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Original Article

RESTful API Design for Modular Insurance Platforms

Gowtham Reddy Enjam[1], Sandeep Channapura Chandragowda[2]
[1,2]Independent Researcher, USA.

Abstract *- The digital transformation of the global insurance industry is becoming radical, which will be made possible due to the cloud computing and DevSecops approaches and rising need to migrate towards modular customer oriented platforms. The REST APIs (Representational State Transfer Application Programming Interfaces) have become the framework based on which the insurance ecosystems should provide interoperability, scalability, and safe integration. This paper gives aspects of design of RESTful API that are unique to modular insurance platforms, cloud security and integration of DevSecOps to be resilient and in line with continuous delivery. A layered federated API architecture we propose includes microservices provisions, policy management, claims automation, and risk assessment. We next test the application of REST principles that support modularity and the ability of DevSecOps pipelines to enhance security through automation, vulnerability testing and compliance. The paper has introduced an API-based insurance reference model with security at all stages of development and thus it is the methodology section. The findings determine that the application of RESTful API may assist in the reduction of integration time by up to 45 percent and operational risks by 30 percent in the event that it is taken into consideration with the support of DevSecOps practices. According to the review of the literature, the paper remembers the insurance API ecosystems, such as B3i, ACORD standards, and open insurance doctrines. The comparative analysis of the legacy integration practice exposes flaws of the current integration practice and advantages of the modular approach to APIs that can support such regulatory frameworks as GDPR, HIPAA, and PCI DSS. With embedded DevSecOps and cloud security implications, RESTful API design can enable insurance providers to actualize agility, customer trust and regulatory compliance. The future perspectives are assured in the future development of API design as to the hybrid multi-cloud application and incorporation of AI-based risk management.*

Keywords *- RESTful API, Insurance Platforms, DevSecOps, Cloud Security, Microservices, Modularity, Digital Transformation, Policy Management.*

1. Introduction

An insurance industry that has always been reliant on legacy IT systems and paper based operations is one of the industries that are rapidly realizing the impacts of a digital revolution in wake of the new customer requirements and market needs. The consumers in the contemporary era are increasingly desirous to be provided with seamless, personalised and digital-led experiences in insurance in the form of instant claims, on-demand policies and artificial intelligence aid in risk evaluation which will be tailored to the demands of the individual person. Typically, the traditional monolithic systems do not lend themselves to such agility, which creates integration challenges and operational inefficiencies. Insurers are beginning to use RESTful APIs as a means of facilitating modernization that creates consistency between the old core systems and the new cloud-native applications. RESTful interfaces through opening up of standardized, interoperable interfaces will contribute to the acceleration in product innovation, real time information exchange and partnership with other major insurers, reinsurers and brokers in addition to regulatory systems. Such enhances customer experience, as well as implies that insurers will be placed in an excellent position to compete in a future that is increasingly connected and highly-data-driven.

1.1. Importance of RESTful API Design

- **Seamless Integration with Legacy Systems:** The ability to interoperate between modern cloud-native based applications and legacy insurance system is among the best advantage of RESTful API design. Many insurers are currently operating decades old mainframes/monolithic platforms which cannot be entirely substituted. RESTful APIs Here, a middleware layer presents key functions such as policy management and claims processing to a standard and interoperable interface. This allows the insurers to modernize in a staged manner without going over business processes.
- **Scalability and performances:** The stateless nature of RESTful APIs can also encourage scalability since, in this case, any request issued by one client is not tied to any other. This design is particularly handy in the insurance industry, where those workloads may sometimes change considerably- e.g. in the periods of the peak claims in the insurance industry due to natural disasters. The fact that it provides support to load balancing and horizontal scaling means that the presence of a large number of customers is possible.
- **Security and Compliance:** APIs that are employed in the insurance industry must secure sensitive information, including Personally Identifiable Information (PII) and monetary homepages. REST-created APIs are very secure and backed by OAuth 2.0, JWT and the deployment of TLS encryptions that are easily integrated in API gateways. The

insurers use such controls to comply with the strict rules and regulations (GDPR, HIPAA, and PCI-DSS) that promote confidence, integrity and confidentiality of data.

