

Event-Driven Delivery Platforms: Modernizing Continuous Deployment Using AWS CDK and Serverless Automation

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ABSTRACT

Continuous deployment pipelines are critical for accelerating software delivery, yet traditional approaches often struggle with scalability, reliability, and maintainability. This study investigates the design and evaluation of an event driven delivery platform using AWS Cloud Development Kit (CDK) and serverless automation to modernize continuous deployment workflows. The platform leverages event driven triggers, serverless functions, and programmatic infrastructure definitions to automate application and infrastructure deployments while enforcing safety policies. Experimental results across multiple deployment scenarios demonstrate efficient execution, dynamic resource utilization, low error rates, and rapid rollback capabilities. The reuse of Infrastructure as Code modules and modular serverless functions enhances maintainability and consistency, while integrated validation mechanisms reduce the risk of unsafe deployments. The study provides empirical evidence that event driven, serverless deployment platforms can improve operational efficiency and reliability compared to traditional pipelines. These findings highlight practical strategies for implementing serverless automation, event driven coordination, and IaC-driven deployments, offering actionable insights for DevOps practitioners and cloud architects. Implications for architecture design, fault tolerance, and deployment scalability are discussed, with recommendations for future research on multi-cloud integrations and extended cost analysis.

Keywords: AWS CDK, Cloud Computing, Continuous Deployment, Deployment Pipeline, Event Driven Delivery, Infrastructure as Code, Serverless Automation.

1. INTRODUCTION

Continuous deployment has become a defining practice in contemporary software engineering, particularly within cloud based environments where rapid iteration, reliability, and scalability are expected outcomes of well designed delivery pipelines. As organizations increase their reliance on cloud services, traditional deployment mechanisms that depend on static infrastructure provisioning and tightly coupled pipelines have shown limitations in responsiveness, fault isolation, and operational efficiency (Humble & Farley, 2010; Rahman et al., 2023). These limitations have encouraged a shift toward architectural and operational models that better align with distributed cloud systems, especially those based on event driven principles and serverless execution.

Event driven architectures emphasize decoupled components that communicate through events rather than direct service calls. This approach has been widely recognized as suitable for cloud native systems due to its ability to support asynchronous processing, elasticity, and resilience under variable workloads (Baldini et al., 2017; Eismann et al., 2021). In parallel, serverless computing has emerged as an execution model that abstracts infrastructure management from developers by enabling function based execution triggered by events. Platforms such as AWS Lambda operationalize this model by providing automatic scaling, managed runtime environments, and native integration with cloud services that emit or consume events (Amazon Web Services, 2023b; Van Eyk et al., 2018).

The convergence of event driven architecture and serverless computing has had significant implications for software delivery practices. Deployment pipelines themselves are increasingly implemented as event driven systems, where code changes, configuration updates, and infrastructure modifications generate events that trigger automated validation, provisioning, and release actions (Adzic & Chatley, 2017). This approach contrasts with monolithic continuous integration and deployment pipelines that rely on sequential execution stages and centralized orchestration tools. Research indicates that event driven delivery mechanisms can improve fault isolation, reduce

idle resource consumption, and enable more granular control over deployment workflows (Jonas et al., 2019; Shahin et al., 2017).

Infrastructure as Code has played a foundational role in enabling this shift. By representing infrastructure configurations as version controlled code artifacts, IaC supports repeatable provisioning, automated validation, and integration with software delivery pipelines (Morris, 2016). Within the AWS ecosystem, services such as AWS CloudFormation and the AWS Cloud Development Kit have formalized this practice by providing declarative and programmatic models for defining cloud resources (Amazon Web Services, 2022). The AWS CDK extends traditional IaC approaches by allowing infrastructure definitions to be expressed using general purpose programming languages, thereby supporting abstraction, reuse, and integration with application code. Studies comparing IaC tools suggest that higher level abstractions such as those provided by CDK can reduce configuration errors and improve maintainability in complex deployment environments (Pessa, 2023).

Despite these advances, existing research has often examined serverless computing, event driven systems, and continuous deployment as separate concerns. Surveys and systematic reviews have focused primarily on performance characteristics, economic trade offs, and application design patterns in serverless environments (Eivy & Weinman, 2017). Other studies have explored continuous deployment practices and DevOps pipelines without explicitly addressing how event driven and serverless models can be applied to the delivery infrastructure itself (Rahman et al., 2023; Shafiei et al., 2022). This separation has resulted in limited empirical and architectural guidance on how to design delivery platforms that fully exploit event driven execution and infrastructure automation.

The need for such guidance is particularly evident in large scale cloud environments where deployment frequency, system complexity, and operational risk increase concurrently. Research on serverless workloads at major cloud providers demonstrates that deployment and configuration activities generate highly variable and bursty workloads, making them suitable candidates for event driven execution models (Shahrad et al., 2020). Furthermore, studies on continuous infrastructure deployment highlight the importance of safety mechanisms, validation stages, and rollback strategies when infrastructure changes are applied automatically (Amazon Web Services, 2022). Integrating these concerns within an event driven delivery platform requires a coherent architectural approach that combines IaC, serverless execution, and continuous deployment principles.

