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Methods for Integrating Chatbots Into Customer Experience Management Systems

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Abstract: The article explores approaches to integrating chatbots into customer interaction management systems, as well as other digital platforms such as educational, financial, and marketing environments. The aim is to study architectural solutions and algorithms that ensure the productive operation of chatbots in terms of performance, scalability, and flexibility in various user interaction scenarios.

The methodology is based on comparing centralized and decentralized integration models. It examines data transfer protocols such as REST API, GraphQL, and WebSocket. Special attention is paid to natural language processing algorithms, including transformers like BERT and GPT, which can interpret queries, maintain context, and quickly adapt to changes in communication scenarios.

The article also discusses hybrid models combining automation with human operators for handling non-standard situations. Approaches focused on active learning are examined, which improve chatbot performance in real-time.

The results demonstrate that the use of chatbots in customer interaction management systems and e-commerce improves query processing, speeds up responses, and enhances personalization. The application of data analytics opens opportunities for predicting customer behavior and generating proposals tailored to user needs. Issues of data security, encryption, authentication, and access control, which are critical for regulatory compliance, are also considered.

The conclusions highlight the necessity of a comprehensive approach to chatbot design, selecting flexible architectural solutions, adapting to business processes, and implementing machine learning

algorithms. The proposed methods are expected to benefit software developers, analysts, marketers, and managers engaged in digital transformation.

Keywords: chatbots, CRM systems, integration, natural language processing, REST API, machine learning, scalability, digital transformation, data security, personalization.

Introduction: Modern business digital transformation processes demand improved customer service quality, faster query processing, and enhanced personalization of interactions. Amidst increasing globalization and intensifying competition, companies face the need to optimize these aspects. Chatbots serve as an effective solution for automating customer communication. These systems utilize algorithms that minimize time spent on task resolution and analyze user behavior to generate personalized recommendations.

The integration of chatbots is becoming increasingly relevant due to the growing volume of data requiring rapid processing across multiple interaction channels. Organizations operating in e-commerce, financial technology, and education are actively adopting such systems to provide support, handle queries, and offer recommendations. Implementing these solutions into existing customer service management structures and digital platforms demands significant preparation and resolution of technical challenges.

Advancements in natural language processing technologies, including neural networks, open up new opportunities for chatbots. These systems can understand the context of user queries, generate precise responses, maintain a coherent dialogue, and handle multiple interactions sequentially. The process of designing chatbots involves selecting appropriate architectural solutions.

The integration of chatbots into small, medium-sized businesses, and micro-enterprises has drawn the attention of researchers. Selamat M. A. and Windasari N. A. [1] emphasize the importance of personalized recommendations, intuitive interfaces, and a human-centered approach in communication for attracting and retaining customers. Bednyak S. G. et al. [2, p. 33] explore the integration of chatbots with various communication channels, which accelerates response times, enhances information accuracy, and improves the customer experience.

The implementation of artificial intelligence (AI) and machine learning technologies into CRM systems enhances client data management and automates customer service. Li R. C. and Tee M. L. [3, pp 1092-1096] analyze the impact of AI algorithms on increasing the efficiency of customer engagement. In e-commerce, chatbots contribute to the creation of personalized customer service. Thatavarthi N. [6, pp. 1-5] studies the use of Angular and Node.js technologies to accelerate order processing. According to Santosh K. et al. [9, pp. 1135-1140], the application of GPT-4 in e-commerce chatbots increases the accuracy of query processing up to 95%, improving user interaction.

Chatbots also play a significant role in marketing strategies. Khoa B. T. [7, pp. 19-32] highlights their role in optimizing communications that influence buyer decision-making in online commerce. Mashkouk R. et al. [12, pp. 1-5] examine the automation of processes and the integration of chatbots into production chains, which increases operational efficiency.

In education, chatbots are becoming essential tools for supporting students by improving access to educational materials and enhancing interaction with learning platforms. Snekha S. and Ayyanathan N. [5, pp. 58-62] note that chatbots help students navigate academic processes, access information about schedules, exams, and consultations. Mohamed I. S., Abdelsalam M., and Moawad I. F. [11, pp. 351-355] demonstrate how ChatGPT enables natural communication and provides recommendations to enhance the educational process.