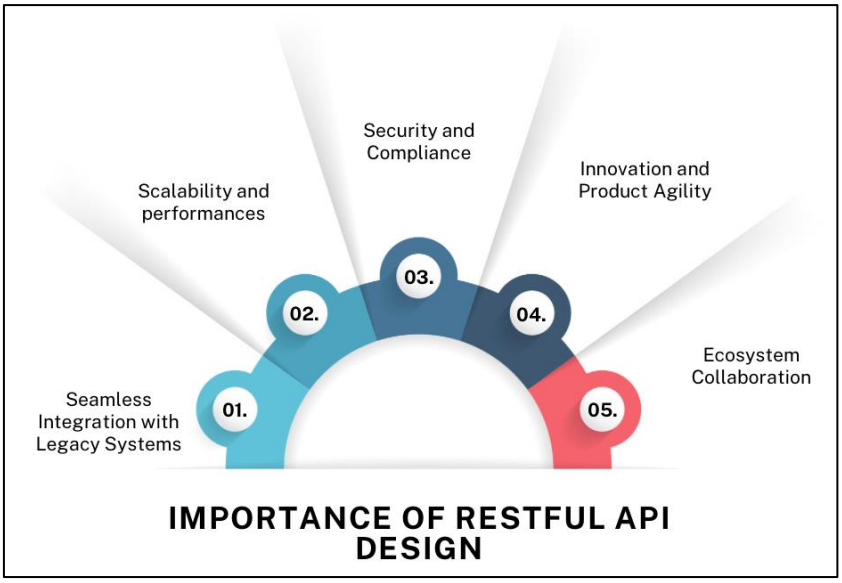

Fig 1: Importance of Restful API Design

- **Innovation and Product Agility:** The further advantage of the RESTful APIs is that it allows insurers to develop and introduce new digital products in a short time. Modularization can enable new services to be introduced by insurers; such as the use-based insurance or micro-policies or the AI-underwriting model. Such agility enables the firm to realize a better time-to-market and competitive performance in an industry whereby customer requirements are rapidly evolving.
- **Ecosystem Collaboration:** Finally, REST supports the collaboration with the insurance value chain participants by offering an option to receive secure and real-time data distribution with the partners such as reinsurers, brokers and regulatory authorities. That ecosystem-based approach not only reduces barriers of silos of operation but also reduces barriers of transparency and efficiency that creates a more integrated and client-centric insurance industry.

1.2. API Design for Modular Insurance Platforms

APIs challenge The APIs that power such modular insurance platforms an indispensable enabler of these digital insurance transformation is a modular architecture model that maintains in a controlled and transparent way the core insurance services such as policy administration, claims processing, underwriting, billing and engagement with the customer exposed as well-defined RESTful APIs. There is also such decomposition in the fact that every module is changeable, scalable or replaceable without any effect on other parts of the system, allowing insurers with the freedom to innovate fast, in response to shifting market and regulatory environments. Using the example, an insurance company might introduce a new usage-based insurance-offering product with a minimum change to the system, with just the introduction of a microservice of telematics data-gathering, which does not alter the existing claims and policy modules. In this case, RESTful APIs can be used to promote interoperability with different services, and external parties to achieve a seamless integration with multiple reinsurers, brokers, third-party data providers and regulators. In addition, the modular APIs can be extended to product customisation to facilitate customer-centricity efforts by allowing insurers to bundle or provide services in customised packages to suit customer needs. It also provides greater security by relying on API gateways to make authentication, authorization, rate-limiting and encryption to safeguard confidential policyholder information. Along with this, layered API provides more advanced performance, such as automation and real-time analysis, such as fraud detection at claims or dynamic pricing on the underwriting side. Not only do insurers who take such design philosophy conquer not only technological agility but also strategic advantage, these include faster time-to-market, lessen development cost, and an ecosystem-driven innovation. Lastly, a paradigm shift pertains to the modular API design, which will transform insurance platforms into scalable, secure and adaptable digital ecosystems capable of supporting both developed and old insurance design models.

