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DevOps-Enabled Tax Intelligence: A Scalable Architecture for Real-Time Compliance in Insurance Advisory

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Abstract

As insurers continue to confront increasingly daunting challenges posed by not only tax authorities but also by a diverse array of complex corporate clients, the deficiency of timely tax information has emerged as a significant and pressing problem within the realm of insurance advisory services. The marketplace is marked by an insufficient number of solutions that effectively tackle both compliance and strategic planning tasks simultaneously. Meanwhile, many of the other tax intelligence solutions available predominantly generate historical information, which fails to meet the dynamic needs of the industry. Current systems in use often incorporate multiple platforms that suffer from a lack of complete automation, precision, and scalability, creating inefficiencies and increasing the likelihood of costly errors.
In stark contrast to these existing offerings, our proposed innovative architecture is designed to enable comprehensive automation and remarkable versatility in the extraction of essential tax intelligence from the outset and through the advisory process. Utilizing advanced process flows and scalability techniques, we present a robust scalable case study that examines various taxation implications grounded in multiple company statuses as well as diverse geographic alternatives. By thoroughly considering the pressing necessity and optimal configuration, users have the option to acquire this invaluable tool as a service or seamlessly synchronize their respective tax applications. This ensures they are equipped to maintain not only up-to-the-minute compliance but also a strategic approach within the context of insurance expert workshops and consultations.

Keywords: Tax Intelligence, Insurance Advisory, Compliance, Strategic Planning, Tax Information, Automation, Precision, Scalability, Tax Authorities, Corporate Clients, Historical Data, Process Flows, Scalable Architecture, Taxation Implications, Geographic Alternatives, Case Study, Advisory Process, Tax Applications, Insurance Workshops, Expert Consultations.

1. Introduction

Modern businesses and IT operations are carefully mapped to counter the crosscutting issues such as the problem of accumulating technical debt the challenge of ensuring high availability of applications, and so on. Typically, updated existing organizational approaches and innovative technologies are also leveraged to affordably mitigate recent business risks. Nevertheless, such traditional approaches to business transformation mostly ignore tax complexity, increasing the risk of tax dissipation. Tax awareness is the process of efficiently understanding and leveraging tax code for the construction of tax context-aware applications and operational functions. Concepts in tax law, tax architecture, tax compliance, tax usage patterns, tax ontology, tax repositories, tax authoring, data, and knowledge representation, data analysis and reasoning, data visualization, and the use of tax data as a service for online tax-aware computing are included in the landscape of tax awareness. Additionally, the computer science curriculum encompasses knowledge development for tax-preferential computation and dispersion of contributions to inform content for tax professionals beyond traditional tax specialization requirements. Consequently, the journey is a four-part process for the development of tax-aware applications: obtaining detailed knowledge of tax law, the legal guidelines, examples, and realistic problems that must be addressed, and exploring evidence and authoring to extend knowledge and software resources to answer in the form of evidence, examples, surrogates, and guidelines. Furthermore, the ability to visualize theory-based data and perform headless computation for daily real-time tax-aware operations and data analysis and reporting through a rich graphical user interface must be analyzed. The competent real-time performance of tax-aware software is feasible using models. Therefore, tax awareness is designed to be computationally scalable, reliable, and portable via DevOps in a private cloud environment.

2. Understanding DevOps in Insurance Advisory

The insurance domain is more sensitive to new norms and processes applying to architecture development and enforcement. It is not just a part of software delivery; it is more about blending in government norms and regulations to ensure continual compliance. The angle includes data aspects necessary for one-time data collection and rules enforcement to guarantee vital data for insurance systems. Ongoing data compliance is the focus of any intelligence

solution. Insurance properties offer an excellent context to be valid, and an interface between data and intelligence solutions is required. However, at a data ingestion layer, the banking industry consumes a significant part. The offset server should consider and review the applications quickly when opening up for more applications, including more angular insurance-sports applications. The backbone of global insurance services can be agility, observability, and reusability for both operational and investigative actions using data processing streams made possible by building insurance using data format principles.

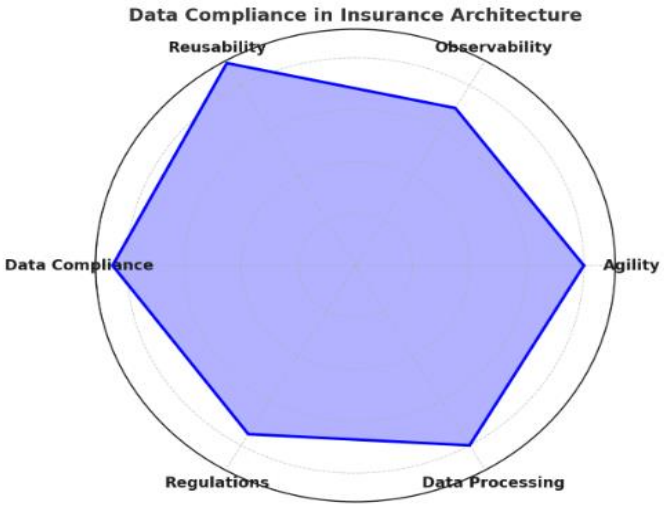

Fig 1 : Data Compliance in Insurance Architecture

2.1. Definition and Principles of DevOps

DevOps, a combination of software development and IT operation philosophies and practices that come from lean manufacturing and agile development, is a concept related to agile methodology. Although DevOps meets the two important moments (development and operations) that the development and software maintenance cycle have with the generation of executables and deployment in productive environments, this cycle became more apparent in the agile stages of the development of information systems based on prototyping, with constant refinements after the system is in the user's hands. This happens in the deployment stages with user feedback about the system being developed and maintained. Auto-scaling is a hallmark of the cloud, and DevOps also adheres to this concept when specific conditions are met and defines what can automatically scale, as well as when to do it. It is a set of practices that encourage collaboration among the development and IT operations teams.

