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BLACK SEA SCIENCE 2021

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3. INFORMATION TECHNOLOGIES, AUTOMATION AND ROBOTICS

RESEARCH OF ONLINE IDE AND ANALYSIS OF DIRECTIONS OF DEVELOPMENT

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Abstract. *This paper describes cloud computing and their impact on the field of software development, and analyzes several issues of developers that can be solved using the online IDE.*

Usage of cloud computing in the enterprise is not new, and it is not difficult in terms of implementation. That is why it is gaining popularity. First, due to the large number of technologies that allow you to optimize internal processes. Secondly, due to the large number of giant companies and small businesses that use these technologies.

IDEs, which developers requires for programming, also have analogs on the web platform. The online IDEs have their advantages for solving some tasks and has become increasingly popular lately. Users of the online IDEs can create, run, and customize software that works with a simple browser.

The main goal of this study is to determine the main advantages of cloud technologies in the application development process, analyze the segment of online IDE. Based on these data to identify the main situations that determine their use, predict further development, and identify principles and technologies used in this area.

Keywords: *cloud computing, online IDE, software development.*

I. INTRODUCTION

The development of modern enterprises today is closely related with the development of technologies that simplify the work with large amounts of information, allow you to automate processes. One of these is cloud computing technology, which has replaced traditional computing technologies.

The idea of cloud computing is not new or complex in terms of technological resources and the Internet. New is the growth and maturity of cloud computing methods and strategies that provide business agility goals.

The number of easily accessible resources is growing, and utilitarian functions or service functions are the main basis for access to information technology resources and services. Because of this, cloud computing is a flexible, cost-effective and proven platform.

Changes from client-server architecture to service orientation have led to the evolution of code that can be composed and reused. Although this practice has been around for many years, a cost-cutting approach and identifying best practices and models for development are now in place. These processes have improved the design and engineering techniques of the computer software industry. It is now possible to transfer large-scale hardware and software resources to meet all automation requirements.

The evolution of reusability through service architecture is increasing the focus

on business goals, as opposed to the number of computing platforms to support. As a viable alternative to resource management, cloud computing is fundamentally changing the way we look at computing solutions in trading, education, and the public sector. The use of cloud computing architecture and standards provides unique ways to provide computing solutions, as well as a variety of platforms to achieve the lowest business goals [1].

II. LITERATURE ANALYSIS

The development and analysis of cloud technologies and online IDEs are reflected in both theoretical research and scientific work, as well as in commercial projects online.

The topic of cloud computing is often raised by scientists and scientists in the literature. Its high popularity is caused by companies which are increasingly providing on-demand services instead of placing their own equipment in data centers.

Numerous studies consider the benefits of using cloud technologies, such as the mobility of technological systems, which are considered as a means of implementing the virtual component of the mobility of hardware and software. Cloud computing concepts form a virtual component of hardware mobility, which is most pronounced in the category of services provided as a service - IaaS, PaaS and SaaS.

There is also a broader concept of software mobility, which means a common feature for software mobility and application mobility, which provides the ability to transfer programs between operating systems and hardware platforms.

A.M. Stryuk notes “cloud technologies are a systematic development of the concept of mobility in technological systems. We can consider different categories of cloud services as a basis for virtual mobility of both hardware and software. Extensive use of cloud technologies in various fields of human activity, in turn, contributes to the development of the virtual component of geographical, social, professional, academic and educational mobility "[2].

Despite the many advantages, there are disadvantages to the cloud model. The most important of these are those related to security.

Because SaaS is one of the most widely used cloud technology concepts, it has been the subject of many attacks. Several aspects of SaaS security are similar to web services, as you only need a web browser and the Internet to use this technology. In general, a large number of users do not dare to use such technologies because of fear of attacks related mainly to data protection, but rather to their confidentiality. The most common data security issues are data backup, access to data and their storage, the availability of authentication [3].