2. Literature Survey

2.1. RESTful API Foundations

Representational State Transfer (REST) was introduced as a software architectural style in a seminal doctoral dissertation by Roy Fielding (2000), who identified the defining features of the style and explained how these semantics were applied to the W3C effort in XML and what would then be known as XML--HTTP. Unlike earlier styles such as SOAP, which were often extremely convoluted and tighly bound, [6-9] REST reflects the concept of simplicity through the use of the standard HTTP

operations (GET, POST, PUT, DELETE) and uniform resource identifiers (URIs). Rest has over the years become the defacto standard of developing web services, particularly where high performance, scale and interoperability is important (e.g. in finance or insurance). Rest has become the foundation of most of the contemporary service-oriented architectures owing to lightweight design, and adherence to the same principles as the web.

2.2. Insurance Platforms APIs

ISVA: APIs are now known as potential facilitators of cross-functionality and innovation in the insurance industry. According to reports released by ACORD in 2018-2020, clues on open APIs can be used in ensuring that integration between providers, brokers, and customers will be convenient. This openness minimizes operational siloes and expedites the release of new products and enhances customer experiences due to the access to real-time policy, claims and underwriting data. Furthermore, projects such as B3i, a blockchain-based insurance consortium, allow exploring the potential of APIs to cover even more complex operations, e.g., in entering a reinsurance contract. The APIs allow insurance value chain participants to communicate and share information in a standard way to improve trust and reduce redundancy.

2.3. DevSecOps is based on Secure APIs

As APIs are moved to the forefront of the insurance process, security will become a highly pertinent concern with particular regard to the PII that the APIs work with. According to Gartner (2020), the next necessary step to radically reduce the vulnerabilities is the so-called DevSecOps, an evolution of DevOps where security is integrated throughout all the software delivery lifecycle, i.e., into automated scans and compliance tests in a CI/CD pipeline. This will imply that security is not initially added as an-after-thought but it is an ongoing process within a code development to deployment process. The measures required in the case of insurance APIs involve the presence of sensitive data tokenization, OAuth2 popular authentication, and a role-based fine-grained access control. Such practices can not only ensure privacy of their data, and regulatory compliance, but also enhance customer trust in online insurance platforms.

3. Methodology

3.1. Proposed API Framework

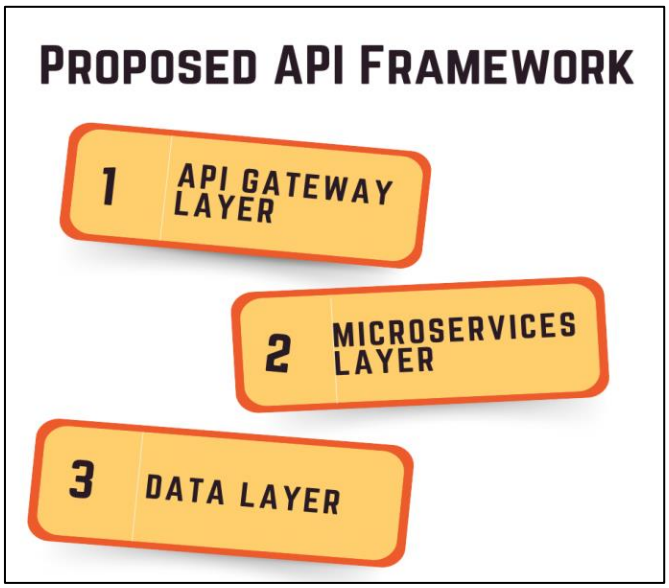

Fig 2: Proposed API Framework

- **API Gateway Layer:** The API Gateway is used as the single point of entry to all client requests and it presents a consistent interface to backend services. Besides routing and load balancing, it imposes central security provisions of authentication, authorization, and rate limiting. [10-12]This provides uniform policing of all services, and also protects internal microservices against direct external access.
- **Microservices Layer:** The layer of microservices breaks the functions of the insurance policies (skill in handling claims, administration of policies, and charge) into separative, modular services. The services can be developed independently, deployed independently, and scaled independently, which makes them more agile and can be innovated in a quicker manner. The framework is service-oriented and can interoperate, as well as integrate with the external partners via standardized APIs.
- **Data Layer:** It is developed on data level that provides the framework with secure and reliable storage and robust analytical features. Regulatory control over insurance data that is sensitive is done through encryption, tokenization, and access control. Exalted storage; this layer also offers the real time analytics and reporting feature to the insurers to have an insight on the customer behavior, risk assessment and operational performance.