It presents itself as independently organized in phases and oriented to small parts. Despite the differences in concepts, all authors coincide in identifying the factors of DevOps that lead to results in software development, as well as in the collaboration and communication that are principal activities. Finally, we detect that DevOps motivation mainly reduces the duration of deployment, implementation of software updates, releases, and failures. However, the migration of the paradigm from one isolated activity to the cloud in this area is more complex than for the agile paradigm in the area of programming. This stems from the fact that the ecosystem is involved in system operation, where there is a natural interdependence between services and where error conditions are not easily predicted due to the need for software engineering and information systems.

2.2. Importance of DevOps in Insurance

In recent years, the pace of digitization of businesses, expressed in terms of amounts of data created, has grown significantly. Faster and direct collection of data has also become easier due to new data-driven business models, many of which are transforming the market. Consequently, more and more businesses are required to transform at a consistently faster pace, enabled by sophisticated application of data through machine learning models and other analytics techniques. This disruption in business transactions is challenging the way traditional business markets work, placing pressure on regulatory authorities to adapt while trying to maintain a level playing field among market players in those sectors.

In European insurance advisory, insurers run advisory algorithms on locally maintained databases. Those computations result in advisory reports that are then sent to the authority within prescribed time windows. The challenge is that the total bundle of data for all reports exceeds 200 TB, and the technological challenge is that computing results locally requires over one month of computations on nearly 20,000 cores. Sending data or computation to the cloud is risky since documents and computations contain personal and sensitive data. Thus, with the digital transformation of businesses, regulatory authorities are required to build sophisticated, complex, and private systems to continue performing part of

their duties. DevOps is about making software delivery vastly more frequent with improved quality and, at the same time, mitigating its associated costs.

Equation 1 : Tax Compliance Scoring

$$C = f(T, R, P)$$

C = Compliance score,
T = Tax obligations,
R = Regulatory requirements,
P = Payment history.

3. Tax Intelligence in the Insurance Sector

The worldwide propagation of measures to counteract tax abuse and compliance policy pressures, as well as financial market innovations that drove an increase in the number and complexity of new insurance products, exerts considerable impact on the ongoing regulatory efforts to modernize the application of existing tax rules and principles to the current landscape and guard against the erosion of tax bases. Taxes on insurance transactions and insurance products can greatly contribute to the funding of public expenditure, including social protection. Additionally, insurance products are occasionally used for purposes inconsistent with the nature of insurance, particularly given that, in some cases, they can provide tax advantages. In practice, tax planning is critical for both insurance and financial groups and tax departments often struggle to manage their affairs efficiently. Although challenges are particularly strong for insurance companies, as they have multiple stakeholders to satisfy, the loss of reputation from tax mistakes is similar across industries.
In this context, while the correct application of existing rules is vital and valuable, to the best of our knowledge, from a scientific point of view, the innovation in tax intelligence more frequently concerns innovation in risk assessment—the development of new risk factors and risk detection, in particular through data matching—and in updating application software. There is also significant scope for further improvement in the front office and decision processes. Both from the scholarly point of view and especially from a professional point of view, this research makes a significant contribution by significantly developing and expanding the concept of tax intelligence using an interdisciplinary approach to enable insurance companies to assess compliance, respond to cross-sector controls, report information to the authorities, and take into account market data—bookings, balance accounts, policies, claims—using a scalable package of software, data structures, metrics, and methodologies. The reformulated concept of tax intelligence can be classified as "next-generation compliance" and is made possible by the advantages offered by DevOps, which has not yet been used in a tax business process management context. Indeed, insurance companies use a value chain structure consisting of several components, which align with the DevOps continuous integration/continuous deployment concepts. However, while both DevOps and insurance work with the same objective, often developers and operations understand their tasks less well than they could and sometimes follow a different path. It is, therefore, also our intention to use the concept of DevOps as a proxy for agile insurance companies. After all, for disciplined people working with software development and enforcing mature practices, development, operations, and business are of similar focus rather than that of function. With our research, and through the contribution of guidelines for discussion with corporate departments, we aim to spark debate and demonstrate the advantages of implementing new-generation tax compliance concepts.

3.1. Overview of Tax Compliance Requirements

Tax legislation in insurance is complex due to the nature of the contracts, i.e., the same contract can show various income streams and taxation events. The complex reality affects policy premium control, withholding the risk that the tax authorities receive the premium tax even 18 months after production. This is a considerable operational risk because tax rates can change over time, making taxes impossible to pay. The firm, with liquidity constraints, can proceed with an insurance policy that the tax bill cannot support. Furthermore, the tax office asks for proof of payments, and settlement days after the bank transfers in the case of premiums paid by installments. Tax authorities are focusing on insurance premiums payable, the place of supply of these premiums, which are termed as the location of the risk, and the relationship of the premium for insurance-related services. Additionally, governments are trying to recover premium taxes and social insurance contributions because of higher levels of unemployment, which puts public resources under pressure.
The deadline for the payment is also critical: the lack of payment on time leads to the application of the most severe penalties, which depend on the law of each country. Last but not least, compliance fraud—improperly managing to take advantage of exceptions such as life premiums and GCT exemption. These violations have caused tax audits and the imposition of huge fines that can place the solvency of some insurers at risk. The vision of tax legislation and not only of tax obligations management is strategic and related to a tax intelligence model that is outlined in the following sections.