To make the best use of the model, you need to close existing security gaps. You can summarize the problem of cloud security as follows:

- some security issues are inherited from the technologies used, such as virtualization and SOA;
- multitenancy architecture and isolation is the main dimension of the cloud security problem, which requires a vertical solution from the SaaS level for the physical infrastructure;
- security management is very important for control and management;

- the cloud model must have a complete security wrapper, so that any access to any object of the cloud platform must first pass through security components [4].

Online IDE is a solution to many narrow problems of developers. It is a large number of works on the development of online IDE for various purposes. The authors of Harmonik=++ (Web IDE) identify 45 articles found in scientific journals [5]. Works such as "Jimbo" [6], "CoVSCode" [7], and «Collabode" [8] emphasize co-programming in the online IDE. In addition, some existing WIDEs support real-time collaboration in one form or another - Cloud9, CodeRun Studio, Eclipse Orion. Cloud IDE supports HTML for web development and real-time collaboration. Code Run Studio supports ASP .NET and C # .NET languages, and allows you to exchange code via hyperlinks. Eclipse Orion focuses on web development (HTML and JavaScript) [5].

The analysis of a large number of scientific papers shows the popularity of the research topic, as well as the large number of advantages of cloud computing, and compared a small number of disadvantages, but quite significant.

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

The object of research is the process of implementation and use of cloud technologies in the field of software development, in particular the use of infrastructure and platform as services - IaaS and PaaS.

The subject of the study is to identify the problems of developers and their solutions - team simultaneous programming, saving code in cloud storage, fast programming without spending time setting up the environment.

In this work, the system-structural approach is a detailed study of existing analogues and their code, research papers, developers and their tasks, their study as a whole. The thematic applied research is devoted to a rather narrow issue - online IDE in a broad topic of cloud technologies. Analysis and comparison also used in this work.

IV. RESULTS

In order to design a high quality and reliable online IDE, you need to carefully research similar systems from a technical point of view and analyze their effectiveness.

GitHub, one of the largest web-based software development services, has more than 50 online IDEs, and about half of them are open source.

After analyzing 20 online IDEs, it was determined that more than 25 percent of all code written in JavaScript, as shown in figure 1. This is not surprising, because web application development is rarely done without this language, and how it is essential for building dynamic sites. However, the language in the considered repositories used not only for the dynamic component, but also for the development of the backend part. Tools for frontend development - HTML and CSS, follow this. Other presented languages are approximately equally distributed, as they are mainly languages for the development of backend parts of applications.