In the financial sector, chatbots automate loan application processing, reducing costs associated with data analysis and improving the accuracy of recommendations. Prathipa S. et al. [8, pp. 1-6] confirm that using chatbots in microcredit services enhances customer service and improves decision-making accuracy.

Giri U. et al. [10, pp. 118-123] investigate the impact of chatbot interface design on customer perception. Factors such as communication tone, response speed, and personalization are crucial for increasing user satisfaction. Kaushal V. and Yadav R. [4] underline the importance of omnichannel support and the ability of chatbots to adapt to various communication channels, thereby enhancing customer interactions in the B2B sector.

In turn, when presenting statistics, the source [13] was used, the information from which is posted on the official website of the Tidio company.

The purpose of this study is to examine architectural solutions and algorithms that ensure the efficient operation of chatbots in terms of performance, scalability, and flexibility across diverse user interaction scenarios.

The methodology of this study is based on comparing centralized and decentralized integration models.

RESULTS

Modern business platforms demand speed and accuracy in processing queries. The complexity of communication flows and the growing volume of data necessitate the adoption of technologies capable of processing information in real-time and adapting to changing interaction conditions. In this context, chatbots become integral components of digital solutions for managing customer interactions.

It is projected that by 2028, the global chatbot market will reach $15.5 billion, compared to $4.7 billion in 2020 (Fig. 1). With an annual growth rate of approximately 23%, this surge reflects the increasing demand for efficient and cost-effective artificial intelligence solutions

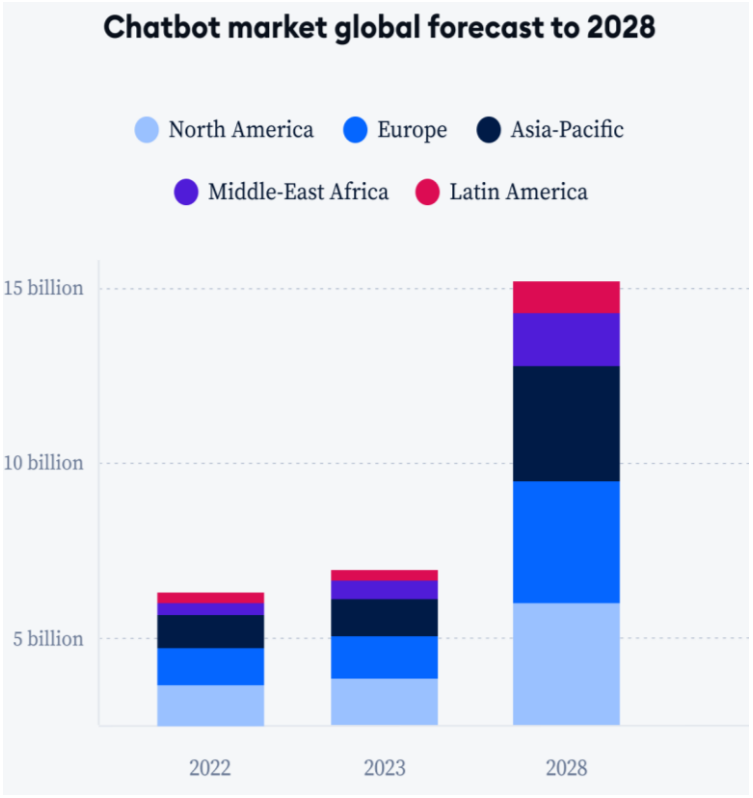

Fig. 1. Global forecast of chatbot market development until 2028 [13].

Small companies are rapidly adopting chatbots because third-party chatbot developers can easily integrate their solutions. In contrast, larger companies typically employ a different approach by developing proprietary solutions, which significantly lengthens the development process. Figure 2 below illustrates the readiness of various companies to implement chatbot technologies.

A key trend for 2024 and beyond is the rise of AI-driven chatbots, led by models such as GPT-4 and other large language models (LLMs). GPT-4, developed by OpenAI, represents a significant advancement over GPT-3, offering more accurate and human-like language processing capabilities [13].

