similar to the fact that the Android OS is quite popular. This application can be installed on most mobile devices under this operating system [6].

OptiView Series III and GOOSEMeter ONE differ in that they have special portable computers; OptiView and GOOSEMeter can not be installed on any machine. In technological mobility they are far behind.

3.3. Amount of implemented functions

The functional of SCTaMCDN: collection of network data, analysis of collected data, generation of network traffic, providing the user with the ability to configure the complex network diagnostics from any device equipped with a web browser. Functional of analogues SCTaMCDN can be found on the manufacturer websites.

Characteristics of SCTaMCDN: tabular representation of measurement results color display errors and other important parameters, save results as text reports, fast preparation for work through loading a previously created configurations.

3.4. Reaction rate

In this analysis, according to this criterion, the reaction rate is considered as the rate at which the user's action entails the actual configuration of the network diagnostics complex, and monitoring provides data on the current state of the network, taking into account only the delays abstracted from the hardware of the mobile device – the carrier access to the diagnostic portal.

As in SCTaMCDN use a web interface, then the rate of reaction here slower than its analogues, but enough for a comfortable user experience. The web interface is very user-friendly, but slightly slow compared to a single application: the hardware capabilities of the device, the media, are not used directly, but indirectly by the web browser.

A comparative analysis is presented in table 1. Evaluation of the characteristics of the five software tools (SS) is made on a three-point scale in the interval from "1" to "3", "1" corresponds to the weakest manifestation of the quality under consideration, not necessarily its complete absence.

Table 1. Comparative analysis.

The name SS	Cross-platform characteristic	Technology mobility	Amount of implemented functions	Reaction rate	Result
SCTaMCDN	3	3	2	1	9
Application AnCom RZA-Test	1	2	3	2	8
OptiView Series III client	1	1	2	3	7
Danneo 400 control PS	2	2	2	2	8
GOOSEMeter ONE user interface	1	1	1	3	5

The total estimates of each of the systems under consideration for all criteria indicate that the relative leaders are developed SCTaMCDN, the application AnCom RZA-Test and the control PS DANEO 400. It is easy to notice that SCTaMCDN performed at the level already recognized developments. Its advantage lies in redistribution of the best qualities, emphasis on cross-platform and mobility of technology.

4. Selecting the web server to use

Preliminary selection of web servers for use in development was made on the following set: Apache, Nginx, Lighttpd, Cherokee. Comparing the requirements to software that is prototyped with the functionality of the considered web servers [7], it is possible to abandon the use of the Apache and Cherokee in the project. The reason for this is the following characteristics of web servers.

Apache:

- excess capacity of Apache for the developed system;
- the lack of high speed relative to other web servers under consideration.

Cherokee:

- excessive snap-in of application software, which is undesirable in the conditions of server deployment on the built-in platform;
- weak fault tolerance.

Conclusion comparing servers is the need to make the final choice between the web servers Lighttpd and Nginx through the test on the subject of prototyping, SCTaMCDN that was implemented.

The underlying platform for SCTaMCDN is TI AM3359 ICE board Rev. 2.1 A. It is based on the microprocessor of the line of the Sitara AM335x from Texas Instruments [8]. Within prototyping, SCTaMCDN using a BeagleBone Black (family of microprocessors are the same), and for remote access use the PuTTY.

Lighttpd and Nginx web servers were deployed on the BeagleBone Black platform [9]. Was written a php script which is responsible for the file download and results download links, and HTML page has a form to test the speed of download/upload, and ajax implementation of the timer. When you click on the corresponding button of the user interface, the file is actually uploaded to the server, ajax note time, displays the result in the HTML field below the form, then the download takes place without actually creating a file on the disk of the diagnostic portal media, the file code simply passes through ajax without saving, and ajax again note time.

The final choice of web server for use in SCTaMCDN test was conducted of speed of loading and reading the captured files. Test showed which server Lighttpd or Nginx optimal in the conditions of work in the role of SCTaMCDN. It was created six model files of sizes 10, 20, 30, 50, 70 and 100 megabits [10]. Test each of the web servers was made after a restart of the platform.

According to the experimental data obtained, graphs of the dependencies of the file download time to web servers and download from web servers on the size of this file were constructed, which is shown in figures 1 and 2.

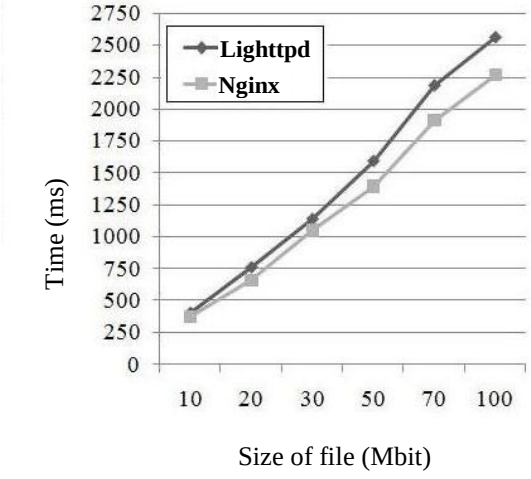

Figure 1. Graph of the file upload time to the web server depending on the size of the downloaded file

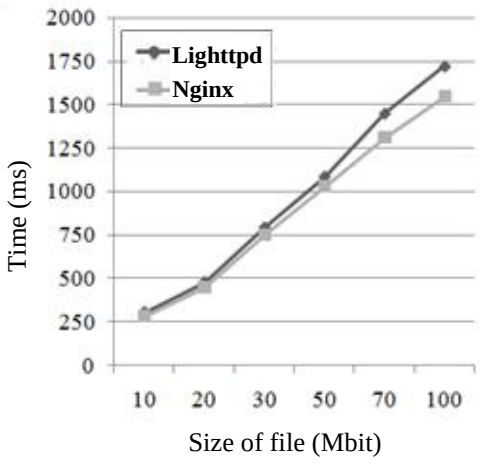

Figure 2. Graph of the file download time from the web server depending on the size of the downloaded file

The size of the files in megabits is chosen for the convenience of mapping to the bandwidth of the Ethernet connection in real time. It is easy to see that the Nginx web server shows the best results, although not with big difference from Lighttpd - in the development of SCTaMCDN was used by Nginx.