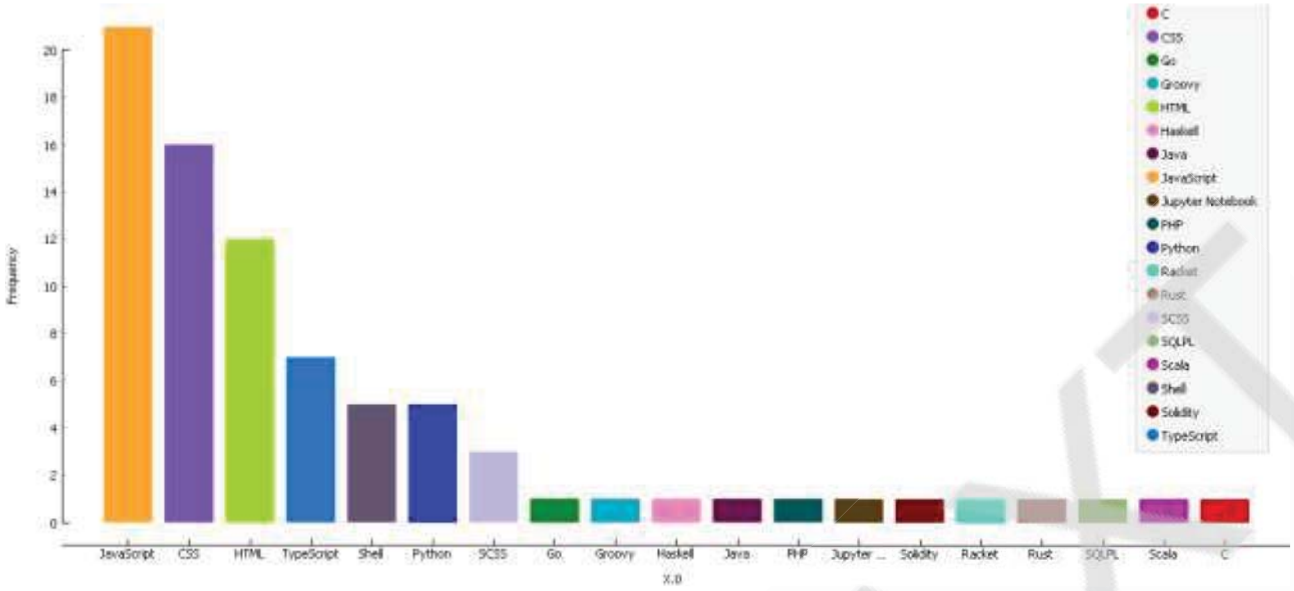

Fig. 1. – Diagram of the use of languages for online IDE development

An online IDE was chosen for the experiment, in which user can execute code in JavaScript, so it is one of the most popular, under the same conditions, i.e. editors send a request to the server during processing, rather than executing it in the browser console.

The following is the JavaScript code that run during the experiment, which finds a factorial of 10.

```
const factorial = (n) => n === 1 ? 1 : n * factorial(n - 1)
const factorialOfTen = factorial(10)
console.log(factorialOfTen)
```

Table 1.Code processing speed

Name	Processing speed, ms
codesandbox	>1200
tio.run	> 800
plunker.co	>2000
mycompiler.io	> 600
repl.it	>1600
glot.io	> 700

For high editor download speeds, it is important to optimize all project modules. These can be compilation systems, error messages, debugger integration, and more. In the case of debugger integration, if a browser-based IDE offers it, UX for debugging remote assemblies is not an easy solution.

Table 2 lists the resources that were tested and the results from Chrome DevTools. The best result is the one that is the smallest and fastest.

Table 2. Comparative analysis of the loading speed of analogues

Name	Number of requests	The amount of data transmitted over the network	The number of resources loaded by the page	Page load completed in	DOMContentLoaded	Load
codesandbox	297	7.2 MB	77.3 MB	25.44 s	2.89 ms	7.00 s
codeanywhere	87	7.2 MB	7.2 MB	11.23 s	945 ms	1.63 s
tio.run	9	184 KB	630 KB	1.27 s	484 ms	691 ms
onlinegdb	248	1.4 MB	4.2 МБ	10.45 s	1.26 s	2.55 s
codepen	41	1.2 MB	3.3 MB	2.10 s	1.50 s	1.70 s
jsbin	41	594 KB	1.8 MB	3.28 s	859 ms	3.00 s
mycompiler.io	73	779 KB	2.2 MB	3.62 c	1.16 c	2.38 c
jsfiddle	16	2.0 MB	7.8 MB	3.14 c	459 мс	3.00 c
repl.it	133	2.7 MB	7.5 MB	5.83	947 мс	3.98 c
glot.io	24	947 KB	984 KB	1.60	858 мс	1.10