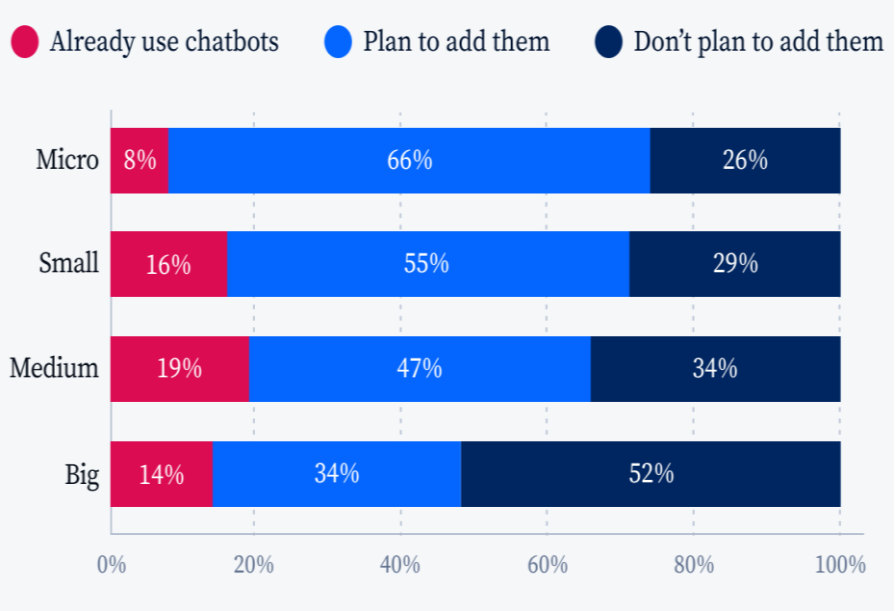

Fig. 2. Willingness to implement chatbot technologies by different companies [13].

The process of integrating chatbots is based on either centralized or decentralized architecture. In a centralized model, interaction management is conducted through a single point—a central server that exchanges data with external systems via APIs. This model simplifies management but introduces a single point of failure. Decentralized architecture, which utilizes microservices, ensures the independence of each component, enabling flexible system scaling and effective adaptation to changes [1, 2, 6, 9].

Several protocols are used to connect chatbots with external systems, which are visually represented in Figure 3.

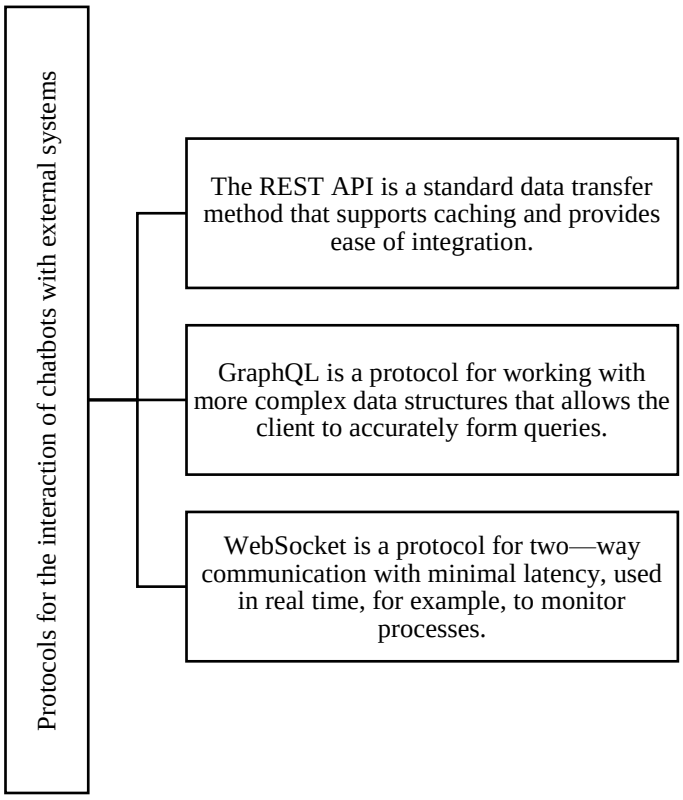

Fig.3. Protocols of interaction of chatbots with external systems [1, 2, 6, 9]

Chatbots leverage natural language processing (NLP) models to perform semantic analysis of user queries. Transformers like BERT and GPT enable the recognition of contextual dependencies and provide accurate answers to ambiguously phrased questions.