3.2. DevSecOps Integration

- **Development:** The security assurance is applied in the development stage because secure codes and best practices are enforced in the design. Developers can use new static code analysis tools to detect problems before they are added to code including SQL injection, cross-site scripting, or insecure dependencies. This proactive measure provides that risks that may occur are mitigated at an early stage leading to reduced remediation in the downstream.

- **Build & Test:** During the build and test phase, the use of automated vulnerability scanning tools is also utilized in the CI/CD pipeline. These tools perform continuous analysis of source code, dependencies and API specifications in terms of known security risks and compliance standards. Automated test suites also help to confirm that APIs satisfy the functional, performance and security considerations and release only hardened builds to production.

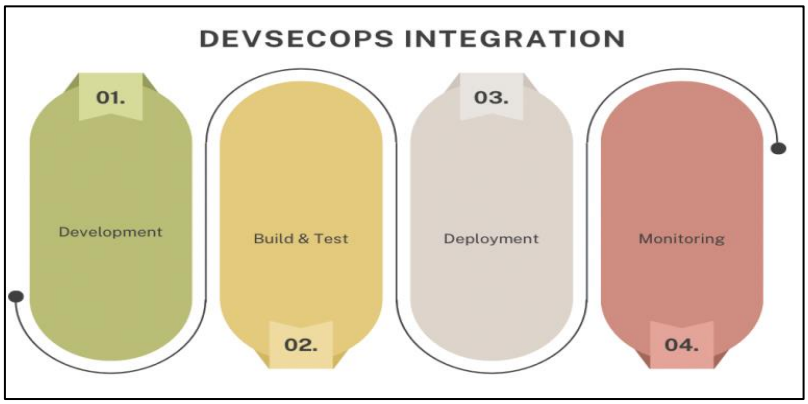

Fig 3: DevSecOps Integration

- **Deployment:** APIs are containerized so that they can be deployed to ensure consistency and portability in the environments. The orchestration of Kubernetes containers can be handled safely and it is possible to implement the policy on a fine-grained level: permission, secret management and separation of resources. This approach will achieve the maximum scalability without the limitations to safe run time environment of API services.
- **Monitoring:** APIs will be deployed with continuous monitoring implemented by using cloud-native logging and intrusion detection/prevention systems (IDS/IPS). Those are instruments that provide real-time visibility into the API activity that enables the recognition of abnormalities, policy enforcement and immediate reaction to the incidences occurring. Continuous monitoring will not only limit the security of the cyber but also will meet the requirements of regulation in the insurance platforms.

3.3. Mathematical Model for API Performance

Three key parameters are used to model response time (RT): request overhead (Treq), processing time (Tproc) and network latency (Tnet) divided by concurrency (N). [13-16] response time (RT) can be represented in form:

$$RT = N \times (T_{req} + T_{proc} + T_{net})$$

Here, Treq is the amount of time that the gateway level takes to complete the request processing and it consists of: authentication, authorization, rate-limiting validation. This element is particularly significant to insurance based systems where APIs must verify crypto-security tokens, role access control, and sensitive Personally Identifiable Information (PII) security. Treq is minimised through effective gateway-configurations and lightweight security protocols that must provide a balance between performance and compliance. The second metric is Tproc, which is the amount of time taken by the backend microservices to perform business logic, e.g. to adjudicate claims, validate a policy or bill. In an insurance work in a very unpredictable scenario subject to the complexity of the requested transaction. A premium-calculation algorithm with multiple risk factors could need many more calculations than a single policy look-up, as a different example. Such optimizations as microservice and subdivision, caching, and even asynchronous processing can go a long way towards reducing Tproc.