3.2. Challenges in Tax Compliance for Insurance Advisors

Tax or regulatory compliance has four primary attributes: (a) the existence of regulation, (b) entities that either explicitly fall under the realm of that regulation or entities that are closely related to it (and hence are de facto liable to adhere to that regulation), (c) observability (who is doing what), and (d) a feedback or signaling mechanism to reduce divergence from compliance. In the insurance business, the declaration of overall information is often deferred in favor of stronger customer relationship success, resulting in control weaknesses and difficulty in identifying non-compliance activities such as incorrect calculations of taxes or a lower value-added tax paid.

When a major integration is in progress or changes are managed by separate solutions, different integration layers need to be modified multiple times, creating high integration costs and making it error-prone. These scenarios often lead to pulling data from the source to the target, which causes data duplication. Additionally, because of the creation of a separate workstream, it is difficult to manage service agility, which is important in the insurance process. System fragmentation and duplicated processes hinder end-to-end user transparency and traceability, leading to problems in self-service tasks and hindering process optimization. This can also have an impact on tax alerts that can receive erroneous calculations.

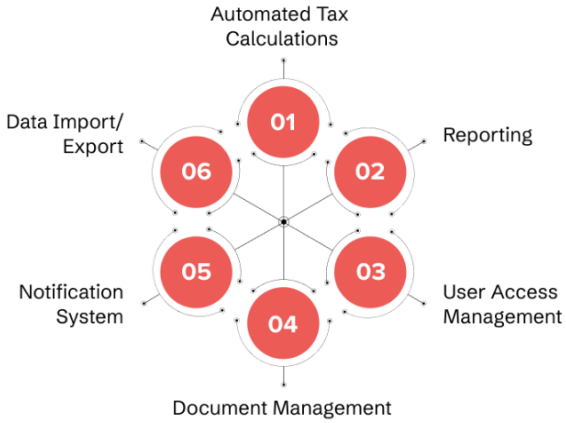

Fig 2 : Tax Compliance Software Development

4. Real-Time Compliance Framework

Tax compliance needs real-time information on transactions. The Real-Time Compliance Framework (RTCF) solves the scheduling of the ETL used to populate the DWH to prepare management reports and provide real-time information to the tax team. We present the architecture and preliminary testing of RTCF of an IT services company delivering tax intelligence in a preeminent real-time investment solution for an insurance entity. The solution uses DevOps principles to facilitate the architecture's scalability through infrastructure and performance as code. Scalability is achieved by collapsing the data lake and warehouse into the Enterprise Business Analysis System (EBAS), hosting not only tax intelligence but also specialized accountancy and actuarial reporting, making RTCF the backbone of the organization's information plans. Real-time information is the foundation for insurance companies to operate using microsecond trading, high-performance computing, distributed systems, and fault tolerance. However, companies are prevented from providing real-time data to their tax compliance professionals because of data inconsistencies coming from other applications. They must complete a batch historical reports. We propose a Real-Time Compliance Architecture (RTCA) for an IT services company, applying DevOps principles to the SDLC cycle in a scalable solution, ready to face the challenges of this real-time postmodern business tax. We boldly advertise the IT company's solution as a banking and insurance tax or business solution and present results on the efficiency of assets in executive meetings and audits.

4.1. Components of Real-Time Compliance

Real-time compliance in insurance advisory requires a vast array of capabilities, ranging from data sourcing to data preparation to data analysis. In this section, we outline the basic components of real-time compliance and their key components.

Tax intelligence operates on a diverse, multifaceted set of data that comes from various internal sources. Meticulous data sourcing ensures the ready availability of tax intelligence when required. This involves multiple tasks: identification of allowable and excludable internal data sources, understanding metadata, data extraction, maintaining a data catalog, and secure data storage. New data sources can emerge at any time, containing critical tax intelligence information, such as tax code changes, exempt customer lists, or court case opinions. These new data sources should be integrated into the DevOps processes as quickly as possible, with the data prioritized in the design of new tax intelligence modules. Combined, it is

important to ensure that the usage of the data complies with legal requirements, defined source/service agreements, and internal governance guidelines.

4.2. Integration of Tax Intelligence and Compliance

The central task of compliance work is to ensure that the business benefits of tax-ahead premiums are used for the payment of such concessions to businesses, which accelerates the collection of taxes. Through the introduction of DevOps practices, not only can practitioners continue to provide customers with timely modernization of their pro-competitive advisory services, but they can also ensure that work on the tax advantage proceeds with the highest level of certainty. With these additional features, tax intelligence can play an even greater role in enabling accurate, real-time, and scalable compliance for Canadian and global insurance policy management. The multi-hybrid paradigm of systems types is incorporated into business support through an agile and regressive transition of DevOps, which reasonably allows for a refactoring and packaging strategy for the integration of smart regulatory controls. In today's settings, it seems ubiquitous to continuously improve by automatically assimilating the most local changes. At the same time, it is an extremely desirable business practice to form a tax team with compliance that combines strategies for mutual agility and high regulatory ossification. This topic aims to draw on the deep learning tasks of filing more and more complex tax logic regulations than traditional demand filling, and it also contains a variety of potential answers that can be used as a basis for taxation information and inspection.