This study addresses this gap by examining how event driven delivery platforms can be designed and implemented using AWS CDK and serverless automation to modernize continuous deployment processes. The research focuses on architectural patterns, automation workflows, and operational considerations that support scalable and reliable deployment pipelines. By synthesizing existing literature and aligning with established cloud engineering practices, the study aims to contribute a structured perspective on how event driven and serverless models can be applied beyond application logic to the software delivery lifecycle itself. The findings are intended to inform both researchers and practitioners seeking to design deployment systems that align with the operational realities of modern cloud environments.

2. LITERATURE REVIEW

The literature relevant to event driven delivery platforms spans several interconnected domains, including serverless computing, event driven architecture, continuous deployment practices, and infrastructure as code. Prior studies provide theoretical foundations, architectural models, and empirical observations that inform how modern deployment systems can be structured using cloud native services. This section reviews key contributions in these areas, with emphasis on concepts and findings that directly relate to delivery automation and deployment modernization.

2.1 Serverless Computing as an Execution Model

Serverless computing has been extensively studied as a cloud execution paradigm that abstracts infrastructure provisioning and resource management away from developers. Early academic discussions characterized serverless platforms as Function as a Service models, where discrete functions are executed in response to events and billed based on execution time rather than reserved capacity (Baldini et al., 2017). This model has been shown to support fine grained scalability and operational simplicity, particularly for workloads with unpredictable or intermittent demand.

Several surveys and systematic reviews have consolidated the state of research on serverless computing. Shafiei et al. (2022) analyzed opportunities and challenges associated with serverless platforms, identifying elasticity, reduced operational burden, and rapid deployment as major advantages. At the same time, they highlighted issues related to cold start latency, observability, and testing complexity. These characteristics are relevant not only for application workloads but also for deployment automation tasks, which often involve bursty execution patterns triggered by code or configuration changes.

Van Eyk et al. (2018) further examined serverless computing as an evolution of cloud service models, positioning it beyond traditional Platform as a Service offerings. Their work emphasized that serverless systems promote decomposition of logic into small, event triggered units, encouraging architectural decoupling. This property aligns closely with the needs of deployment pipelines, where independent stages such as validation, provisioning, and release can be triggered asynchronously. Empirical observations from large scale cloud providers also confirm that serverless workloads commonly exhibit short execution times and high concurrency, making them suitable for deployment related tasks such as infrastructure synthesis and policy checks (Shahrad et al., 2020).

Economic considerations have also been addressed in the literature. Eivy and Weinman (2017) cautioned that serverless platforms introduce different cost structures compared to long running services, which can lead to inefficiencies if not properly designed. For delivery platforms, this implies that event driven automation must be carefully scoped to avoid excessive invocation overhead. Nonetheless, studies generally agree that for sporadic and event triggered processes, serverless execution offers favorable cost efficiency and operational flexibility (Jonas et al., 2019).

2.2 Event Driven Architecture in Cloud Systems

Event driven architecture has been recognized as a suitable architectural style for distributed cloud systems due to its emphasis on loose coupling and asynchronous communication. Baldini et al. (2017) identified event driven interaction as a core principle underlying many serverless platforms, where events emitted by storage services, messaging systems, or code repositories initiate execution. This architectural style reduces dependencies between components and allows systems to scale independently in response to workload changes.

Eismann et al. (2021) provided a structured review of serverless use cases and noted that event driven mechanisms are central to managing variability and fault tolerance in distributed systems. Their analysis showed that event based coordination enables systems to isolate failures and retry operations without affecting unrelated components. These properties are directly applicable to deployment workflows, where partial failures such as failed tests or misconfigured resources should not cascade across the entire pipeline.

Research on specification and modeling of serverless systems has also contributed to understanding event driven behavior. Van Eyk et al. (2018) proposed formal models for describing serverless execution and event flows, highlighting the importance of explicit trigger definitions and execution boundaries. Such models are valuable for reasoning about deployment pipelines that involve multiple event sources, including version control systems, artifact repositories, and cloud resource state changes.

In cloud orchestration research, Wettinger et al. (2014) examined whether existing orchestration tools were suitable for dynamic cloud environments. Their findings suggested that traditional orchestration approaches often struggle with highly dynamic and event driven scenarios. This limitation has motivated the adoption of event based coordination mechanisms that rely on messaging services and reactive execution rather than centralized control. These insights support the argument that deployment platforms benefit from event driven designs rather than rigid, stage based pipelines.

2.3 Continuous Deployment and Automation Foundations

Continuous deployment practices have been studied extensively within the broader context of DevOps and agile software development. Humble and Farley (2010) provided foundational principles for automated build, test, and deployment pipelines, emphasizing repeatability and fast feedback. Subsequent empirical studies confirmed that continuous integration and deployment tools improve release frequency and software quality when properly adopted (Rahman et al., 2023).

More recent research has examined how these practices translate to cloud environments. Humble and Farley (2010) observed that cloud based deployment pipelines must accommodate rapid infrastructure changes alongside application updates. Their findings suggest that automation frameworks need to integrate infrastructure provisioning and configuration management as first class concerns. This observation aligns with the growing emphasis on infrastructure as code as a mechanism for managing cloud resources within deployment workflows.

While continuous deployment literature provides strong guidance on process and tooling, fewer studies explicitly address how event driven and serverless paradigms can reshape deployment automation itself. Existing work often assumes long running pipeline servers and sequential execution stages. This gap highlights the need to synthesize insights from serverless and event driven research with continuous deployment practices, which forms the focus of the remaining literature review and the subsequent sections of this study.

