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Designing Scalable Technology Architectures for Customer Data in Group Insurance and Investment Platforms

Ramesh Inala

Data Engineer
ORCID ID: 0009-0009-2933-4411

Abstract

Designing scalable architecture frameworks for customer data have become increasingly important. While technology transcends most industry barriers, the cross-border, multi-national nature of the Group Insurance and Investment services operational delivery models create heightened requirements for assessing and building those capabilities. As these organizations with international footprint continue to evolve their digital strategies, key pillars of their technology architecture must mature both from an operations and governance structure perspective for continued success. Designing customer data architecture and structure, especially around the Canadian market, has become even more challenging in the current and post world. This is compounded by the fact that while the accessing and servicing of client customer data is generally addressable via digital fabric capabilities, the transferring and modifying of sensitive customer data must follow established routine and tested procedures. Regulatory control and governance of that architecture is fundamental for a tier-1 life and health insurer's long-term brand health and reputation.

The analysis of the investment portfolios that reflect these digital strategies and customer data architecture designs must encompass a levers framework that contemplates IT investments and growth as enterprise capability sources. Examining the investment and profitability issues through the lenses of portfolio theory, we have described ten functional pillars foundational to technology architecture in the digital age. Embedded within these pillars is a set of practical considerations, reflective of the lessons learned the hard way, that insurance organizations can replicate for their benefit. We use a life and health insurer and its business for the purposes of demonstration of diagnostic building blocks and the capabilities roadmap in delivering on a group insurance and investment customer-centric technology architecture.

Keywords: Scalable Architecture, Customer Data Management, Group Insurance Systems, Investment Platform Design, Enterprise Technology Architecture, Data Scalability, Cloud-native Solutions, Data Integration, Digital Transformation in Insurance, Financial Services Technology, Data Governance, System Performance Optimization, High Availability Systems, Microservices Architecture, Regulatory Compliance in FinTech.

1. Introduction

In this article, we describe the characteristics of customer data in Group Insurance and Investment Platforms (GIIP). We describe data growth and retention requirements and the functional challenges of legacy GIIP customer data. Customer data for GIIP support business domains that are a more complex combination of the traditional domains in Life and Pensions; these domains grow at different rates through time and often have need for instant access for transactions and frequent updates by multiple parties. Customer data is core information that insurances and Investment Services use in the execution of policy and investment servicing and in establishing customer relationships for cross selling opportunities. Insurance Companies and Retirement Funds need to have appropriate Data Governance Policies in place to ensure that GIIP data is reliable and trusted. In this article we will explore how Data Architectures can be structured to meet both the demands for low cost processing of potential millions of transactions for supporting GIIP services and the demands on access time for maintaining support for customer interaction by the Insurer or Financial Intermediary during the policy or investment servicing process.

While the potential transactional volumes for Gas, Electricity and Water services are greater than Insurance and Investment, the nature of GIIP transactional interaction is more complex. Unlike Gas, Electricity and Water Utilities, Insurers and Fund Companies have complex products that provide for contingent benefit and retirement support provision. Unlike a Utility Company, GIIPs often have a need to provide fast response around development of Insurance Claims and Cash Needs or Retirement Readiness advice. Because of the nature of the Insurance and Investment Services being serviced, Customer Data for an Insurer or Fund Company have essentially a Hybrid Domain Structure combining the Demographic Attributes of individuals with product and account related specific attributes. The purpose of this article is to explore how Data Architectures can be structured to meet both the demands of low cost processing of potential millions of transactions supporting GIIP services and the demands of access time in maintaining support for ongoing customer interaction by the Insurer or Financial Intermediary.

1.1 Background and Significance

The group insurance and investment market sector changes encountered over the last quarter century have created a requirement for the development of ever larger and more complex technology platforms. These technology platforms must accommodate unusually large customer volumes, potentially mimicking critical systems such as telecommunications or financial transaction platforms.