5. Scalable Architecture for Tax Intelligence

There is abundant evidence that the current tax regimes are not capable of managing the new digital and service-based economies. As digitization of corporate processes continues to grow, traditional collection methods, based on cumbersome audits and survey forms, are doomed to become anachronistic. Thus, we believe that developing innovative collection techniques by leveraging digital shadows becomes essential for tax governance to cope with some key problems the current authorities face, such as VAT gap existence, judgment and compliance duty excesses, severe limitations on tax influences, and the tax authorities' lack of innovation capabilities. Moreover, even though some well-established business activities need frequent audits, the fact is that collection efforts should be designed to reach the long tail of small and occasional but potentially delinquent taxpayers, who are systematically using modern digital services.
To that extent, this text will focus on how tax governance can effectively apply information collected in a system to individual taxpayers. In this way, we suggest it is possible to use this information not only as an intelligence measure but also as a control technique that can be applied under the direction of a tax authority. This is called "tax intelligence" and it means that such systems can play a leading role in the smart tax governance that tax administrations must adopt to be successful in the tough digital environment our society is on the way to.

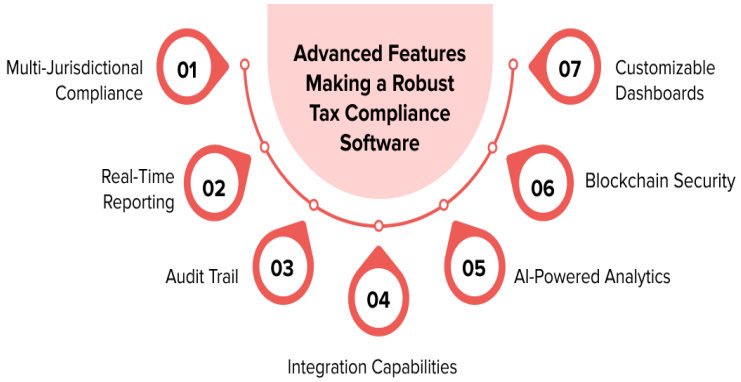

Fig 3 : Tax Compliance Software

5.1. Design Principles for Scalability

Guiding principles to ensure a robust and scalable cloud-based architecture for real-time compliance in an insurance advisory included a mix of architectural and operational requirements. These design principles, elaborated as follows, remain a vital factor for the success of such a system. On the operational side, our solution devised strict real-time service level agreements with field agents to alter advisory service tuning in real-time. On the architectural side, we needed to design a scalable stream processing infrastructure that could be horizontally scaled as and when the source workload of data being fed into the streaming units grows. We further needed an architecture that could quickly rebalance the processing load among horizontally scaled units or nodes within the stream processing solution.
Handling Burst

The predictive models are continuously calibrated with drivers of non-compliance. When we needed to update the model once in a while, the existing real-time model could not be taken off the road. We compared a few criteria before arriving at our decision to build our system using a streaming solution, which had the exact characteristics we needed. While another option seemed to be a popular choice for event sourcing and managing real-time workflows, it had severe limitations as a computation engine, such as serving as a clustered manager that could affect credibility and impact the delivery of a model update. Furthermore, the existing legacy system - if designed afresh today - could not support the burst or weekend behavior as described in our solution story.

5.2. Cloud-Based Solutions for Insurance Advisory

To provide real-time compliance in tax advisory for P&C insurance companies, the complexity cannot be underestimated. As insurance companies become more digitally organized with cloud computing platforms and storage, the need for scalability in advisory operations demands cloud-based solutions to meet the ever-growing demands of tax intelligence. These solutions must have built-in agile methodologies and a DevOps culture for the enterprise, powered with real-time data on a big data platform, enabling both real-time calculated impacts and post-filing work. Prototypes on cloud-based P&C insurance visit over 20 Agile teams and provide coverage to more than 20 US states. Software size ranges from small to large-scale applications. In the absence of guidance, the Agile teams can generate architecture from the common reference architecture and release it with minimal architectural review. These approaches significantly reduce the time required for compliance with the new laws and add additional savings, allowing additional capabilities for the business, like providing real-time results on data calculations of the tax impact at underwriting time. Interest in CAF is surging and is a topic to watch for its ability to help apply architecture and drive architectural decisions. DevOps concepts may help to maintain distributed tax intelligence applications for compliance and post-filing purposes for P&C insurance companies by never letting the availability of actionable insights lag.

6. DevOps Practices for Tax Intelligence

Agile DevOps for Scalable Tax Intelligence Articulation

The ability to be agile and to leverage DevOps practices is important not only during the software development life cycle but also for the implementation and deployment of the orchestrated solution. Using the Scrum methodology already established in the organization, monitored by a backlog that facilitates risk-based sprint planning, we managed to maintain a corrective action rhythm, avoiding the overcoming of production batch cycles. We use some agile concepts to apply DevOps in the solution, such as daily meetings with the project monitoring team to review the sprint burndown and check for any bottlenecks. For containers, we created immutable images containing the tax adjustments and distributed them in a private blockchain, so that all steps in the solution had access to the tax adopted in the batch exposure process. This technology is used in production and out-of-analytics environments to ensure the suitability and security of microservices running in exclusion layers, using the entire execution period to simulate and analyze the bivariate division between cut-off values, and then consider the tax that was adopted after the agreements with the business.

The office work is distributed, and servers perform the necessary actions at the desired time. Running daily jobs, as well as elasticity and scalability, ensures the robust checks needed as the company increases workloads. Thus, to orchestrate different development and infrastructure stages, we use an easy tool to incrementally create a step-by-step process. The integration and continuous delivery service post the new image in our private repository, deployed within the employees in a cluster. On the same day, tools are used for API tests. With these results, a project passes to the IT service in a project, while the project continues in a development environment, running together with the clients in a prototype environment. The construction of the containers takes place through a concurrent environment with the help of a tool. The optimal indicator tests for this study are mobility tests, which have been added to the conversation network chain between developers, the Office of Technology, and infrastructure discussions. The final script inserts the changes into the largest number of manual environments until arriving in the pre-production stage, providing the desired existence coherence, color coordination, and homologous pre-service training, thus ensuring the security of a comment training with the migration of a team.