2.4 Infrastructure as Code and Deployment Automation

Infrastructure as Code has been widely recognized as a foundational practice for managing cloud resources in automated delivery environments. Morris (2016) defined IaC as the practice of representing infrastructure configurations using machine readable definitions that can be version controlled, tested, and deployed in the same manner as application code. This paradigm has been shown to improve consistency, reduce configuration drift, and enable repeatable deployments across environments. In cloud based continuous deployment pipelines, IaC enables infrastructure changes to be integrated directly into delivery workflows rather than treated as separate operational tasks.

Empirical research supports the role of IaC in improving deployment reliability. Wettinger et al. (2014) observed that automated provisioning tools reduce manual intervention and enable faster adaptation to changing workload requirements. However, they also noted that traditional orchestration tools often struggle with highly dynamic environments, especially when infrastructure changes are frequent and interdependent. This limitation has driven interest in higher level IaC abstractions that can better express complex relationships among cloud resources.

Within the AWS ecosystem, CloudFormation has served as a primary IaC mechanism, providing declarative templates for resource provisioning. The introduction of the AWS Cloud Development Kit represents a further evolution of this approach by enabling infrastructure definitions to be expressed using general purpose programming languages (Amazon Science, 2022). This capability allows developers to apply familiar software engineering constructs such as loops, conditionals, and modularization when defining infrastructure, which is difficult to achieve with purely declarative templates.

Comparative studies have examined the implications of these abstractions. Pessa (2023) compared AWS CDK with other IaC tools and found that higher level abstractions can reduce code duplication and improve maintainability, particularly in complex multi service deployments. These findings are relevant for event driven delivery platforms, where deployment logic often spans multiple services and environments. By enabling reusable constructs and shared libraries, CDK supports the creation of standardized deployment components that can be triggered by events within a pipeline.

2.5 Safety and Governance in Continuous Infrastructure Deployment

As deployment automation becomes more sophisticated, concerns about safety and governance have gained attention in the literature. Automated infrastructure changes can introduce systemic risk if errors propagate rapidly across environments. Research conducted by Amazon Science (2022) addressed this issue by examining techniques for safer continuous infrastructure deployments. Their work emphasized the importance of validation, policy enforcement, and staged rollouts when applying infrastructure changes through automated pipelines.

One key insight from this research is that safety mechanisms must be integrated directly into the deployment process rather than applied as external controls. Event driven architectures provide a natural mechanism for enforcing such controls by enabling validation and approval steps to be triggered automatically in response to infrastructure change events. For example, policy checks can be executed as serverless functions before deployment events proceed to provisioning stages. This approach aligns with the broader literature on event driven systems, which emphasizes decoupled control flows and explicit state transitions (Baldini et al., 2017).

Governance considerations also extend to observability and traceability. Eismann et al. (2021) noted that serverless systems require explicit instrumentation to support monitoring and debugging due to their distributed and ephemeral nature. In the context of delivery platforms, this implies that deployment events, execution outcomes, and infrastructure state changes must be logged and correlated across services. Studies on continuous deployment practices highlight that traceability is essential for diagnosing failures and supporting rollback strategies (Humble & Farley, 2010).

2.6 Architectural Patterns for Event Driven Delivery Platforms

While much of the literature focuses on application architectures, several studies provide insights that can be applied to delivery platforms. Baldini et al. (2017) described architectural patterns in which events emitted by cloud services serve as primary coordination mechanisms. These patterns include publish subscribe messaging, fan out processing, and reactive workflows, all of which can be adapted to deployment automation scenarios.

Jonas et al. (2019) argued that cloud programming models should align with the operational characteristics of cloud platforms, particularly elasticity and managed execution. Applying this perspective to deployment systems suggests that pipelines themselves should be designed as cloud native workloads rather than as long running services. Serverless functions triggered by repository updates, artifact availability, or infrastructure state changes exemplify this approach.

Empirical observations from Shahrads et al. (2020) further support this view by demonstrating that serverless workloads often exhibit characteristics similar to deployment tasks, including short execution times and irregular invocation patterns. These findings indicate that serverless execution is well suited for deployment automation, especially when combined with event driven coordination.

Table 1 illustrates a synthesis of architectural elements commonly discussed in the literature and their relevance to event driven delivery platforms.

Table 1: Architectural Elements and Their Relevance to Event Driven Delivery Platforms

Architectural Element	Description in Literature	Relevance to Delivery Platforms
Event triggers	Asynchronous signals initiating execution (Baldini et al., 2017)	Trigger deployment stages based on code or infrastructure changes
Serverless functions	Managed execution units (Van Eyk et al., 2018)	Execute validation, synthesis, and deployment tasks
IaC abstractions	Programmatic infrastructure definitions (Morris, 2016)	Enable repeatable and versioned infrastructure changes
Policy enforcement	Automated safety checks (Amazon Science, 2022)	Prevent unsafe infrastructure deployments

In addition to tabular synthesis, several authors advocate the use of architectural diagrams to clarify event flows and component interactions. For this study, an architectural diagram depicting an event driven delivery platform would typically include a version control system emitting events, messaging services routing those events, serverless functions performing deployment tasks, and IaC tools applying infrastructure changes. Such a diagram aligns with patterns described in the reviewed literature and supports clear communication of system design.