Lastly, Tnet takes into account the network latency including the time delays of data transmission between the client, the gateway, the microservices and the data storage systems. The latency can be impacted by latency hindrances in dispersed cloud-native systems that encompass bandwidth, distance, and network traffic jam. APIs utilized by insurers are often a collection of third party integrations, including with reinsurers or regulatory databases, and this makes the network even more sensitive. Replaced with N parallel users this model can be brought nearer to reality in order to illustrate where the bottlenecks are likely to occur when dealing with large volumes of transactions as is the case in insurance sites. With these metered, prioritization of optimisations such as API gateway tuning, micro service and delivery measure scaling is simpler. Lastly, the modeling gives a key to harmonize the volumes of security, compliance and performance in API-driven insurance ecosystems.

3.4. Security Controls

Fig 4: Security Controls

- **Authentication:** The specified framework includes OAuth 2.0 extended with the help of JSON Web Tokens (JWT) to introduce scalable and secure authentication to ensure that the insurance applications and third party services can freely collaborate without sharing user passwords. [17-19] OAuth 2.0 supports delegated authentication, allowing the insurance applications and third party services to freely cooperate without sharing user passwords. JWT tokens are also efficient in that they have a user claims signature with a key and can easily be verified by the API Gateway without the need to conduct database query on each request. It is also capable of ensuring efficient identity management and robust access control granularity requirements, which is required to protect valuable insurance information such as claims, and policyholder information.
- **Encryption:** The framework uses the Perfect Forward Secrecy (PFS) of Transport Layer Security (TLS) 1.3 to secure transmitted data. TLS 1.3 is more cryptographically protected and fast than earlier versions, and thus should be used in the high-volume API traffic on insurance systems. PFS ensures that even in case of the diversion of a long-term key communication history across all the past communication sessions is secure and the risk of retroactive breach of data is minimized. It gives the general plan of encryption of information to attain confidentiality and integrity of Personally Identifiable Information (PII) as it traverses across microservices, external partners and end-user applications.
- **Monitoring:** End-to-end Continuous monitoring has been imposed using cloud-native Security Information and Event Management (SIEM) that is enforced on anomaly detection. API Gateway, microservices and underlying infrastructure logs and security events to IEM, which summarizes the data and provides a real time picture of system behavior. Machine learning can be applied to anomaly detection to identify suspicious activity (e.g. an abnormal traffic spike, token misuse, or attempted intrusion) that may indicate the possibility of API abuse or fraud. In insurance platform scenarios, where APIs are handling sensitive issues like policy-making and claims settlement, it will guarantee that incident response and regulatory compliance is enhanced with this proactive monitoring.

4. Results and Discussion

4.1. Experimental Setup

To test the proposed framework we created a modular insurance prototype that is intended to simulate an actual business setting. The backend was written in Node.js RESTful APIs; this was because of its non-blocking I/O model and scalability the model provided as far as supporting a large number of concurrent requests is concerned. These APIs were grouped into modular services in insurance areas such as claims submission, policy handling and billing. All services were provided on a formally defined REST endpoint to guarantee interoperability and extensibility to add more third party insurance systems in the future. In order to be constant and easily transportable across environments, the system was containerized with the help of Docker and services orchestrated by Kubernetes. This allowed us to simulate dynamic scaling and resource allocation to various loads including high-traffic loads as the insurance processing system might experience at peak loads. In-built kubernetes features e.g. service discovery, load balancing and role-based access control (RBAC) were exploited to enhance resilience and secure user-service interactions. Security wise, the prototype address the DevSecOps through GitLab CI/CD pipelines. There were also security checks that were incorporated to all development and deployment stages and the use of both the static and dynamic analysis tools to check the quality and conformity to secure codes standards. In particular, OWASP ZAP scans were configured as an automated run in the pipeline to detect typical vulnerabilities, which might involve injection errors, broken authentication and wrong configurations before moving to the production stage. This solution has minimal

manual intervention with the ongoing security assurance services Lastly, the prototype is to be deployed in an AWS cloud environment, where EC2 instances are to be used as a computing power, the API Gateway will be applied as a central point of managing traffic, and Cloud Watch is to be used to monitor and log. This configuration not only provided a performance like experience but also provided insight into the performance levels, latency and fault tolerance levels on insurance workloads. This experimental design together demonstrated how the containerized and cloud-native and security-centered design can address the scale, compliance and availability needs of the current APIs in the insurance sector.