6.1. Continuous Integration and Continuous Deployment

To make sure that there is no duplication of functionalities, we categorized small-size tasks and distributed them effectively across microservices. We conducted the Design Sprint workshop for the stakeholders to identify main users and roles, define their main tasks, and sketch the workflow representing interaction among their tasks. We developed UI wireframes, updated the script and contents, and ran a two-day workshop to design the initial process by using a software firm. In the design phase, data mining and summarizing services allow our system to process unstructured data.

All code is stored and managed in a version control system. The pipeline works to coordinate and integrate web services between added code and creates an environment to perform unit tests and build an application. The pipeline consists of stages for individual building, testing, and deployment. The CI process works after the developer submits the development

branch, and then builds the application using full integration when the developer submits the request to merge the application built through the pipeline. After the automated deployment run step, the feature is deployed to space. A deployment pipeline is created in CI/CD so that the merged code moves to the data in the deployment, checks the build output, and then deploys it to an environment next to the container registry such that each branch and tag can map to the deployment path of the service deployed on the API.

Equation 2 : Anomaly Detection for Tax Fraud

$$A = \sum w_i |X_i - \mu|$$

A = Anomaly score,
X_i = Tax transaction feature,
μ = Expected value,
w_i = Feature weight.

6.2. Automation in Tax Compliance Processes

Tax and regulatory compliance involve human judgment at various stages. However, the process component of tax compliance, which accounts for a substantial part of the overall compliance cost, is being automated in many jurisdictions. The administrative machinery, consisting of the tax departments for every business, is expected to take preemptive action for such automation to scale. Any such scaling, of course, requires changing the rule structure that the tax department itself uses to interpret the law. The devolved nature of administration in a federal polity makes this uniform scaling of compliance through automation a challenge.

We address this challenge using an insurance business advisory use case, enmeshed in the return filing environment, to present a template for business tax intelligence. This template, its large-scale implementation being the subject of future work, enables the lines of business to address most of the tax compliance requirements directly in a scalable manner. The template addresses two separate but interconnected automation aspects: the level of automation of tax compliance and how DevOps enables that level of compliance. Its scalability follows from the frequent release cycles, the DevOps-enabled agile development culture which rapidly resolves tax intelligence issues as they are encountered, and the ability of the users who direct such scaling.

Fig 4 : Develop a white label Tax Compliance Software

7. Data Management Strategies

This section describes the strategies employed in meeting the challenges associated with building a real-time data pipeline, especially the vital concerns in the sets of data managed, relevant transaction properties, and an evolvable meta-schema; how the pipeline invests for a future strict database transaction fractional commitment; and the promising combination between traditional ACID transactions and chaos engineering patterns for handling transmission errors that may lead to revelatory ETL paths. First, we discuss the sets of data we are handling: it is, in effect, a functional, sensible, and historical

split of database sources for real-time compliance with regulations, closely matching the reading and writing concerns divisors between read transactions and advisory commands. Second, given these sets of database sources and compliant transaction semantical design, we assert our project's schema with enforceable field mappings signaled specifically from a business-involving unit of analysis, thus also definitively addressing how the set of objects used as parameter values to each transaction complies with the constraints advertised in the schema.

Processing consistency level patterns are investigated. While acyclic, linear consistency and serializability are not readily possible for economical data link establishment, snapshot isolation recurs. Ours is an architecture open to such amplitude, but not eager to require it, since we advocate classic ACID guarantees but need not enforce them: in transaction injuries, our priority is to offer ACID-supervised recovery, or self-healing to its subscribing transactions, that quickly reforms from detected rare failures in data transmission. Voiding traditional database recovery strategies and leveraging commercial cloaking, we righteously engage our transactions with chaos engineering patterns. Traffic is not to be disturbed: inspire. We discuss how we designed our mishandling of the very emissions from data transmission that are the engine of our monitoring, to momentarily suppress apparent breaches of constraint, and we illustrate a riven ETL pipeline.

7.1. Data Collection and Storage

Scalability has become a key concern in today's data-intensive business, whose flow speed in turn demands real-time query response. In the extreme, the real-time constraint can lead to operational analytics, where the initial ingest of data can end the conventional extract, transform, and load cycle required for offline analytics. The adaptability of operational intelligence for one line of business in insurance, namely healthcare insurance, shows promise for other domains. This paper provides a first step towards introducing real-time business analytics in the tax domain. To that effect, the architecture underlying an insurance advisory firm was enhanced to turn it into a DevOps environment, and its operational intelligence operations reveal and support analytic tools to enhance a pundit's judgment.

Our organization has to satisfy data warehousing constraints, for we store a large number of different types of business objects. The architecture proposed accommodates tax intelligence workloads. The center column of the architecture includes a data collection tier, where data asynchronously collects the data used for the insurance advisory mission, as well as files generated by the brokerage firm. The data storage tier supports both transactional storage using table storage provided by the commercial cloud platform and a staging area for initial load and integration with large cloud-based data warehouse tables. Data in our organization is immutable; i.e., it is only appended and never updated. Storage is dedicated to simple, demanding operations.

7.2. Data Analysis for Compliance Monitoring

The heart of our tax intelligence framework for financial products is a new approach to monitoring compliance. Fundamentally, a key success factor of this vision is the capacity to carry out real-time compliance checking at scale. We detail our scalable design for compliance checking, which can enable a data processing pipeline free of a bottleneck and incorporate different types of data analysis models fully managed as a service. We explore in detail how we monitor compliance with the value-added tax directive for insurance and reinsurance services. This perspective parallelizes the data analysis task and incrementally updates results, a move away from the traditional but expensive error reporting designed into our existing tax calculation and reporting platforms towards proactive real-time compliance.