Classification and clustering algorithms help predict user actions and adapt communication scenarios accordingly. Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) process textual and voice-based requests with minimal distortions.

Long-term memory mechanisms based on LSTM architecture and attention mechanisms enable maintaining extended dialogues while preserving context across multiple sessions. This feature is critical for B2B systems, where queries are often complex, requiring repeated clarifications.

The integration of chatbots into customer interaction management systems is a multi-level process involving the development of architecture, data processing algorithms, and security mechanisms. Technically, this process is grounded in microservices architecture principles, allowing the creation of scalable and fault-tolerant solutions. Within this structure, the system is divided into several functional layers, each with clearly defined tasks.

- Presentation Layer: Processes user requests, providing interaction interfaces via web applications, messengers, and voice assistants.
- Logical Layer: Manages dialogues, analyzes user intents, and processes information.
- Integration Layer: Ensures connectivity with external platforms such as CRM, ERP, databases, and analytics systems through API protocols and intermediary services.

Data transfer between system components is implemented through REST API, GraphQL, and gRPC. REST API serves as the standard for most CRM platforms, simplifying integration. However, for working with more complex data structures, GraphQL is preferred, as it allows for querying only the required fields. The gRPC protocol is used in high-load systems where data transmission speed is critical. For real-time interaction, WebSocket connections are utilized. These channels are ideal for handling events requiring immediate reactions, such as updates on application statuses or changes in user profiles.

At the core of query processing are NLP algorithms that ensure understanding of text and speech. Initially, data undergoes tokenization, stemming, and lemmatization. This is followed by syntactic and semantic analysis to extract key entities and comprehend user intent. Modern NLP models, such as BERT and GPT, employ attention mechanisms and contextual vector representations, facilitating precise query understanding. Machine learning algorithms like RNNs and transformers analyze data sequences, maintaining context over multiple sessions [3, 7, 12].

Various approaches are employed to manage dialogue states. Simple scenarios are implemented through rule-based systems, which establish fixed transitions between stages of interaction. For dynamic systems, such as technical support, adaptive models are used that adjust based on context. For instance, a chatbot can automatically switch from autonomous query handling to redirecting queries to a live operator if the issue requires more in-depth resolution. Systems based on neural networks with long-term memory retain information about previous interactions, which is essential for extended processes like contract negotiations or deal management.

Depending on the structure of information, relational databases such as PostgreSQL and MySQL, or NoSQL solutions like MongoDB and Cassandra, are utilized. Relational databases are suited for transactional data storage, while NoSQL databases are ideal for unstructured data such as conversation logs and metadata. Graph databases, such as Neo4j, allow modeling complex relationships between entities, such as client-agent interactions or event chains in business processes. For faster data access, caching systems like Redis and Memcached are frequently employed.

To ensure scalability and reliability, cloud platforms and containerization technologies are applied. Tools like Docker and Kubernetes facilitate the deployment of microservices in containers, enabling flexible responses to changing workloads. Cloud platforms such as AWS, Google Cloud, and Microsoft Azure offer tools for traffic balancing, database management, and performance monitoring. Load balancers distribute requests across chatbot instances, while monitoring systems track metrics like response time and the number of unprocessed queries [5, 11].

Data security is a critical consideration as chatbots handle sensitive information. Encryption using algorithms like AES-256 protects data during transmission and storage. Anonymization and tokenization minimize the risks of personal data leaks. Multi-factor authentication and intrusion detection systems safeguard against attacks by identifying suspicious activities. Audit logs and data transaction

records help reconstruct incidents and enforce compliance with security policies.

The integration of chatbots with multichannel platforms broadens the scope of client interactions across various channels: messengers (WhatsApp, Telegram), social networks (Facebook, Instagram), and voice assistants (Google Assistant, Amazon Alexa). Unified interfaces are developed to manage data and dialogues regardless of the request channel. Interactions with contact centers are facilitated via SIP protocols and CPaaS platforms, which unify text and voice channels into a single query processing system.

Active learning has become a significant area in chatbot development, enabling adaptation to new scenarios based on real-world data. This approach is particularly relevant for markets with evolving conditions. The integration of chatbots with predictive analytics systems unlocks the potential for anticipating client needs based on behavioral data and offering personalized solutions [2, 4, 7].