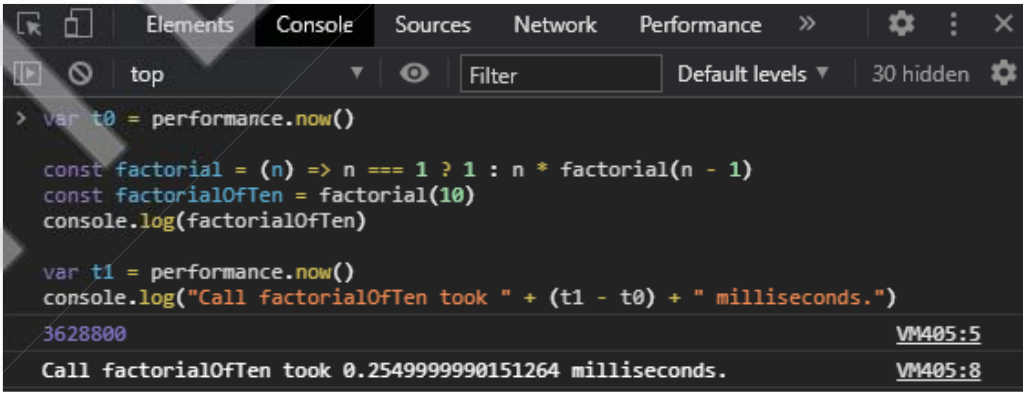

Fig. 2. Code execution speed in the browser console

For comparison, the same code executed in the browser console. It took about 0.25 milliseconds to complete. This figure is much lower than in the online IDE, as the request is performed locally and does not require additional resources to send the code

to the server.

The conclusion of this experiment is that the code in the online IDE runs longer than locally, as cloud applications usually have a complex way of executing it: from sending code from a browser to a server to creating docker containers. The architecture of the project and its optimization also play an important role, as any non-optimized functions or the choice of inappropriate technologies can significantly slow down processing. Also important is the hardware on which the code will be run remotely. Free versions usually have resource constraints, as cloud computing of large amounts of data is an expensive process.

The application should consist of small separate modules with several programming languages, so the best choice will be the architectural style of microservices.

Microservice architecture is when a single application is built as a set of small, self-sufficient, independent, not closely related services that communicate with each other through mechanisms such as HTTP, gRPC, AMQP. These services are built around business needs (each responsible for a specific process) and are deployed independently using a fully automated environment. There is an absolute minimum of centralized management of these services. The services themselves can be written in different languages and use different storage technologies.

The main feature and complexity of the application is the execution of user code on the server. This imposes some limitations on the system architecture, as the executable code can be potentially dangerous. Therefore, in order to ensure the required level of security and fault tolerance of the system, the code will need to be executed in an isolated environment, such as a docker container. This module for code execution can be made in a separate so-called service worker, which will create containers, execute code in them and then send the result back to the user.

Docker chosen as an isolated environment due to a number of advantages. Docker images share a Linux kernel with the main machine, making Docker much lighter and more efficient than virtual machines - a regular computer can run no more than a few virtual machines at a time, but won't have problems running 100 containers, as shown in figure 3 [9]. This feature has made the Docker particularly attractive to the industry and is largely responsible for the huge popularity of the Docker.

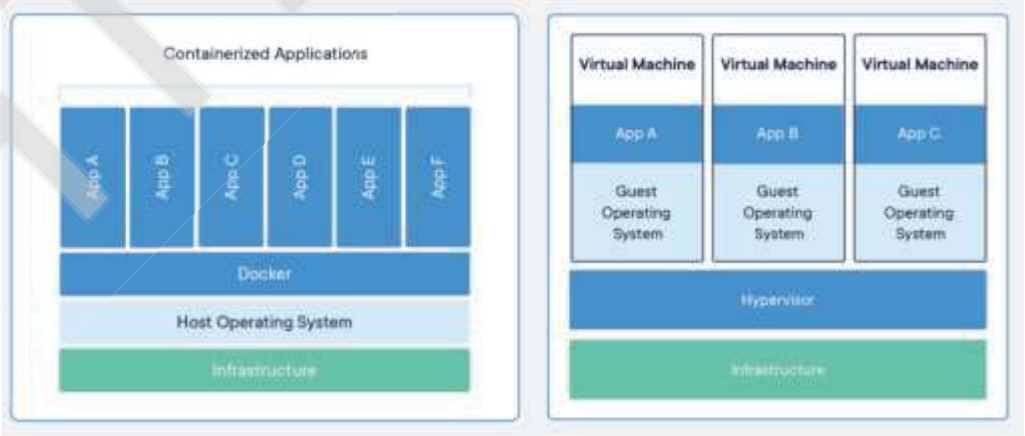

Fig. 3. Advantages of using docker containers

The frontend in this system, as well as in any IDE, is difficult enough therefore it was decided to do SPA. This will make the user's interaction with the application as

fast and enjoyable as possible. A SPA is a web application or website that interacts with a user by dynamically rewriting the current web page with new data from a web server, instead of the default browser loading entire new pages. This allows faster user interaction with the application, making the website feel like a native program.