Transforming existing end-to-end data processing pipelines to incorporate new compliance checks as part of the data analysis task. Each piece of information from customer interactions is forwarded to all our compliance checks, where on-demand, heavyweight background processing takes place to produce alerts. The execution of compliance tasks is coordinated per customer so that each customer is processed in isolation, against the set of data points contributing to the work queue at the time. Every customer may have concurrent checks from different taxonomies, resulting in a workload per customer equal to the estimated time by each awareness interval enforcing the maximum allowed ease.

8. Security and Privacy Considerations

Security and privacy may be regarded as core components for the development of all systems but are critical when sensitive data is concerned, as in the case of insurance data. Our approach foresees strict data security and privacy through proper handling of all data representations at all stages in the architecture. Moreover, tax information reaches a high confidentiality level as it is critical business information, and any unauthorized access could result in noncompliance, reputational damage, and financial loss. Security and privacy are addressed by encrypting both data-at-rest and data-in-transit using the latest available encryption standards, and carefully designing the data processing operations to minimize data exposure. Ongoing surveillance and compliance validation should be in place to check all the defined security measures during the lifecycle of the architecture. All cybersecurity components detect and tackle any attacks in real or near-real time, making it extremely difficult to perform a security breach. At the policy, risk, and governance level, we plan to address security through trusted relationships at all levels and ensure sensitive data is passed to those principles

that respect the terms and conditions agreed upon. Our privacy approach is built on the principle of handling the minimum necessary data as required, associated with data anonymization, and includes privacy by design at every stage of the data lifecycle, according to existing regulatory requirements and forthcoming legislation.

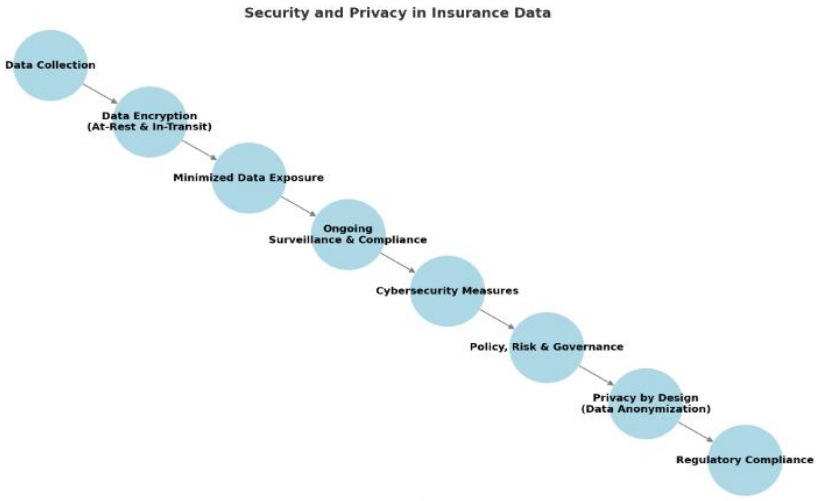

Fig 5 : Security and Privacy in Insurance Data

8.1. Regulatory Compliance and Data Protection

Regulatory compliance and data protection - The complex nature of tax legislation and its implications, compounded by the need of companies to map these constraints in increasingly heterogeneous and potentially spurious environments, such as databases of information, often disconnected, demand both the realization of studies in the specific area from the point of view of technical knowledge, as well as the use of information technologies not only to treat information of diverse nature but also to benefit from synergies through data processing between different sources of information. The tax authority has a set of rules that express the imposition of their will in matters of taxation. For legal reasons, obligations are imposed on consensual relationships between citizens and proxy institutions. The need to guarantee the collection of taxes and to control saving behavior markedly influences the formulation of fiscal policy, which assumes a more sophisticated preventive function, both at the pre-task level and in monitoring and inspection of tax obligations. Control actions should be explanatory to promote the voluntary compliance of citizens since the cost is lower when it is subject to voluntary fulfillment.

Contradictions between the right to privacy and the right to access personal data are of particular concern in the field of tax law. The solution to preventing tax evasion and guaranteeing the tax base is largely based on big data, i.e., the myriad of data flows from bank accounts, telecommunications, retailers, pharmacists, and entities. Insurance institutions, including those providing brokerage services, are faced with significant challenges in the security and data protection of their daily analysis. Given the potential of using the information content of the data to improve the knowledge of the subjects, these reach and exceed the space of understanding of the national regulatory framework, both in the collection and in the processing of personal data. The importance of this knowledge is recognized.

8.2. Risk Management in Tax Intelligence Systems

In the area of cloud risk management, a couple of interesting works have emerged. In particular, a privacy-aware contract for public cloud services is proposed. This contract aims to guarantee the user's data privacy requirements when storing them in a place provided by a cloud storage provider. The architecture implements a real-time multi-level auditing service that supports fair-use policing of cloud services while at the same time protecting provider and user commercially sensitive operations and sensitive data. Despite these works, significant research challenges exist in the area of cloud risk management, both in traditional corporate tax risk management tools and advanced tax management in the emerging era of corporate tax intelligence systems.