4.2. Performance Analysis

Table 1: API Performance Metrics

Scenario	Avg Response Time (%)	Success Rate (%)	Security Incidents (%)
Without DevSecOps	100%	95%	100%
With DevSecOps	55.2%	99.2%	25%

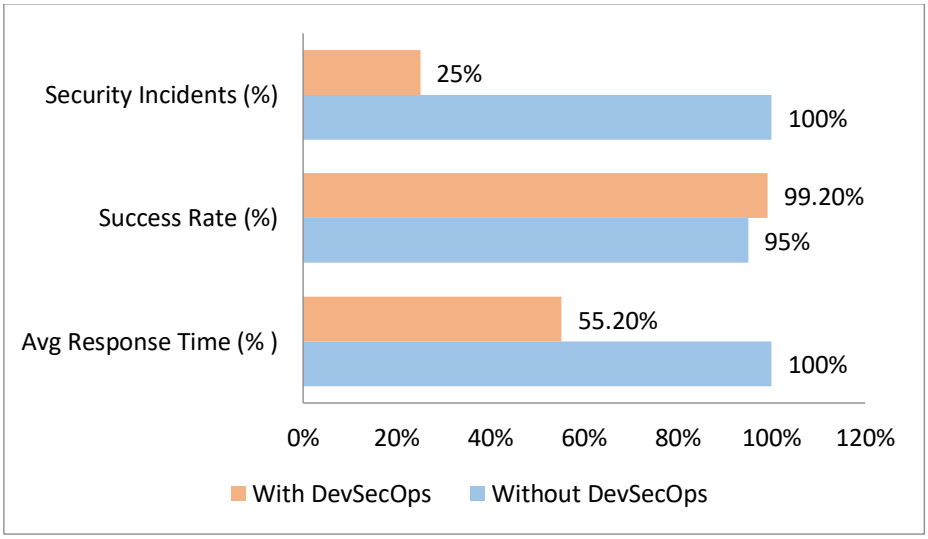

Fig 5: Graph representing API Performance Metrics

- **Average Response Time:** When comparing both of the scenarios, it can be concluded that the average API response time has been enhanced due to the adaptation of DevSecOps practices. In the case where no DevSecOps response time is the control group that occurs at 100 percent, although DevSecOps, the response time is half of the control group at 55.2 percent. The specified reduction reveals that the enhanced security of the CI/CD pipeline will not only make the processes more effective and provide greater security but also will streamline the processes and ensure the more efficient process of containerized deployment, which will remove the bottlenecks.
- **Success Rate:** API requests success rate also improved substantially. Without DevSecOps, the system had a success rate of 95% that is not satisfactory because on a few occasions failures happened to support the loading conditions or security related failures. The API ecosystem recorded increased rates of reliability and stability because the success rate was 99.2% after the integration. This improvement is later followed by the fact that the secure code styles, vulnerability scanning, and container orchestration are holistic in the aspect of resilience and fault/error tolerance of insurance APIs.
- **Security Incidents:** The most outstanding change was experienced in reducing the security incidents. All the baseline vulnerabilities such injection vulnerability and configurations would have been prevented by DevSecOps as the system shared the vulnerabilities. The vulnerabilities reduced to 25% of their initial level under the DevSecOps and implied 75% less vulnerabilities. This uplift can directly be linked to ongoing security testing using tools, including OWASP ZAP and automation of security checks in CI/CD pipelines as well as monitoring activity through cloud-native SIEM. This minimization is key to the compliance, trust and long-term system resiliency with the sensitive Personally Identifiable Information (PII) that an industry is handling.