A general view of the system architecture can be seen in Figure 2.8.

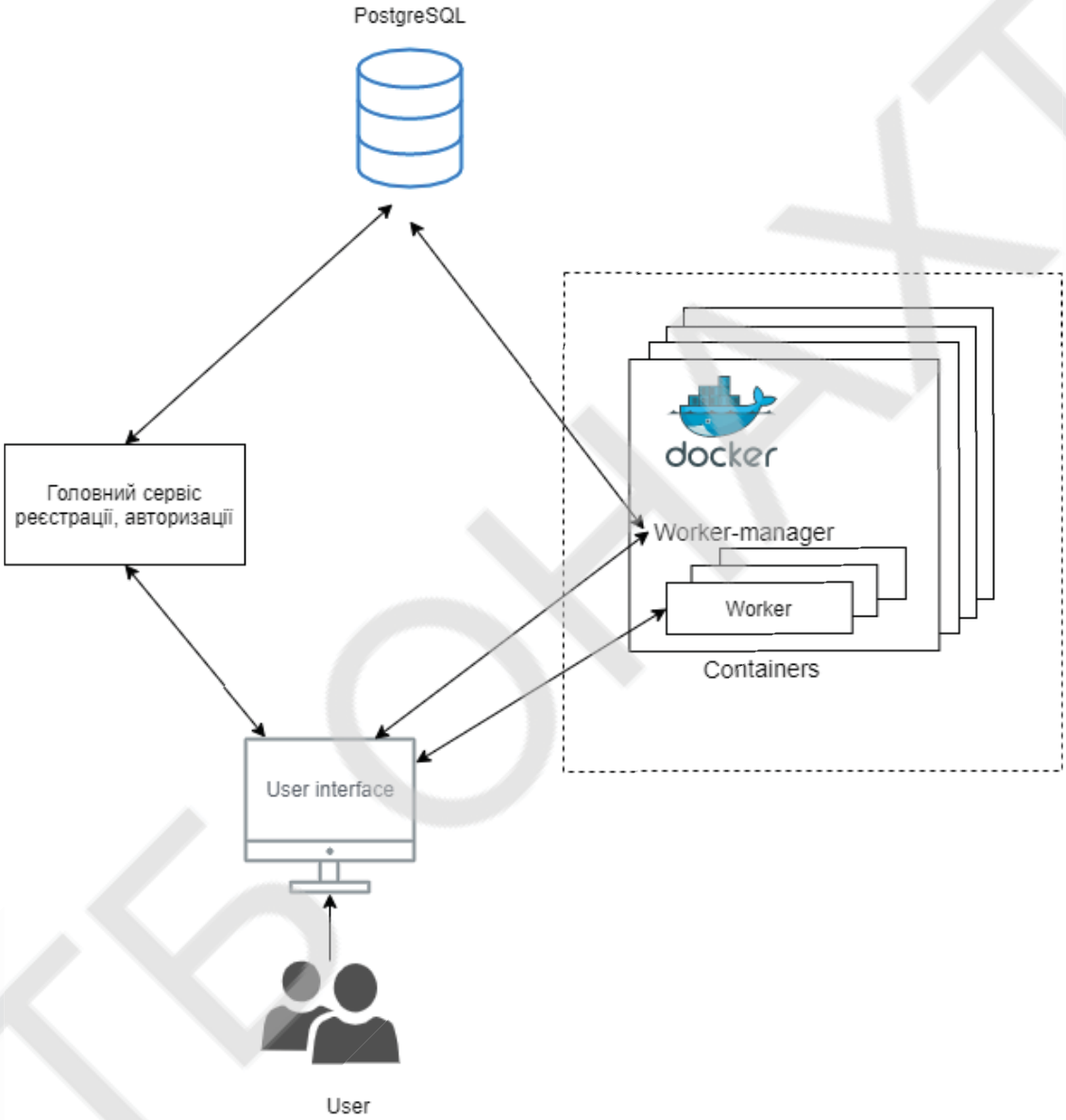

Fig. 4. View of architectural elements

User starts working on the project from the landing page. It introduces the product and provides the user with brief information.

Further work can be continued only after authorization through GitHub. You do not need to spend time creating an additional account to work with the application. In modern conditions almost every developer has a GitHub profile, and in its absence, the account can be created in minutes.

Fig. 5. Creating a project

You can start working with projects from the project list page, if they have been created, or create a new one. The list of projects can be seen in Figure 6.

When clicking on the "Create new project" zone, you need to enter the name of the project in the form and select the language that will be used by this project.