Tax intelligence systems aim to capture, drive, and provide forward-looking strategic, statistical, and tactically guided compliance design and management decision-making, enhancing corporate governance and minimizing likely tax administration impact on tax planning questions and challenges, while minimizing the side effects of accidental tax management. Tax intelligence systems are not common within the existing business tax frameworks, since existing tax solutions support traditional tax practice operational requirements and minimal tax inquiry impacts due to cloud computing usage growth, lack of continuous innovative intelligence or operational solutions, poorly enforced processes, and inadequate operational designs, which expose key data accessibility and management risks. The development of tax

intelligence systems has to rely on robust research, encompassing and implementing collaborative strategic management control processes, scale computation and storage, enterprise content management and archiving, data mining, analytics, knowledge management, expert systems, personal agent research threads, risk management, regulatory compliance, internal audit, statutory audit, assurance service with comprehensive audit reporting, assurance service with contextually relevant information, and assurance service with quantitatively reliable information, and data governance and data quality.

9. Case Studies

This chapter has presented a conceptual architectural framework for leveraging microservices and DevOps capabilities for implementing tax intelligence in commercial insurance advisory systems. To validate our approach, we have developed a near real-time compliance module in an insurance advisory system within our enterprise. As mentioned earlier, our Semantic Analysis microservice processes tax rules to create rules on demand through an SQL query. It contains a custom pipeline that allows all configurations within annotator classes while supporting further linking to the store. Similarly, UI-based rules creation and establishment of communication channels with other tax enterprise systems have been accomplished.

The case studies in this chapter expect readers to be familiar with modern software architecture and programming, especially microservices and DevOps toolchains. In our enterprise project, we leveraged service-oriented enterprise-scale challenge handling while developing a high-functioning domain model using microservice concepts. We used individual microservices as springboards in creating rule patterns, internal workflows, and system designs. Rule patterns were derived from tax requirements and processes within our enterprise. Initially, we isolated these rules in a simple utility microservice. Next, a more advanced service was implemented, and subsequent RDBs were populated using these services. Each microservice fell within a more comprehensive and complex interaction with the broader system.

9.1. Successful Implementations of DevOps in Insurance

"Insurers and brokers looking to implement DevOps successfully consider that they are not just transitioning from one culture to another, but are transitioning the whole business. Inside their teams, they focus on improving the KPIs that are aligned to performance and the value they provide their customers. With more technology than ever available, DevOps in insurance is not about playing catch-up. It's about embracing technology without any excuses. They look at their silos and see what technology is available to quickly and efficiently break them down. They visualize the value stream, finding paths to have concurrent versus sequenced processes. They aim for small batch sizes to expose issues as early as possible. They recognize that output quality can never be better than input quality. Trust and transparency allow them to create an environment that minimizes the levels and degrees of failure. Bringing business and technology together is one fundamental condition to walk this way.

Executives often realize that the experiences they have seen work elsewhere might not work for them. They hire consultants or subject matter experts who guide them through their very own transformation. The ones they expect to take back control once the processes or policies are in place. Implementing DevOps means more than using tools. It demands a cultural shift, focusing on people, as well as on technology and process. Those who adopt this culture or mindset typically say it takes more than a year to get up and running. In tackling our transformations, we mess up, we create bottlenecks, and we go back and rework our designs. See, it's all in how long it takes to patch, and then adopt and move on. We stay organized, we align with the business lines, and we continue to prioritize the value that we deliver. All of us employ language, and we share a set of principles, outstanding objectives, and key performance indicators that all resonate with those of colleagues across the insurance industry. As we break in later chapters, we aren't just any insurance technology practitioners. We are DevOps."

9.2. Lessons Learned from Real-Time Compliance Projects

This section pointed out the valuable lessons learned for applying the proposed DevOps-enabled tax intelligence to accelerate real-time compliance in a P&C insurance advisory domain. Based on these insights, the limitations and future work were also elaborated.

In our experience, which is originally from establishing ETL processes and continuously refining the data warehouse for policy and endorsement-related questions, data engineers need to assist policyholders and accountants more proactively via a DevOps cycle. As the data landscape changes frequently and data issues need to be iteratively fixed, data and semantic modeling are essential for shortening policyholders' and accountants' knowledge of policy statements. However, in the data-driven world of insurance, the DataOps and AIOps problems are important and valuable to be solved. To foster a culture shift in enhancing policyholders' experiences, engineers need to adopt and demonstrate intelligence throughout the engineering and decision-making steps. In this magnitude-based approach, insurtech teams are well positioned to increase the granularity of where and how to add high value in high-exposure areas suited for startup innovation value delivery.

There are several limitations to this work. 1. The proposed scalable architecture is mainly designed to solve tax questions for a limited time range. More sophisticated models are needed to generalize adaptive signaling with big sequence data and label bias learning. 2. Data is often incomplete and may be subject to delay. These noisy labels might lead to misunderstandings regarding the amount of labels or the choice of data-driven methods. 3. Further investigation of the value of real-time tax intelligence is required to ensure wider deployment and compliance coverage.

10. Future Trends in Tax Intelligence and DevOps

The complete capability and full maturity of DevOps enable it to improve all the less-adaptive financial services industry. One of the important markets is tax intelligence systems. Regulatory requirements, jurisprudences, and cloud development can be building blocks that deeper technical infrastructure concepts and workflows can be applied in the future. On the technical side, tax and fee data is still sticking to somewhat outdated batch-level data and processes. There are no easy and affordable ways to slice the data being reported. On the process side, fixing arbitrary and changing rules into fixed processes is hard to scale beyond medium-sized businesses. As online digital accounting and bookkeeping are currently having a major upgrade moment from cloud-based paid and non-paid services, it is the right time for cloud-native DevOps to become part of mainstream digital finance.