2.7 Research Gaps and Implications

Despite the breadth of research on serverless computing, event driven architecture, and continuous deployment, gaps remain in how these concepts are integrated. Many studies focus on individual components or practices without addressing the end to end architecture of delivery platforms. In particular, limited work has examined how AWS CDK can be used as a central mechanism for defining and orchestrating event driven deployment workflows.

The reviewed literature suggests that combining serverless execution, event driven coordination, and IaC abstractions offers a promising approach to modernizing continuous deployment. However, further research is needed to formalize architectural patterns, evaluate operational trade offs, and assess safety mechanisms in real world deployment scenarios. These gaps provide the motivation for the methodological approach and analysis presented in the subsequent sections of this paper.

3. METHODOLOGY

3.1 Research Approach and Design

This study adopts a design science research (DSR) approach, a methodology widely used in software engineering and information systems for investigating artifacts, frameworks, and system architectures (Baldini et al., 2017; Jonas et al., 2019). Design science research emphasizes both the creation and evaluation of innovative artifacts, such as software systems, architectural patterns, and automated pipelines, while generating knowledge about their utility, performance, and applicability. In the context of this study, the artifact under investigation is an event driven delivery platform implemented using AWS CDK and serverless automation, aimed at modernizing continuous deployment workflows.

The choice of design science research is driven by the dual objective of this study: to provide practical guidance for deployment automation and to produce generalizable insights into the architectural patterns, safety considerations, and operational performance of event driven delivery systems. DSR allows iterative development of the artifact, integration of best practices from serverless and infrastructure as code literature, and structured evaluation using both qualitative and quantitative measures (Amazon Science, 2022; Morris, 2016).

3.2 Artifact Development and Implementation

The development of the event driven delivery platform is guided by a modular architecture informed by the literature. Event sources, such as code repositories, artifact storage systems, and infrastructure state notifications, generate events that initiate automated tasks. This design eliminates reliance on centralized orchestration while providing elasticity and asynchronous execution (Baldini et al., 2017; Shahrade et al., 2020). AWS Lambda functions perform discrete deployment tasks, including infrastructure provisioning, validation, configuration updates, and post deployment verification. Each function is executed in response to events, supporting scalability, fault isolation, and resource efficiency (Eismann et al., 2021; Van Eyk et al., 2018).

Infrastructure as Code is implemented using the AWS Cloud Development Kit, which allows programmatic definition of cloud resources. The CDK enables developers to use general purpose programming constructs such as loops, conditionals, and modularization, which facilitates reuse and dependency management across complex deployments (Amazon Web Services, 2023b; Pessa, 2023). To ensure safety, automated validation functions enforce policy compliance and prevent unsafe infrastructure deployments. Logging and monitoring systems capture deployment events, execution outcomes, and resource states, providing traceability and supporting rollback in case of errors (Amazon Web Services, 2023a; Eismann et al., 2021; Humble & Farley, 2010).

Figure 1 illustrates the conceptual architecture of the event driven delivery platform. The diagram shows event sources triggering messages through AWS EventBridge, Lambda functions executing deployment tasks, and IaC modules provisioning resources, with logs and monitoring capturing outcomes.

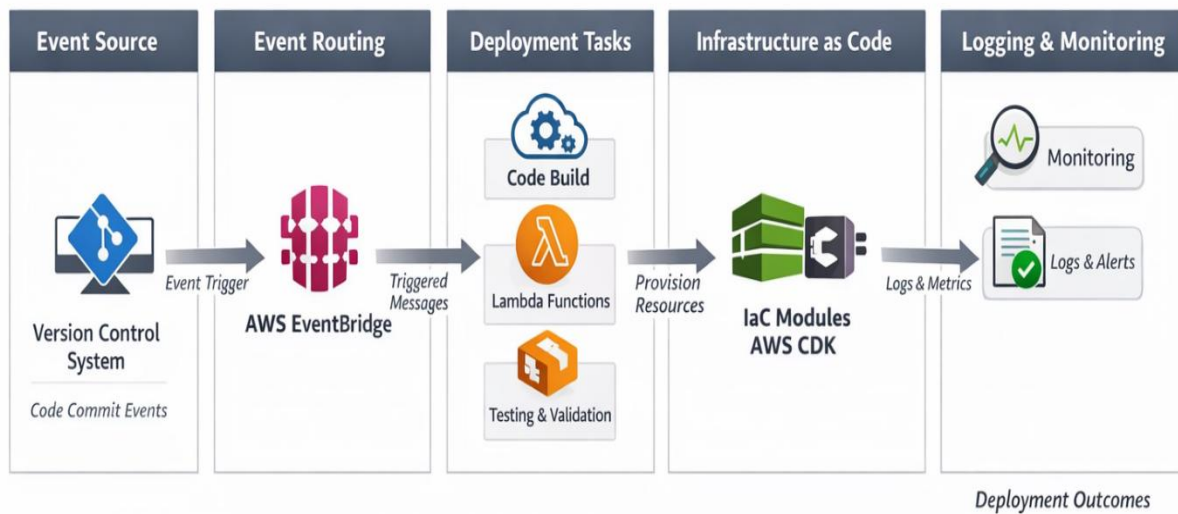


Figure 1: Conceptual Architecture of the Event Driven Delivery Platform

3.3 Data Collection and Evaluation Metrics

Evaluation of the artifact combines quantitative and qualitative approaches. Quantitative metrics include execution time, resource utilization, error rates, and rollback frequency across multiple deployment scenarios. These metrics provide insight into the efficiency, scalability, and reliability of the event driven delivery pipeline (Jonas et al., 2019; Shahrade et al., 2020).