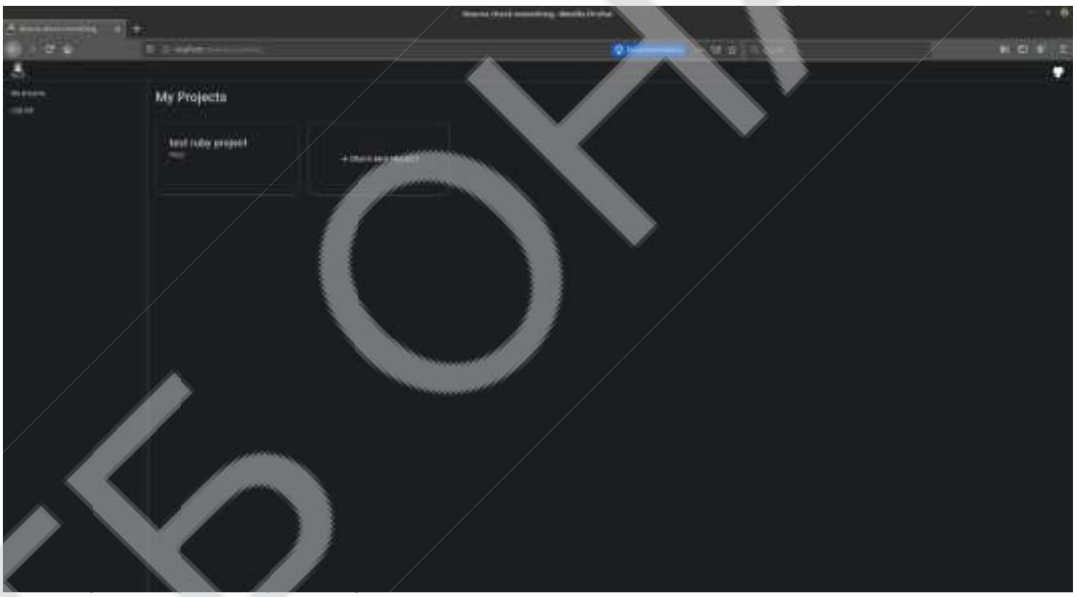

Fig. 6. List of projects

The view of the project editor is shown in Figure 7. The code editor has syntax highlighting for many popular programming languages, markup, and other files, as it has a built-in Ace editor. On the left is a list of project files. Each file can be easily identified, as all files have corresponding icons. To the right is a terminal where you can create, delete, modify files, and manage a project with commands. The size of each zone can be changed at will by dragging their frames.

On the tab with the settings icon, you can go to the project settings and change the name or delete the project. There is no need to save the project in addition, because the application has a self-preservation function.

