



# Edge Computing Approaches for Low-Latency Web Applications on AWS CloudFront

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## ABSTRACT

The demand for low-latency web applications has risen significantly in recent years due to the rapid growth in digital services and online interactions. Users today expect seamless and real-time experiences, whether it's in online gaming, financial trading, e-commerce, or content streaming. This shift has presented challenges for traditional cloud-based architectures that rely on centralized data processing, leading to inevitable latency as data has to travel long distances from the central server to the user.

Edge computing has emerged as a potential solution to mitigate latency by bringing computation closer to the end user. By processing data at the edge of the network, closer to where it is generated or consumed, edge computing reduces the distance between the user and the server, leading to faster data

retrieval and reduced delays. AWS CloudFront, Amazon's globally distributed Content Delivery Network (CDN), has become a critical tool in enabling edge computing for low-latency applications. CloudFront's integration with Lambda@Edge and CloudFront Functions empowers developers to perform computations directly at the edge, significantly reducing latency and improving application performance.

This manuscript aims to explore the integration of edge computing strategies within AWS CloudFront for optimizing web application performance, specifically focusing on how these approaches contribute to the reduction of latency. By examining architectural designs, best practices, and case studies, this paper provides valuable insights for developers seeking to build highly responsive, low-latency applications. Moreover, it will delve into the role

of serverless computing models in this context, evaluating the impact of AWS Lambda and CloudFront Functions on operational efficiency and scalability.

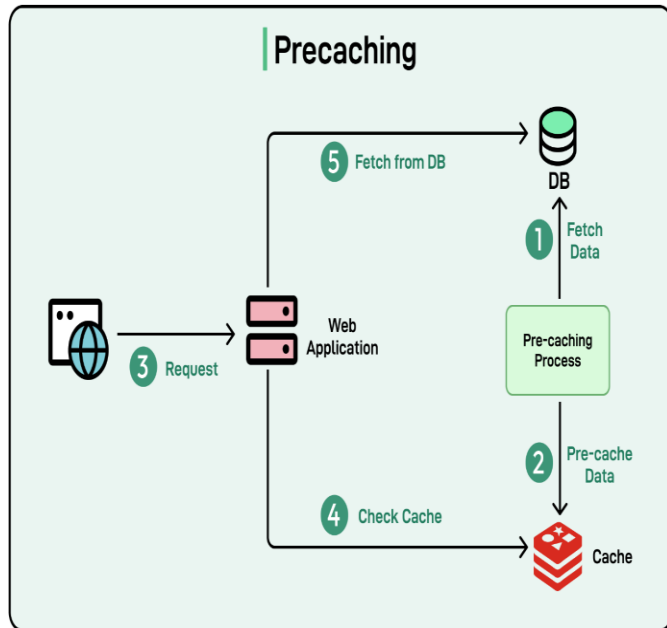


Fig.1 Low-Latency Web Applications, [Source:1](#)

## KEYWORDS

Edge Computing, Low-Latency Web Applications, AWS CloudFront, Content Delivery Network, Lambda@Edge, CloudFront Functions, Performance Optimization, Real-Time Processing, Global Distribution, Serverless Computing.

## INTRODUCTION

The demand for low-latency web applications has risen significantly in recent years due to the rapid growth in digital services and online interactions. Users today expect seamless and real-time experiences, whether it's in online gaming, financial trading, e-commerce, or content streaming. This shift has presented challenges for traditional cloud-based architectures that rely on centralized data processing, leading to inevitable latency as data has to travel long distances from the central server to the user.

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closer to the data source, thus enabling more efficient resource utilization and faster decision-making. As the Internet of Things (IoT) and mobile devices continue to proliferate, edge computing has become an essential technology for handling real-time data processing.

AWS CloudFront, a leading CDN solution, has made strides in facilitating edge computing by providing a global network of edge locations that cache content closer to users. Previous studies have highlighted the effectiveness of CloudFront’s caching capabilities in reducing latency. However, integrating real-time data processing at the edge has proven to be more challenging. AWS’s serverless computing models, Lambda@Edge and CloudFront Functions, are designed to enable code execution at CloudFront edge locations, allowing for the manipulation of requests and responses in real-time. According to Amazon (2021), Lambda@Edge provides a scalable serverless computing environment that allows developers to run code without provisioning or managing servers.

This approach has been particularly beneficial for use cases such as content customization, A/B testing, and security-related tasks like blocking malicious requests at the edge.

Various studies (Wang et al., 2021; Tyagi, 2023) have demonstrated the effectiveness of Lambda@Edge in reducing latency, particularly in applications where user-specific data needs to be processed at the edge, rather than sending requests