For requests requiring human intervention, escalation mechanisms are employed, transferring the query to a live operator. Hybrid interaction models strike a balance between automation and human engagement, reducing response time and enhancing service quality.

To improve chatbot performance, monitoring systems are implemented to track key metrics. These metrics are detailed in Figure 3.

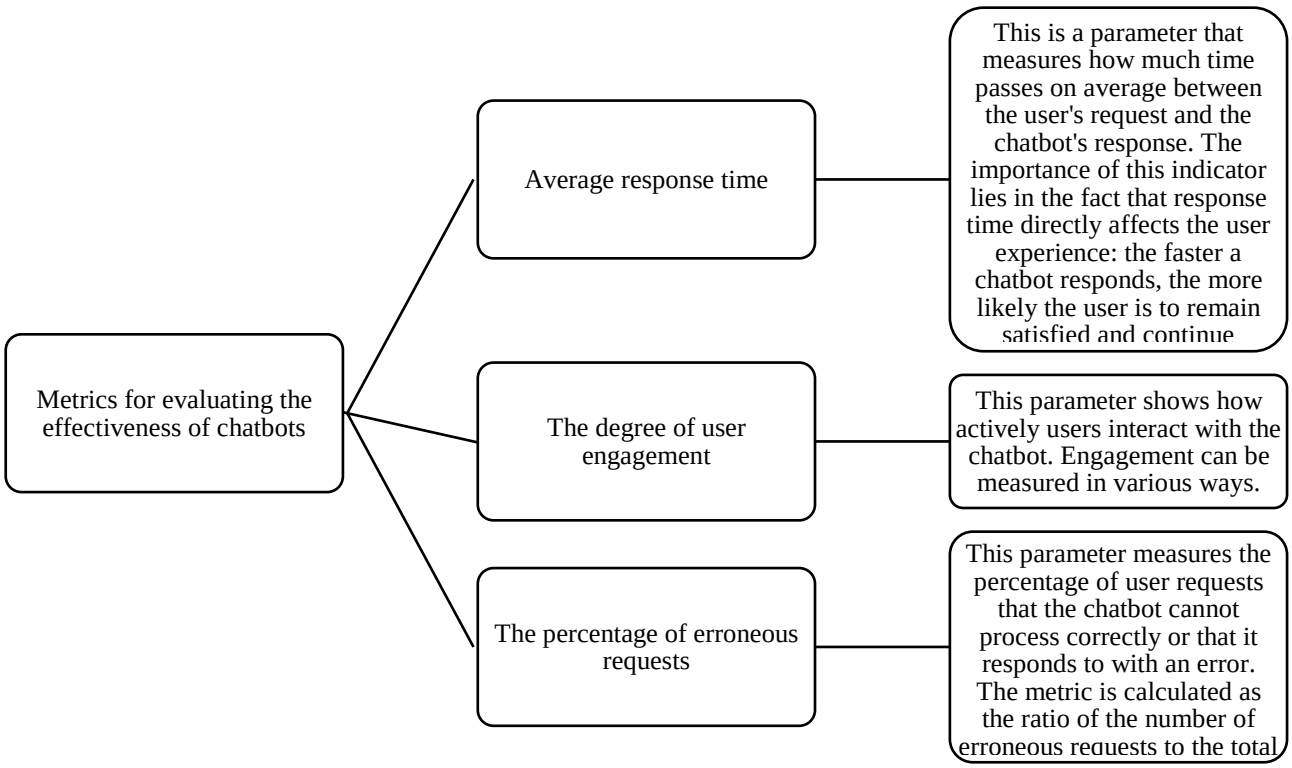

Fig.4. Metrics for evaluating the effectiveness of chatbots [4, 8, 10]

Logging systems and event log analysis tools assist in promptly identifying failures, thereby minimizing the time needed for adjustments.

Active learning methods ensure the continuous improvement of algorithms based on new data and feedback. This is especially crucial for systems operating under rapidly changing market conditions. Next, Table 1 outlines the advantages and disadvantages of using chatbots in customer interaction management systems.

Table 1. Advantages and disadvantages of using chatbots in customer interaction management systems (compiled by the author).