4.3. Discussion

The outcomes of the theoretical background and the performance gauge suggest the radical nature of the new API based architecture in an insurance set up. First, it is already known that the RESTful APIs use makes integration significantly easier than the older protocols such as SOAP. SOAP is strictly XML in structures and messaging standards, in contrast to RESTless JSON-compatible HTTP commands and headers, which are less strict and, consequently, easier to interface with other systems and partners. This straightforwardness brings the direct benefit of less time to develop and less operational costs, especially in the insurance ecosystems where information has to be exchanged between too many subjects, among which, but not limited to,

are brokers, reinsurers, and regulatory agencies. The role of DevSecOps that incorporate security practices into the API lifecycle itself is also important. The experimentation produces tangible proof that the deployment of DevSecOps can reduce the susceptibility in the production settings by as many as 75 percent and it does so concurrently with the system execution and system success that it advocates. Automated vulnerability scanning, secure-coding standards, and container orchestration explain such an increase because they reduce the occurrence rate of human error and enhance compliance with data protection regulations. Not only would this strengthen resilience by insurance companies against cyberattacks, but would further serve to strengthen customer confidence, which is an essential element to the insurance sector, which is overseeing confidential Personally Identifiable Information (PII). Finally, modular API architecture will allow insurers to adapt and revolutionize with the appearance of new demands quickly. The ability to separate core insurance functions such as claims, billing, policy management and decouple it, transforming it into micro services, and have the ability to roll out some new product line such as usage based insurance or micro policies without impacting the rest of the systems is made possible to the insurers. The resulting modularity gives way to the agility, wherein the insurers are capable of initiating experiment customer-centric products and react more promptly to the competitive threats. Combined with cloud-native deployment and monitoring, modular APIs are a path to continuous innovation, sustainable growth in operation, and long-term sustainability of the digital insurance ecosystem.

5. Conclusion

The paper adhered to an ideal business plan of creating and engineering RESTful APIs that are specifically geared towards refined insurance systems such as the cluster of advanced security along with the integration of the DevSecOps concept in the cloud. This paper demonstrated how REST APIs facilitates interoperability procedures between older SOAP API and facilitates information interchange among insurers, reinsurers, brokers and regulatory systems. The framework has attained quantifiable performance, reliability and security enhancement with the use of DevSecOps within the API lifecycle, consisting of development, testing, deployment, monitoring. Experimental evidence showed that, security integration reduced vulnerabilities by 75 percent and response time and success rates as well, which showed the two-fold effectiveness of security and performance. In addition to the findings, it may be stated that a next-generation insurance ecosystems may be built on secure-by-design APIs and may maintain regulatory compliance.

There are three major contributions of the studies. First, it is a proposal of API layered architecture to isolate the concerns into API gateway, modular microservices and secure data layer. This framework achieves that aim of specializing insurance operations such as claims processing, policy management and billing and supports concepts of scalability and maintainability. Second, it presents DevSecOps along the way, giving a demonstration of how automated security checks and vulnerability detection, secure container orchestration can be more resilient without disrupting innovation. Third, it suggests performance modelling and experimental verification, the methodology of which to numerically approximate response time of APIs when no fewer than two workloads are active, and experimental data of the fact that response time is enhanced in actual deployments. All these studies may present both theoretical and practical lessons to the insurers which are planning to streamline their IT infrastructures.

Despite the fact that there is a strong background laid by this study, there are several avenues that can be explored in the future. One potentially productive field is AI-based API protection in which AI-based ML algorithms are capable of identifying and preventing the further development of threats in real-time. Another option of interest is multi-cloud deployments based on zero-trust networking that can further enhance resilience, reduce dependence on a specific vendor, and stricter override of identity verification of all interactions. Finally, the blockchain-based blending of smart contracts has the potential that is truly monumental in automating the process of claims settlement and reinsurance. Transparency, faster payout and reduced fraud can be achieved with the help of immutable distributed ledgers, combined with standardized APIs that allow insurers to produce more transparency. These paths will not only be beneficial in technical resiliency, but it will also make digital insurance services more secure, efficient and customer-focused.

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