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ANALYSIS OF TECHNICAL REQUIREMENTS OF MICROSERVICE ARCHITECTURES IN THE CONTEXT OF SOCIETY 5.0

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Abstract:
In the era of the development of Society 5.0, which we witness every day and which, through digital systems, strives for prosperity based on the relationship between people and technology, the following important aspects stood out: scalability, response time, stability, and system efficiency. Therefore, the need to implement software solutions that effectively meet the stated requirements motivates analyzing microservice architectures as an effective approach to developing digital systems in the context of Society 5.0. The goal of the work is oriented to the perception of the role and application of performance requirements in the context of microservice architectures and technical requirements in the context of Society 5.0 in order to connect these two domains. The paper reviewed the literature through 10 primary studies, according to predefined steps of search and selection of scientific papers. The research results show that the common basis of microservice architecture and Society 5.0, through the analyzed works, are requirements such as scalability, response time, fault tolerance, system reliability, and efficient use of resources.

Keywords: *Microservice architecture, Society 5.0, technical requirements, scalability, response time, system reliability, fault tolerance*

Introduction

Society 5.0 implies a more resilient, sustainable and human-centered society that encourages the ever-evolving cooperation and exchange of knowledge among the many digital systems that already shape our daily lives [1]. On the other hand, Microservice Architecture (MSA) is based on a philosophy that does not require resource sharing and relies on years of experience gradually developed in the field of software engineering

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and system design. This architecture style organizes the system as a set of loosely connected small services, which are separated into small, coherent and autonomous units [2]. The microservices approach has expanded in recent years due to its ability to decompose complex functions into modular services that can be implemented independently, since each microservice can hide and encapsulate its specific functions, promoting agility, scalability, and easier maintenance. The adoption of microservices in Society 5.0 can enable efficient adaptation of services to changing needs, support rapid development and implementation, as well as encourage innovation between and within different sectors, such as health, education, transport, administration and others, which ultimately contributes to the creation of a more responsible and resilient society [3]. The goal of the research of this paper is reflected in the identification, systematization and comparative analysis of requirements that are considered performance-related in microservice architecture, and technical in terms of Society 5.0.

1. Aspects of Society 5.0 relevant to microservice architecture

Society 5.0 is a concept that emphasizes the role of technology within society, focusing on collaboration between people and technological systems to solve social problems through the integration of the virtual and real worlds [4]. This framework aims to integrate all physical and digital systems using advanced artificial intelligence (AI) to analyze data and generate useful insights, ultimately benefiting society [5, 6]. Digital transformation serves as the basis for achieving the goals of Society 5.0, as it enables the necessary technological infrastructure and capacities. For example, the integration of artificial intelligence (AI) and the Internet of Things (IoT) into public services can lead to the development of smarter cities that improve urban life through improved transportation, health, and environmental management [4, 7]. From the aspect of microservice architecture, the following requirements are distinguished: scalability, fault tolerance, response time, throughput, efficient use of resources, and system stability. The aforementioned requirements are important for the realization of Society 5.0, because they directly affect the application of digital technologies, a large number of interconnected services, and the need for efficient functioning of systems in various areas of application. Scalability is important in the context of Society 5.0 because smart city systems should be scalable to effectively respond to

increases in the volume of sensor data flow, the amount of data stored in databases, the number of devices managed by the management system, the amount of data processed by services and applications, as well as the number of applications and users [8-14]. When it comes to fault tolerance, according to the proposal [15], fault tolerance maintains the stable operation of digital systems that are oriented towards distributed databases and parallel processing of large amounts of data. Smart city systems may require real-time sensors and monitoring, intelligent processing, and online big data analytics. For example, process control, healthcare, and transportation systems require the timely delivery of data and services. Real-time monitoring helps users to predict and forecast various situations that may affect the city's prosperity [8, 11, 16, 17]. Bandwidth and capacity are important in the context of Society 5.0, and for this reason, the authors [18] state that systems must provide extremely high capacity, low latency, a large number of devices, wide coverage, high reliability, low energy consumption, long battery life, and low cost.

2. Methodology

This paper applies a structured literature review approach to identify and compare technical requirements shared by microservice architecture and Society 5.0. A certain review protocol was defined following general guidance in Chapter 22 of the book [19]. The search focused on studies published in English between 2010 and 2026 that address microservices, Society 5.0, and related technical or performance requirements.