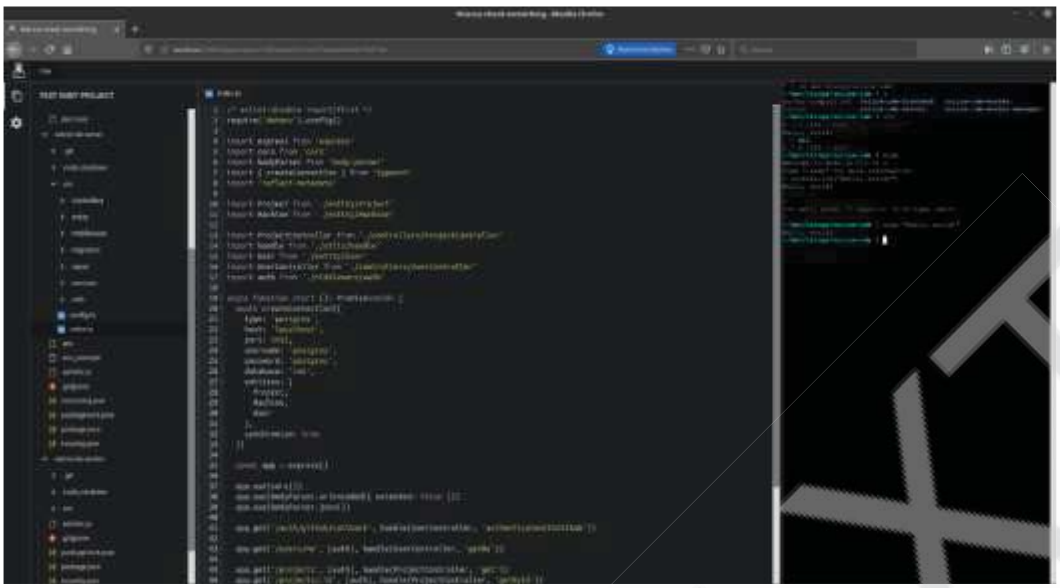

Fig. 7. Editor's view

The application has a nice and clear interface that helps you work quickly without being distracted by settings, installation of additional elements and integration of tools. This is an advantage for a product that is used to quickly check pieces of code or write small functions

V. CONCLUSIONS

A comprehensive analysis of the subject area was conducted, which is a key stage of the work. As a result, the technical features, performance, and scope of the online IDE cluster were identified.

As a result of the analysis of development languages and architectural solutions, it was chosen to use JavaScript and TypeScript as the main development language. Based on the collected data from public repositories and blogs and documentation of technology companies, methods and tools have been identified. They were used to create a software product, select architectural models and design a prototype of an online IDE.

Developed MVP - cloud programming environment. The product is not a replacement for the traditional IDE, as it has very limited functionality. The application is ready to use, and with further optimization and development of new features can become a successful competitor in the online IDE market.

Online IDEs open up new opportunities for sharing and collaboration and allow, for example, programming in pairs with a colleague who is on another continent.

Most existing online IDEs are designed to work on small projects and small teams or to quickly share code in discussions or forums. Since processing large amounts of data on cloud services is a rather expensive process, the free Online IDE cannot be a full-fledged replacement for the desktop version, which can be used for multi-year projects with a large codebase. However, the advantage will be the availability of a large number of languages, the availability of chats, speed of writing, and the ability to conduct online classes.

This can also be useful when it comes to outsourcing and a colleague is a casual developer. For example, a developer needs the services of a DBA expert, who can be found online and work on a joint project immediately.

On-demand services open up new possibilities: instead of buying an expensive application, users can pay for the time used, or even use free versions.

Since many online IDEs are open source, developers will be free to use existing solutions and to develop additional modules. As the number of online services provided grows, the demand grows, which in turn opens up new directions and opportunities and is a promising area of development.

The development and analysis of cloud technologies and online IDEs are reflected in both theoretical research and scientific work, as well as in commercial projects online. The analysis of a large number of scientific papers indicates the popularity of the research topic, as well as a large number of advantages of cloud computing, and a relatively small number of quite significant disadvantages.

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