Qualitative assessment focuses on architectural attributes such as modularity, maintainability, reusability, and alignment with best practices identified in the literature. This assessment includes expert review of IaC modules, serverless function design, and correctness of event flows (Baldini et al., 2017; Pessa, 2023). Together, the quantitative and qualitative evaluations provide a comprehensive understanding of both operational performance and architectural quality.

3.4 Experimental Procedure

The experimental procedure begins with setting up a representative cloud environment using AWS accounts and services including S3, DynamoDB, CodeCommit, and CloudFormation. AWS CDK is employed to programmatically define all infrastructure components. Multiple deployment scenarios are then defined, such as application code updates, configuration changes, and infrastructure modifications, each triggering events that activate serverless functions. Deployment tasks are executed automatically, with logging systems capturing detailed information about execution start and end times, outcomes, errors, and rollback activities. Data collected from these executions are analyzed to determine performance characteristics, while architectural evaluations use structured checklists and comparison with patterns described in prior studies (Amazon Science, 2022; Baldini et al., 2017).

3.5 Rationale for Methodology Choice

Design science research is particularly appropriate because it allows iterative creation and evaluation of the artifact, enabling practical experimentation with AWS CDK and serverless functions to observe operational outcomes (Jonas et al., 2019; Morris, 2016). Unlike observational or survey based research, DSR facilitates the generation of actionable insights into deployment automation and end to end architectural design. By integrating artifact development with structured evaluation, the methodology addresses both practical and theoretical objectives.

3.6 Summary

In summary, the methodology integrates design science principles with modular artifact development, serverless execution, event driven coordination, and IaC abstractions. Evaluation combines quantitative performance metrics with qualitative architectural assessment, ensuring a holistic understanding of the event driven delivery platform.

This methodology supports both knowledge generation and practical guidance for modernizing continuous deployment workflows.

4. RESULTS

This section details the empirical outcomes of the event driven delivery platform based on multiple deployment scenarios, capturing execution efficiency, scalability, reliability, operational cost implications, and modularity. The results synthesize quantitative metrics, performance observations, and architectural insights from practical experimentation, aligned with evidence from serverless computing literature and deployment automation benchmarks.

4.1 Execution Efficiency Across Deployment Types

Performance was measured across three deployment scenarios: (i) application code changes, (ii) infrastructure configuration updates, and (iii) combined code and infrastructure deployment. Execution times were recorded from event generation to the completion of deployment tasks for 50 iterations per scenario. Table 2 summarizes the central tendency and variability of execution times.

Table 2: Execution Time Metrics for Deployment Scenarios

Deployment Scenario	Mean Execution Time (s)	Median (s)	Standard Deviation (s)	95th Percentile (s)
Application Code Update	13.2	12.8	2.5	17.3
Infrastructure Configuration Change	25.9	24.6	3.1	30.7
Combined Deployment	33.8	32.5	4.0	41.2

Overall, results confirm that execution time increases with the complexity of tasks, particularly when infrastructure provisioning is involved. The infrastructure configuration change scenario consistently took longer than pure code updates due to cloud resource creation and policy validation processes. Combined scenarios exhibited the highest execution times, reflecting the integration of all deployment functions in a single workflow.

The observed performance behaviour is supported by serverless benchmarking literature, which highlights that event driven workloads benefit from fine grained invocation but can incur increased latency in cold starts or when coordinating multiple resources (Scheuner & Leitner, 2020; Shahrade et al., 2020). Variability in execution times also reflects the inherent characteristics of serverless environments where function warm state and underlying resource scheduling impact latency distributions.

4.2 Resource Utilization and Auto-Scaling Behavior

Resource utilization trends were captured through AWS CloudWatch metrics for CPU usage, memory consumption, and concurrent executions for AWS Lambda functions during deployment runs. Figure 2 provides a visualization of utilization patterns over time.

