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**АНАЛІЗ ПРОЦЕНТИЛІВ ПРОДУКТИВНОСТІ ІНСТРУМЕНТІВ
ТЕСТУВАННЯ НАВАНТАЖЕННЯ**

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**ANALYSIS OF PERCENTILES FOR PERFORMANCE OF LOAD
TESTING TOOLS**

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***Анотація.** У роботі представлено аналіз метрик перформанс тестування при порів'язанні поведінки інструментів тестування Postman та JMeter для публічних інтерфейсів програмування додатків (API). Результати свідчать про потенційну користь використання Postman при умовах середнього навантаження для Create і Delete запитів, та JMeter для Read (Get) та Update операцій у складних системах, що потребують стабільності та передбачуваності в умовах змінних навантажень.*

***Ключові слова:** процентиль, тестування продуктивності, відсоткове відхилення, стабільність, Postman, JMeter.*

***Abstract.** The paper presents an analysis of performance testing metrics when comparing the behavior of Postman and JMeter testing tools for public application programming interfaces (APIs). The results indicate the potential benefit of using Postman under medium load conditions for Create and Delete requests, and JMeter for Read (Get) and Update operations in complex systems that require stability and predictability under variable loads.*

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Keywords: percentile, performance testing, percent deviation, stability, Postman, JMeter.

In real-time systems, average response time values can be influenced by anomalous outliers (e.g., if one request takes 10 seconds while others are processed in 100 ms due to a failure rate of 1-10%, such as user or validation errors) [1]. However, percentiles provide a more reliable representation of system behavior for most users, capturing significant delays that the average response time would miss [2]. The aim of this work is to analyze ARTs and percentiles values obtained during performance testing of 5 public APIs using Postman and JMeter in order to identify cases where particular test tools are more stable. For each of public APIs 4 types of HTTP requests were sent: GET, POST, PUT, DELETE. Additionally, 8 different test cases (TC) were executed for each type of request in both test tools. Test cases used different type of load (Ramp Up, Spike, Peak, and Fixed type in Postman and corresponding Thread Groups in JMeter), number of virtual users (VU), think time or delay, and test duration. ART values and values of 90th, 95th, 99th percentiles (P90, P95, P99) were collected for each TC and type of request from performance test reports in both test tools. Percentile values for each request and API were calculated using *numpy.percentile()* function in Python. The percentage deviation (D) from ART, calculated with Formula 1, highlights test tool stability, where a deviation under 20% indicates better stability:

$$D = \frac{P_p - ART}{ART} \times 100, \quad (1)$$

where P_p - the percentile value (e.g., P_{90} is the value of 90th percentile).

Percentile and D values for each request type were averaged across all 5 APIs, as shown in Table 1. Percentiles exceeded ART for both tools, indicating presence of performance degradation. The most significant values are highlighted in bold. Postman has a better ART and processes requests faster than JMeter. Postman shows minimal differences in P90 and P95 D for POST (6.855% and 0.112%) and DELETE requests (11.364% and 17.611%), showing good stability. Moderate and high differences in P90 D and P95 D for GET (26.45% and 68.236%) requests suggest stability issues and performance fluctuations, which impact the user experience. Additionally, JMeter demonstrates better performance in P99 under demanding conditions for PUT requests and in all scenarios for GET requests.

Table 1.

Aggregated mean values of ART, percentiles, and percentage deviation for different requests in Postman and JMeter

Method	Tool	ART, sec	P90, sec	P95, sec	P99, sec	P90 D, %	P95 D, %	P99 D, %
GET	Postman	166,175	298,48	392,650	521,656	101,240	158,613	311,005
GET	JMeter	181,65	306,32	326,500	496,108	74,790	90,376	267,864
POST	Postman	148,1	188,82	219,400	328,572	20,233	36,872	106,621
POST	JMeter	147,175	194,04	207,600	385,248	27,088	36,760	161,460
PUT	Postman	144,925	193,46	224,800	643,546	25,320	43,121	399,459
PUT	JMeter	152,075	234,98	286,100	364,792	53,631	82,779	146,312
DElete	Postman	166,225	200,04	210,69	434,812	16,309	22,629	160,728
Delete	JMeter	163,325	212,3	232,66	581,036	27,673	40,240	229,010

In conclusion, Postman with a lower ART improves response time and efficiency under average loads, but does not ensure stability in the presence of significant outliers. JMeter, with smaller deviations for GET and PUT requests, is more stable and predictable, which is crucial for testing complex systems under fluctuating load conditions.

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COMPARATIVE ANALYSIS OF UAV SIMULATION PLATFORMS: CHALLENGES, OPPORTUNITIES, AND FUTURE DIRECTIONS

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ПОРІВНЯЛЬНИЙ АНАЛІЗ ПЛАТФОРМ ДЛЯ МОДЕЛЮВАННЯ БПЛА: ВИКЛИКИ, МОЖЛИВОСТІ ТА ПЕРСПЕКТИВИ РОЗВИТКУ

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