Advantages	Disadvantages
Chatbots can automatically handle simple queries, such as order status, schedules, or general information, reducing the workload for human operators.	Chatbots face challenges when dealing with complex or unconventional queries that require creativity and flexibility, necessitating human intervention.
Chatbots operate 24/7, providing clients with constant availability and instant responses to inquiries at any time.	Chatbots do not always correctly interpret user context or intent, which can result in inaccurate responses.
Automation through chatbots reduces the need for staff to handle standard queries, lowering customer service costs.	Chatbots cannot fully replace human interaction, affecting service quality, especially when emotional support or complex consultations are needed.
Chatbots can process multiple requests simultaneously, increasing service speed and reducing wait times.	Chatbots cannot adapt to new or evolving situations without additional training or programming, limiting their flexibility.
Instant responses to standard questions and the convenience of using chatbots enhance overall customer satisfaction.	Chatbots require ongoing updates and training to accurately understand queries and maintain relevant answers, necessitating resource investment.
Modern chatbots can integrate with CRM systems to provide personalized service, including product recommendations or purchase history.	Systems can encounter failures or errors due to technical issues, inaccurate data, or poor integration with other platforms.
Chatbots can perform routine tasks, allowing human operators to focus on more complex issues.	Chatbots lack the ability to perceive emotions or the nuances of human interaction, which can degrade service quality in stressful or emotionally charged situations.

The integration of chatbots into customer interaction management systems encompasses a wide range of technologies. The use of modern data processing methods, cloud platforms, and neural networks makes these systems efficient, flexible, and adaptable to evolving market conditions.

Recommendations for implementing chatbots in customer interaction management systems

Based on the conducted research, a set of practical recommendations has been formulated to guide the integration of chatbots into customer interaction management systems. It is crucial to define the objectives the system aims to achieve. One primary goal is the automation of routine operations, reducing the workload on staff. Chatbots handle standard user requests such as checking order status, answering frequently asked questions, and scheduling appointments. This reduces wait times, eases the workload of employees, and, thanks to 24/7

availability, accelerates the service process.

Implementation requires selecting the right platform and technologies to ensure seamless integration with the CRM system. The chatbot must have access to customer data to provide accurate and personalized responses. Utilizing information about past purchases, preferences, and interaction history enhances service quality by offering tailored recommendations. To achieve this, the chatbot should be equipped with natural language processing (NLP) algorithms to ensure accuracy in understanding user queries.

Configuring the chatbot requires a thorough approach. In the initial phase, it should be set up to handle standard queries effectively in daily operations. Training should rely on real data collected from customers. However, the launch is only the first step. The system must be regularly updated and tested to adapt to business changes. Additionally, collecting user feedback is essential for promptly addressing shortcomings.

Equally important is the creation of a scalable system. The chatbot should be able to adapt to business growth by integrating new features and connecting additional services. For companies operating in international markets, it is critical that the bot supports multilingual capabilities, ensuring high-quality interactions with users from different countries.

Testing and monitoring the system's performance should become integral to its operation. The launch of a chatbot is not the end of the process but the beginning of ongoing effectiveness analysis and interaction scenario checks. Analytical tools should be used to monitor interactions, identify issues, and address them in a timely manner.

Adopting an omnichannel approach allows the integration of the chatbot with various customer interaction channels, such as email, social media, and phone calls. This enables employees to access relevant communication data, ensuring a personalized approach regardless of the channel used.

In conclusion, the implementation process should follow a phased approach. It is recommended to start with a pilot project involving a limited number of users, enabling the system to be tested and refined before full deployment. This approach helps identify and resolve issues early. However, it is essential to remember that chatbot implementation requires continuous improvement and adaptation. The bot must evolve, analyze new data, and enhance its accuracy and efficiency over time.

CONCLUSION

The technologies discussed automate service processes, personalize customer interactions, and improve satisfaction levels. The use of artificial intelligence and natural language processing methods, such as BERT and GPT models, enables the creation of systems that maintain conversational context, adapt to diverse scenarios, and provide rapid responses.

The analysis of architectural solutions for chatbot integration highlighted that the choice between centralized and decentralized models depends on the requirements for system scalability and stability. Centralized architectures simplify data and interaction logic management, while decentralized solutions offer greater flexibility and resilience to failures. Protocols like REST API, GraphQL, and WebSocket optimize data exchange between chatbots and CRM systems, reducing latency and enhancing performance.

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