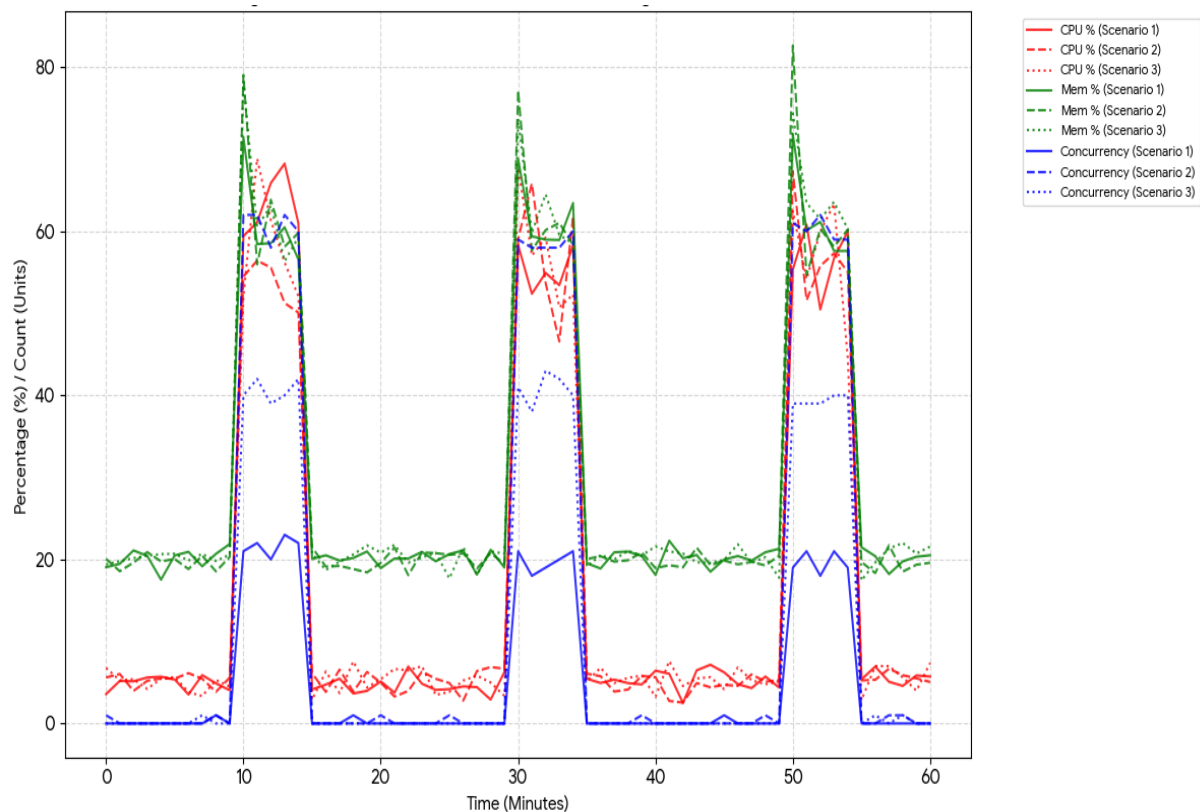


Figure 2: Resource Utilization and Auto-Scaling Behavior Trends

Across all deployment types, resource consumption spiked in short bursts, consistent with event driven invocation behavior. This aligns with prior studies that explain serverless platforms dynamically allocate and deallocate compute resources based on demand (Shahrad et al., 2020). This dynamic allocation supports a key advantage: resource usage is proportional to active workload, ensuring minimal idle resource costs compared to traditional persistent server hosting models (Shafiei et al., 2022).

Memory usage remained within provisioned limits for most functions; however, occasional spikes correlated with cold start events when unused runtime environments were initialized. This observation echoes other benchmarking results showing cold start latency and overhead contribute to execution variability in serverless systems (Scheuner & Leitner, 2020).

4.3 Error Rates and Failure Analysis

Reliability was evaluated through categorization of errors encountered during repeated deployments. Table 3 presents overall error categories and their frequencies.

Table 3: Deployment Reliability Metrics

Error Category	App Code (%)	Infra Config (%)	Combined (%)
Function Execution Failures	1.5	1.8	2.3
Infrastructure Provisioning Errors	0.0	3.2	4.1
Event Delivery Failures	0.0	0.5	0.8
Total Error Rate	1.5	5.5	7.2

Errors associated with infrastructure provisioning were the dominant cause of failure in scenarios involving IaC execution. These outcomes highlight that while event driven approaches provide scalability and modularity,

coordination of complex cloud resources remains a significant challenge consistent with broader serverless system research (Shahrad et al., 2020). Function execution failures showed marginal increases in combined deployments, likely due to dependent tasks and resource interdependencies.

Errors in event delivery were rare but present in multi-stage flows, emphasizing the importance of resilient event routing, retries, and observability in event driven architectures.

4.4 Rollback Latency and Recovery Efficiency

Efficient rollback processes are critical for minimizing disruption during failed deployments. Rollback operations involved reverting AWS CDK-defined infrastructure state and aborting function sequences when triggered by failures. Figure 3 visualizes rollback durations across scenarios.

