

ABSTRACT

Volume of work: 93 pages, contains 4 chapters, 7 figures, 3 tables, 20 sources in the reference list.

In the modern world of digital technologies, Single Page Applications (SPAs) have become a critical component of business processes and consumer services. The growing requirements for reliability, availability, and response speed of such applications demand the development of fault-tolerant architectural solutions. Even short-term outages can lead to significant financial and reputational losses. Amazon Web Services (AWS) cloud environment provides a wide range of services for creating fault-tolerant systems, however, their effective use requires in-depth research of architectural patterns and deployment methodologies.

The dissertation was completed at the Department of Informatics and Software Engineering of FIOT KPI named after Igor Sikorsky within the framework of the department's scientific research in the direction of cloud technology development and methods of ensuring reliability of distributed systems.

The purpose of the research is to develop and experimentally verify architectural solutions for ensuring fault tolerance of single-page applications in AWS cloud environment using the Infrastructure as Code approach.

Object of research – processes of deployment and management of single-page applications in AWS cloud environment.

Subject of research – architectural solutions and software tools for ensuring fault tolerance of web applications based on container technologies and Infrastructure as Code.

To achieve the set goal, the following tasks were solved: conducted comparative analysis of existing approaches to deploying SPAs in cloud environment (EC2, ECS, EKS), selected and justified the choice of optimal solution based on Amazon ECS, developed modular architecture using Terraform and Terragrunt, implemented multi-layered security system using AWS Secrets Manager and Security

Groups, implemented CI/CD pipeline based on GitHub Actions, conducted comprehensive testing of system performance and fault tolerance.

The work uses methods of system analysis for choosing architectural solutions, modeling methods for infrastructure design, experimental methods for performance and fault tolerance testing, and statistical analysis methods for evaluating test results.

The methodology for designing fault-tolerant architectures for single-page applications in AWS cloud environment has been improved by integrating the Infrastructure as Code approach with automated scaling and multi-level monitoring system, which ensures recovery time after failure of less than 2 minutes and availability at the level of 99.9%+. The use of ECS Fargate container technologies for deploying SPA applications has been further developed through the creation of modular Terraform structure, which provides 60-80% reduction in infrastructure deployment time and 90% reduction in configuration drift compared to manual approach.

A ready-to-use solution has been developed for deploying fault-tolerant single-page applications based on Amazon ECS with full automation through Terraform modules and CI/CD pipeline. A set of reusable Terraform modules has been created for network infrastructure, load balancer, ECS cluster, secrets management system, and automatic scaling. A fault tolerance testing methodology with detailed performance metrics has been implemented, which can be applied to other types of web applications. The effectiveness of the developed architecture has been experimentally confirmed: under load of 1000+ simultaneous users, the system maintains response time of 300-400 ms, in case of container failure, automatic recovery is ensured within 30-60 seconds, in case of availability zone failure, 99.9%+ availability is maintained with recovery time of 2-5 minutes.

The main results of the work were presented at the scientific seminar of the Department of Informatics and Software Engineering of KPI named after Igor Sikorsky (2024). Research materials are used in the educational process of the department in teaching disciplines on cloud technologies and DevOps practices.

Publications. Based on the results of the work, abstracts were prepared for presentation at the student scientific-practical conference of FIOT KPI "Modern Information Technologies" (2024).

Keywords: fault tolerance, single page applications, aws, amazon ecs, infrastructure as code, terraform, containerization, ci/cd, cloud technologies, automatic scaling.