5. On-screen forms of the software complex

For the full implementation of SCTaMCDN necessary condition is the development of screen forms. Each part of the functionality of the complex has its own specific screen shape.

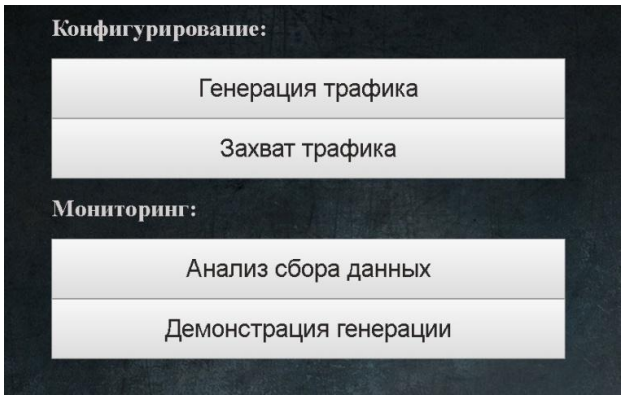

Figure 3. Input on-screen form to the CDN diagnostics portal

Configuring SCTaMCDN involves tuning two modes of operation. The complex is capable of generating and capturing traffic. Both modes have their own screen forms.

Monitoring requires a window of statistics and a list of network nodes (data collection analysis), as well as a form in which the demonstration of traffic generation is implemented. The latter implies the reflection of the state of a certain node: "ready" or "not ready", and length of generated packets, their numbers, the container of the counter. The screen form, which is the entry point to the diagnostic portal, is shown in figure 3.

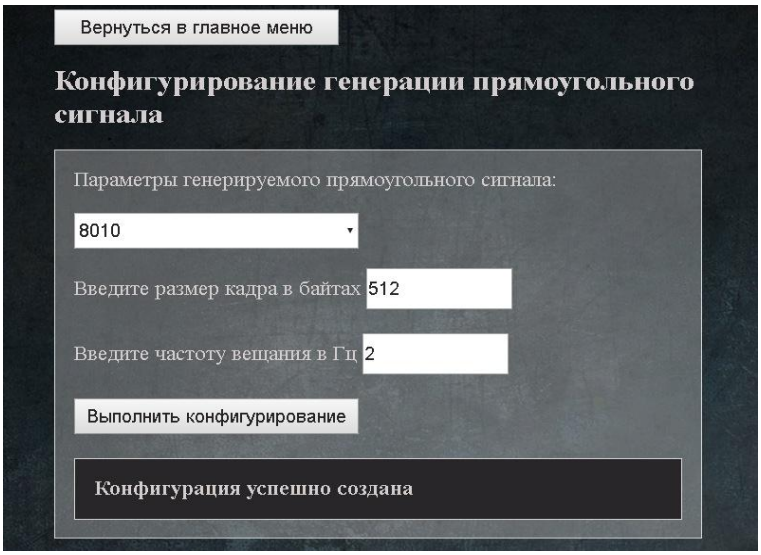

Figure 4. On-screen configuration form for signal generation

The configuration file consists of fields, most of which are displayed in the corresponding screen form. The on-screen form of traffic generation configuration is a menu for selecting the type of generated signal: rectangular, sawtooth, random signals and the ability to conduct a GOOSE test according to RFC 2013. Each of these items has its own form. The parameters of the generated

rectangular signal are specified by the user (operator) in the fields of the screen form of the same name, then the php script collects, complements the necessary and structures the entered information, creating its containing configuration file, which then gets to the specified node of the complex from the station. As an example, figure 4 shows the on-screen configuration form for generating a rectangular signal with filled fields.

6. Conclusion

Summing up, the following should be noted: developed software for configuring and monitoring the network diagnostic complex (SCTaMCDN) performed at the level of recognized solutions. Moreover, it surpasses existing analogues in technical characteristics, not inferior to them in the breadth of functionality.

Based on the study of popular web servers and experimental studies decision is that the ***Nginx*** web server is the optimal base for the developed system.

It is shown that the basis of a comfortable user interface is the way of creating configuration files and screen forms.

It should be noted that the developed software tool contains the ability to expand its implementation in the form of a further increase in the number of screen forms, followed by their elaboration to a greater extent.

Referenses

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List of abbreviations

SCTaMCDN - Software Tool for Configuring and Monitoring the Network Diagnostics Complex.
CDN - network diagnostic complex
AnCom RZA-Test - the mobile interface of the relay analyzer AnCom RZA-Test / GOOSE, designed to control the transmission parameters of messages during commissioning
OptiView Series III - a special desktop application implemented on a laptop OptiView Series III
DANEO 400 control PS - Distributed Hybrid Signal Analyzer for Power Systems Automation Systems

GOOSEMeter ONE is a portable tool management tool for analyzing messages and monitoring data arrays in a diagnosed network
Apache, Nginx, Lighttpd, Cherokee - proper names, server names
Sitara Am335x - microprocessor name
TI - Texas Instruments
TI AM3359 ICE board Rev. 2.1A - the name of the electronic board with microprocessors Sitara Am335x