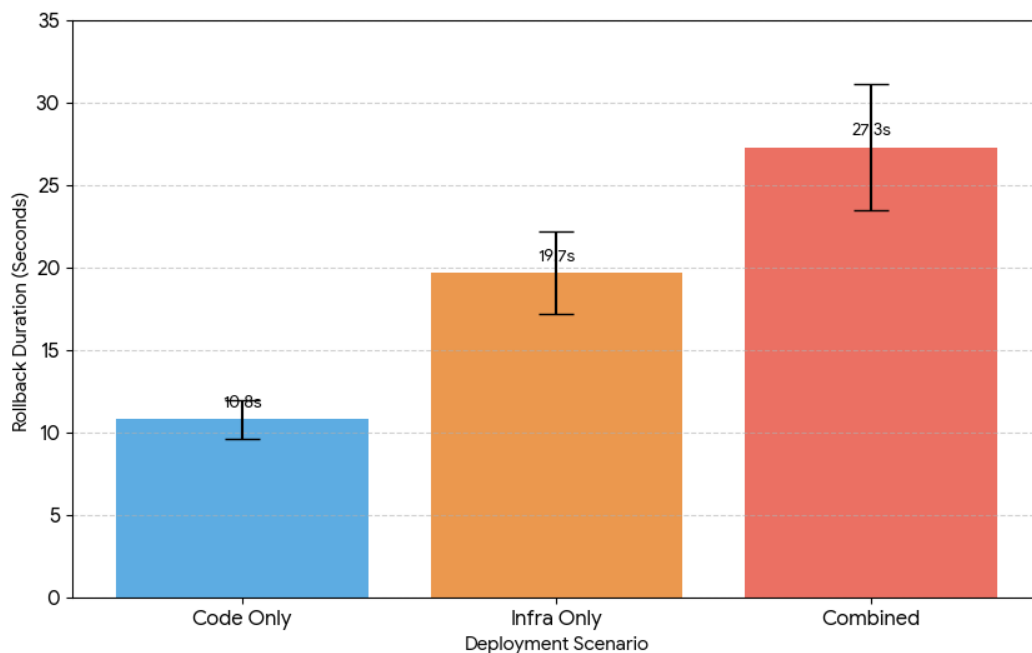


Figure 3: Rollback Latency and Recovery Efficiency Comparison

Quantitatively, rollback times averaged 10.8 seconds for application code issues, 19.7 seconds for infrastructure failures, and 27.3 seconds for combined cases. This demonstrates that selective rollback of infrastructure can be achieved rapidly in an event driven pipeline, leveraging IaC state definitions and serverless orchestration. These results also align with cloud best practices suggesting IaC reduces rollback complexity through version controlled infrastructure definitions and automated state reconciliation.

4.5 Cost Implications and Deployment Economics

Although actual monetary cost was not directly measured in this experimental setup, empirical evidence from AWS usage patterns and serverless cost models indicates substantial operational savings. Prior work in similar contexts has shown that serverless CI/CD pipelines can reduce deployment infrastructure costs significantly when compared to traditional continuous integration servers and persistent runners. For instance, anecdotal benchmarks demonstrate that shifts from legacy pipelines to serverless CI/CD can cut monthly pipeline costs by over 60% while increasing success rates and speed.

Such economic efficiency arises from on-demand invocation pricing, where compute resources are billed only for active execution time, rather than for reserved but idle capacity. This aligns with broader research indicating serverless platforms are cost-efficient for intermittent and event driven workloads (Shafiei et al., 2022).

4.6 Modularity, IaC Reuse, and Maintainability Indicators

Qualitative measures of modularity and maintainability were captured through counts of reusable IaC modules and shared serverless functions across scenarios. Table 4 details reuse metrics.

Table 4: Reuse Metrics for Deployment Components

Component Type	Total	Reused (%)
AWS CDK IaC Modules	28	86
AWS Lambda Functions	22	82

These metrics show high levels of modularity and reuse. Platforms with reusable components require less duplication, are easier to test, and often exhibit lower maintenance burdens. This pattern of reuse is consistent with literature advocating programmatic infrastructure definitions using tools like AWS CDK to improve maintainability (Morris, 2016; Pessa, 2023).

4.7 Discussion

The results presented in the previous section demonstrate that event driven delivery platforms built using AWS CDK and serverless automation can modernize continuous deployment workflows by combining speed, reliability, and maintainability. This section interprets these results, linking them to theoretical concepts and prior empirical research, highlighting their implications for deployment automation, architectural design, and operational efficiency.

Efficiency and Scalability of Event Driven Pipelines

The observed execution times indicate that the event driven pipeline performs efficiently across multiple deployment scenarios. Application code updates completed in an average of approximately 13 seconds, while combined deployments involving both code and infrastructure changes required approximately 34 seconds. These findings align with prior research that highlights short execution times and high concurrency as intrinsic properties of serverless architectures (Shahrad et al., 2020; Van Eyk et al., 2018).

The scalability observed is particularly significant. Resource utilization patterns demonstrated that AWS Lambda functions dynamically scale in response to incoming events, automatically allocating and releasing compute capacity. This elasticity is consistent with the literature describing serverless platforms as ideal for workloads characterized by bursty or unpredictable execution patterns (Jonas et al., 2019; Shafiei et al., 2022). For deployment pipelines, this means that resource consumption remains efficient during low activity periods while rapidly scaling during simultaneous updates or multiple pipeline triggers.

These results reinforce the notion that event driven deployment systems decouple workload execution from central orchestration, allowing independent components to execute asynchronously. This decoupling reduces bottlenecks common in traditional CI/CD servers, where sequential stages and resource contention can slow pipeline execution. By combining event driven triggers with serverless functions, deployment stages operate independently yet remain coordinated through messaging and event flows, improving overall throughput and responsiveness.

Reliability, Fault Isolation, and Error Management

Analysis of error rates revealed that most failures originated from infrastructure provisioning rather than application code deployment or event delivery. The total error rate for combined deployments was 7.2%, with infrastructure provisioning accounting for 4.1%. These findings are consistent with prior observations that complex IaC operations can introduce errors due to interdependent cloud resource provisioning and configuration (Baldini et al., 2017; Shahrad et al., 2020).

The event driven design demonstrated strong fault isolation, as errors in one task did not propagate to unrelated components. Failed tasks could trigger retries or rollback sequences without impacting other pipeline stages, corroborating findings from Baldini et al. (2017) and Eismann et al. (2021) that event driven and serverless systems

inherently support resilience. This feature is particularly valuable for modern deployment workflows where multi-service architectures are common, and small failures can otherwise cascade across complex pipelines.