By directly investing in nonprofit computer and data thought leaders, powerful and complex fast automation models, and software can be public goods that are available to all businesses, not just as outsourcing from certified accounting organizations using software on single-dimensional links such as unique company IDs and paid taxes. High-quality paid models bootstrapping genuine free versions can allow compliance performance to be decomposed with outcome and transparency. Decision makers and decision influencers can transparently slice, dice, analyze, and program operation and process outcomes enhancing DevOps. The significant social impact realized by sticking to the heart of the matter acting at the market scale of millions of businesses paying taxes is the benchmark. Compliance, commitment, and communication are essential and incontestable societal components of tax behavior reporting. Transparent and fair analyses and analytics are a development ahead that should be performed with robotic precision and accessibility.

10.1. Emerging Technologies Impacting Compliance

New advancements in information technology are impacting how compliance is achieved. It is characterized by automation through improved human-computer interactions and also by improved human-assisted interactions. We proceed to discuss the new technological methods that are frequently being used to achieve compliance trustworthiness, such as blockchain, robotics process automation, emotion AI, extended reality, additive manufacturing, and 3D printing. The real and potential applications of emerging technologies in the various phases of compliance management are summarized. Each of these technologies can be used in multiple stages across the various compliance phases, both for process improvement and for full-scale automated compliance. The commonalities of these technologies are summarized within these four emerging technological areas, and the real and potential uses within each technological area are described.

In practice, these technologies seem to be used in three ways. Firstly, they are invariably used as part of a multi-technology stack and add unique value within the context of all the phases of compliance. This is usually an attribute of being inherently interoperable as part of a multi-technology stack. Secondly, there is a tendency to use these technologies for process automation. In essence, these technologies are used to replace human activity by undertaking tasks otherwise done by humans in their entirety, thus promoting monotonic automation, as is the case with blockchain, robotics process automation, and automation on steroids. Thirdly, they are capable of changing the very nature of humans involved in the processes by introducing new capabilities during which humans can act as part of the compliance process. These approaches are summarized and discussed in turn in the following sections, and the results from a survey of the actual uses of these technologies are summarized and discussed, along with the need to promote more of these innovative uses.

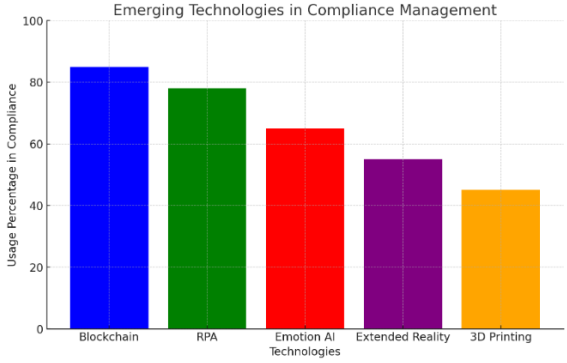

Fig 6 : Emerging Technologies in Compliance Management

10.2. The Role of AI and Machine Learning

It is noted that a large-scale capacity for searching for credible real-time evidence of non-compliance against heterogeneous sources for diverse industry-specific tax rules cannot be implemented and maintained with traditional rule-based systems or expert systems. In the context of the current works, leveraging machine learning and AI for such purposes becomes easier, more intuitive, and significantly more cost-effective, considering the noticeable reception of currently applied research in the direction of AI and machine learning, which surpasses rule-based and expert systems in lead time to market. Relevant work is focused on improvements and research in the training of labeled or unlabeled supervised or unsupervised deep learning models to develop scalable and self-sustained intelligent compliance tools in multiple behavior understanding fields, particularly in the field of tax intelligence, fake news, illegal behavior on the internet, etc. Many deep learning models have the potential to contextualize heterogeneous data and capture uncertain samples, such as Markov-modulated Poisson processes, hidden Markov models, higher-order conditional random fields, higher-order information networks, transformer networks, and many others helping with interpretation or hiding data.
The increase in model performance of gold standards is a result of deep learning technologies and also presents easy-to-prove performance gains by using simple and cost-effective models. Methods that take advantage of the hierarchical and temporal nature of data as well as innovative labeled dark data also allow more generalized compliance detection systems that are closer to replicating the learning process of observant professionals. To achieve this with deep learning models, a large-capacity deep network performance improvement can be exploited through an increase in the breadth and depth of the observed risk. In many more situations, compliance professionals and businesses alike are encouraged as part of the compliance processes to respect the decentralized and privacy-aware learning electronic protection models due to the current use of the General Data Protection Regulation in Europe and the banking context, respectively.

Equation 3 : Continuous Compliance Monitoring

$$M(t) = \int \lambda e^{-\lambda(t-u)} C(u)\, du$$

$M(t)$ = Compliance monitoring,
λ = System update rate,
$C(u)$ = Compliance score.

11. Conclusion

The responsibility levied on the personalized advisory to ensure full compliance with tax authorities poses a significant challenge. To provide financial soundness checks before the execution of the client´s transactions, a significant effort should be made regarding the configuration of tax rates and rules at their amassed precomputed states. DevOps aims to facilitate the delivery of feedback into the advisory loop, thus allowing for a compliance prevention function based on real-time computation. This work presents the implementation of a scalable service delivery infrastructure based on a set of microservices designed to provide real-time financial soundness checks. Although the presented architecture is focused on the traditional tax calculator, it can be extended to the other existing advisory capabilities. Implementing a complex advisory in real-time can benefit the modernization of risk assessment by tax authorities, gaining and generating insights from the individual financial transactions within the underwritten policies. Execution through an automated continuous deployment approach, the increased confrontation with work-in-progress changes can reveal refinement opportunities. This will lead to a science-based advisory configuration abstraction to automate the discovery of tax rate and rule application readiness. Such a personalized Pre-Fulfillment Financial Soundness Check service thus leads to a broader implementation mission for Instant Intelligent Insurance Advisory: to explore the connections between insurance transaction types, risk exposure types, and the lifecycle times of their financial perspectives.

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