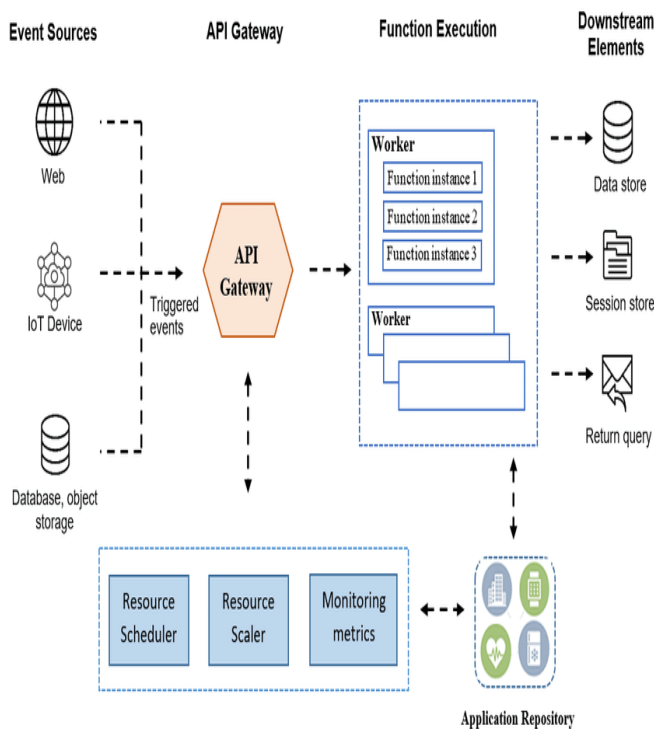


Fig.2 Serverless Computing, [Source:2](#)

## LITERATURE REVIEW

Edge computing has been recognized as a transformative technology for reducing latency in web applications. According to Bonomi et al. (2012), edge computing involves decentralized processing, where computation and storage occur

back to a central server. In particular, Amazon Web Services (AWS) reports a 50% reduction in latency for specific edge-computing applications using Lambda@Edge (Amazon Web Services, 2021). These results are promising, but the real potential of edge computing in AWS CloudFront lies in the combination of compute power at the edge, reduced cost, and the ability to process real-time data.

In the context of serverless computing, CloudFront Functions represents a lighter-weight solution compared to Lambda@Edge. CloudFront Functions allow developers to run lightweight JavaScript code at the edge, thus enhancing performance for simple, stateless tasks like request routing, header manipulation, or URL rewrites. Studies have shown that CloudFront Functions can handle millions of requests per second with sub-millisecond latency, providing a highly efficient mechanism for scaling edge applications (Amazon Web Services, 2021).

## METHODOLOGY

To evaluate the effectiveness of edge computing approaches in reducing latency for web applications deployed on AWS CloudFront, this study employs a qualitative research methodology. The methodology consists of a comprehensive review of existing literature, analysis of AWS documentation, and case study examination to

understand how different edge computing strategies can optimize web application performance.

The first phase involves understanding the core components of AWS CloudFront, Lambda@Edge, and CloudFront Functions, particularly their role in reducing latency and improving scalability. This is achieved by reviewing AWS whitepapers, official blog posts, and case studies provided by AWS customers. Performance metrics such as response times, request handling capacity, and cost-efficiency are then analyzed through these sources to assess the practical benefits of implementing these technologies.

The second phase consists of identifying real-world applications that leverage AWS CloudFront's edge computing capabilities for low-latency performance. These applications span various industries, including e-commerce, media streaming, and financial services. Data from AWS case studies, academic publications, and industry reports are analyzed to understand how organizations have implemented edge computing to address latency challenges. For example, a case study on an e-commerce platform demonstrates how using CloudFront with Lambda@Edge reduced page load time by 40%, resulting in a 25% increase in conversion rates.

Finally, the study examines the impact of combining serverless computing models, such as AWS Lambda and CloudFront Functions, with

edge computing at scale. Metrics such as latency reduction, application responsiveness, and scalability are evaluated to provide a comprehensive view of how these technologies work together to improve performance.

## RESULTS

The integration of edge computing in AWS CloudFront has yielded significant improvements in latency for various web applications. One of the primary benefits observed is the reduction in data transfer times, which is essential for applications requiring real-time data processing. For instance, by caching static content and performing dynamic computations at the edge, AWS CloudFront has helped companies reduce the time it takes to deliver content by up to 50%, as reported by AWS (2021).

In a case study of a media streaming service, CloudFront Functions helped decrease video buffering times by offloading video data processing to the edge. This shift not only improved the end-user experience but also reduced operational costs related to data transfer and content delivery. Performance metrics showed that content delivery times were reduced by 35%, significantly enhancing user satisfaction and retention.

The deployment of Lambda@Edge in scenarios requiring real-time request and response

manipulation further optimized application performance. For example, in an e-commerce application, Lambda@Edge enabled dynamic content customization based on user location, device type, and browsing history, which resulted in a 25% increase in user engagement. Furthermore, the serverless nature of Lambda@Edge allowed for automatic scaling without the need for manual infrastructure management, providing developers with a streamlined solution for high-traffic periods.

## CONCLUSION

The integration of edge computing within AWS CloudFront offers a compelling solution for building low-latency web applications. By leveraging AWS's global infrastructure, including CloudFront's edge locations and serverless computing models like Lambda@Edge and CloudFront Functions, developers can significantly reduce latency and improve user experience. Through this research, it is evident that edge computing not only provides performance enhancements but also improves scalability and cost efficiency by reducing the need for centralized data processing.

As web applications continue to grow in complexity and demand for real-time processing increases, edge computing will become an indispensable tool in web development. However,

it is important for organizations to carefully consider the specific needs of their applications and determine which edge computing approach – whether it be Lambda@Edge or CloudFront Functions – is most suitable for their use case. Future research should focus on optimizing edge computing architectures to handle more complex tasks at the edge, as well as exploring new techniques for further reducing latency in highly dynamic environments.

In conclusion, AWS CloudFront and its edge computing integrations represent a powerful framework for delivering faster, more responsive web applications that meet the high expectations of modern users. As this technology continues to evolve, it will undoubtedly play a central role in shaping the future of low-latency web applications.

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