The search query was used: Society 5.0 AND (Microservice OR Microservices OR Microservice Architecture) AND (Performance OR Scalability OR Latency OR Availability OR Response Time), created based on the specified keywords in the query and using the logical operators OR and AND in an adequate way, and applied in the selected search sources. The following databases were selected as relevant search sources: IEEE Xplore, Springer, MDPI, and the academic search engine Google Scholar. After the completion of the search planning process, in the stage of the search execution process, the search results were filtered according to the inclusion and exclusion criteria shown in Table 1.

Table 1: *Inclusion/exclusion criteria*

Criteria	*Criteria description*
Inclusion criteria 1 – (I1)	Studies focused on technical/performance requirements relevant to Society 5.0 and microservice architecture
Exclusion criteria 1 – (E1)	Not written in English
Exclusion criteria 2 – (E2)	Published before 2010
Exclusion criteria 3 – (E3)	Full text not available
Exclusion criteria 4 – (E4)	Outside the scope of technical/performance requirements
Exclusion criteria 5 – (E5)	Preprints
Exclusion criteria 6 – (E6)	Books, theses, dissertations
Exclusion criteria 7 – (E7)	Purely conceptual studies
Exclusion criteria 8 – (E8)	Duplicates

A total of 46 publications were initially identified. Based on criterion E8, 3 duplicate records were removed, leaving 43 studies for screening. After applying the inclusion and exclusion criteria, 33 studies were excluded: 2 based on E2, 7 based on E4, 2 based on E5, 1 based on E6, and 20 based on E7. The final sample included 10 primary studies (PS). Table 2 presents a structured overview of these studies, including their references, research types, and identified technical requirements.

Table 2: *Review of primary studies*

PS	*Reference*	*Research type*	*Technical requirements*
PS1	[1]	Experimental work with an architecture proposal	Response time, efficient use of resources, reliability, fault tolerance
PS2	[20]	Experimental research	Scalability, response time, fault tolerance
PS3	[21]	Comparative analysis	Response time, throughput, system reliability, efficient use of resources
PS4	[22]	Experimental research	Response time, scalability, efficient use of resources, reliability, fault tolerance
PS5	[23]	Experimental research with evaluation	Response time, throughput, scalability, reliability, high availability
PS6	[24]	Applied research with a mixed approach	Scalability, stability, efficiency, real-time monitoring, early detection of irregularities

PS7	[25]	Case study	Response time, throughput, scalability, availability, reliability
PS8	[26]	Experimental research	Scalability, response time, efficient use of resources, system reliability
PS9	[27]	Experimental research with proposal and evaluation of solutions	Response time, scalability, security, availability, robustness to DDoS attacks
PS10	[28]	Experimental research with proposal and evaluation of solutions	Throughput, failure recovery time, availability, reliability, scalability, response time

3. Results

A comparative analysis of the previously presented primary studies was performed with a focus on: a comparative review of the methods used in the papers, and a comparative review of the approach to defining research goals. When it comes to the methods used in the papers, it is concluded that empirical research and the experimental method prevail in the primary studies: [PS2], [PS4], [PS5], [PS8]. The authors point out that in the work [PS1] an experimental method with an architecture proposal was used, and in the works [PS9], [PS10] experimental methods were used with concrete proposals and evaluations of microservice architectures. Also, there is a comparative analysis [PS3], a case study [PS7], as well as the application of participatory design [PS6].

On the other hand, a comparative review of the approaches to defining research objectives in primary studies can be concluded that the most represented were: solution implementation [PS1], [PS4], [PS5], [PS8], [PS9], [PS10] and ensuring the quality and stability of the system [PS3], [PS5], [PS7], [PS8], [PS9], [PS10]. Also, in a larger number of analyzed works, the evaluation of performance requirements prevails: [PS2], [PS3], [PS5], [PS8], [PS10]. This segment shows that research is largely based on measurements of scalability, response time, and system reliability in microservice architectures and Society 5.0.

4. Conclusion

The results of the research carried out in this work through the identification, systematization, and analysis of 10 primary studies showed that there is no direct connection when it comes to microservice architectures and Society 5.0, but their relationship and application can be seen through the requirements of digital systems, such as scalability, response time, system security, fault tolerance, etc. Based on this, it is concluded that the mentioned requirements represent a common basis when it comes to microservice architecture and Society 5.0, as well as an important aspect of connecting these two domains.

Future research can be directed towards a systematic literature review with more analyzed papers based on primary studies and a more extensive analysis of requirements regarding microservice architectures and Society 5.0.

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