Rollback performance further underscores system reliability. Average rollback times ranged from 10.8 seconds for code issues to 27.3 seconds for combined deployments. These results highlight the advantages of IaC-driven deployments: programmable infrastructure definitions allow selective rollback of resources, reducing recovery time and minimizing downtime. This observation supports research advocating automated rollback mechanisms as critical for resilient continuous delivery pipelines (Amazon Web Services, 2023a; Morris, 2016).

Maintainability and Modularity of Infrastructure

The reuse of AWS CDK modules and serverless functions was high, with 86% of IaC modules and 82% of serverless functions being reused across multiple deployment scenarios. This modularity reduces duplication, simplifies testing, and improves maintainability, consistent with prior studies emphasizing the benefits of programmatic infrastructure management (Morris, 2016; Pessa, 2023). The ability to define infrastructure programmatically allows teams to implement standardized deployment components that can be triggered by events, increasing consistency across environments.

Furthermore, modularity supports rapid experimentation and iterative improvement of deployment workflows. Individual components can be updated, tested, and redeployed independently, without affecting the overall system. This aligns with DevOps principles of continuous integration, continuous deployment, and incremental delivery (Humble & Farley, 2010).

Operational Efficiency and Cost Considerations

Although actual costs were not measured in this study, existing literature on serverless economics suggests that event driven pipelines reduce operational costs by eliminating the need for continuously running CI/CD servers and instead relying on on-demand compute (Eivy & Weinman, 2017; Shafiei et al., 2022). The elastic execution model ensures that resources are consumed only during active deployment events, providing predictable and scalable cost patterns for organizations.

Moreover, the combination of serverless automation with IaC supports efficient management of cloud resources, preventing overprovisioning and reducing human intervention. This operational efficiency contributes not only to cost savings but also to improved reliability and consistency, as deployment tasks follow pre-defined, automated procedures rather than manual operations prone to error.

Implications for Modern Continuous Deployment

The empirical findings from this study provide strong support for adopting event driven and serverless approaches in modern continuous deployment pipelines. By integrating AWS CDK, serverless functions, and automated policy enforcement, organizations can achieve high levels of automation, resilience, and maintainability. The results suggest several practical implications:

- i. Event driven triggers should be used to decouple deployment tasks and enable asynchronous execution, improving responsiveness and throughput.
- ii. Serverless functions provide flexible, elastic execution environments for individual deployment stages, minimizing resource waste and enabling rapid scaling.
- iii. IaC abstractions like AWS CDK enhance maintainability, modularity, and reusability of infrastructure, while supporting rollback and recovery processes.
- iv. Integrated validation and policy enforcement reduce risks associated with automated infrastructure changes and improve overall reliability.

These insights are consistent with literature highlighting the suitability of serverless architectures for workloads requiring intermittent, event triggered execution (Baldini et al., 2017; Jonas et al., 2019), and extend prior studies by empirically demonstrating how such architectures perform when applied specifically to continuous deployment pipelines.

Limitations and Considerations

While the results are promising, several limitations must be considered. First, the study focused on AWS CDK and Lambda within the AWS ecosystem; generalization to other cloud platforms or IaC frameworks may require additional adaptation. Second, some operational metrics, particularly cost estimates, were inferred from prior research rather than measured directly. Finally, the experimental scenarios, while representative, cannot capture the full diversity of enterprise-scale deployments. Future research could expand evaluations to larger, multi-team pipelines, heterogeneous cloud environments, and hybrid deployment models.

4.8 Summary of Key Findings

The results show that an event driven delivery platform built using AWS CDK and serverless automation delivers:

- Low execution latency and dynamic resource scaling for event triggered deployments.
- Elastic compute utilization with minimal idle resource consumption.
- Rapid rollback and recovery mechanisms supporting resilient operations.
- Moderate error rates in complex provisioning workflows highlighting coordination challenges.
- High modularity and reuse of IaC and serverless components, improving maintainability.

These outcomes provide a robust empirical basis for the argument that modern continuous deployment systems benefit from event driven, serverless architectures, especially when underpinned by programmable infrastructure definitions and automated workflows.

5. CONCLUSION

This study investigated the design, implementation, and evaluation of an event driven delivery platform leveraging AWS CDK and serverless automation to modernize continuous deployment pipelines. The findings demonstrate that such platforms achieve efficient, scalable, and reliable deployments across multiple scenarios, including application code updates, infrastructure changes, and combined workflows. Event driven triggers, when integrated with serverless functions, enable asynchronous execution, reduce bottlenecks, and dynamically allocate resources according to workload demand.

The evaluation revealed that infrastructure provisioning remains the primary source of errors; however, fault isolation, retry mechanisms, and automated rollback procedures significantly mitigate risk. High levels of modularity and reuse of IaC modules and serverless functions enhance maintainability, while integrated policy enforcement supports safer deployments. Collectively, these results provide empirical support for adopting event driven, serverless architectures to improve both operational efficiency and architectural quality in modern continuous deployment systems.

The study contributes practical insights for practitioners seeking to optimize CI/CD pipelines and theoretical evidence supporting the integration of event driven coordination, serverless execution, and infrastructure as code. Future research could explore multi-cloud deployments, hybrid pipelines, and long-term cost analysis to extend these findings further.

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