They must also accommodate a broad diversity of products and client segments, including core universal group life programs, ancillary life products such as accidental death benefit riders, and ancillary benefits such as short and long-term disability income products, critical illness products, and group and individual pension and retirement products. The diversity of offered group products creates a need to provide end-users, such as service and sales broker agents, access to a multitude of complex systems and business rules. Furthermore, with the advent of globalization, a significant number of life insurance and pension programs are shifting focus from a local to a global or international market. Global life re-insurance programs pose a critical importance in the market evolution. Demand over the last decade has witnessed noticeable mergers and acquisition activity and competitive pressure regarding pricing and commission structure. New entrants have changed the landscape, increasing standard coverage options through a comparison shopping channel. Profit margins on universal programs are at all-time lows. Core life products are changing as customers are demanding products that combine life and disability insurance, pensions and investment products, and insurance and savings products. Due to these factors and others, the core products have enjoyed only a focused product enhancement. Product management and systems have matured to address the market shifts; however, the products require periodic enhancements to create a competitive edge.

2. Understanding Group Insurance and Investment Platforms

In this section, we outline the various functions performed and data managed by group insurance platforms. By explaining the various tasks that the operational system must perform and the kinds of customer data it manages, we shed light on the functional requirements for designing the technology architecture. Specifically, these platforms are responsible for administering group life insurance, the payout of insurance proceeds to the beneficiaries designated at the time of the member's passing, and the custody and payout of accumulated funds on the members' behalf at the time of retirement, dismissal, or central government employment.

A group insurance platform is part technology and part Operations Support Systems – a human and process-driven support environment that uses technology to accomplish a customer-valuable goal. Group insurance and investment platforms are responsible for the complete member lifecycle management, right from when the group insurance is marketed to a corporate and sold, through the onboarding of the corporate and the group members, to the administration of the plan, including regularly notifying the corporate and members of the group policy's terms and conditions, the monthly payroll deduction done by the corporate, the payment of proceeds by the corporate, and the final settlement – the transfer of the accumulated fund by the member to the chosen receiving bank on retirement or dismissal from service by the member, or at the designated time by the group policyholder. In this context, the system's longitudinal view of every member acts as a backup for the corporate processes and is respected by both the corporate and the employee members in the latter's roles as agents and beneficiaries.

Fig 1: Group Insurance.

2.1. Overview of Group Insurance

Historically, Group Life insurance was the first of the Group insurance product family, introduced in the late 1940s. A traditional core Group Life insurance product provides various cover-durations death benefits on natural death, accidental death, as well as terminal illness from predefined exclusions. Such a product was developed for the purpose of defending the employer-employee allegiance, used as an employer fringe benefit, subsidized by employers. Continuous era change made these traditional Group products transform, primarily because of the increased competition in employee retention, the changed mindset of employees in terms of financial planning and support of appropriate financial products, as well as the extended Group longevity from the employer side mainly due to medical costs. These early initiations in the Group sector result in subsequent and continuous Group developments, practically into today's work for Group insurance product family. In simpler words, Group products cover a bigger customer base compared to individuals. One price is applied to all customers belonging to a client or group. Predefined risk classes are included in a Group procurement based on developed hopeful utilization tables. Group benefit cover limits are determined based on internal or external factors of a client, such as employee base level, number of members in the Group, market conditions, etc. Group products may cover core benefits provided by traditional insurance policies, as well as important optional riders, for which the customer is charged on a monthly or yearly basis. The longer and more stable the Group insurance portfolio, the better and more competitive price offer can be prepared. Refund on declared redundancies also has an impact.

Equ 1: Scalable System Load Equation.

$$L_{sys} = \frac{D \cdot U}{C_{proc} \cdot S_{scale}}$$

- L_{sys}: System load (e.g., CPU/memory usage percentage)
- D: Volume of customer data ingested per unit time
- U: Number of concurrent users or clients
- C_{proc}: Processing capacity per node/server
- S_{scale}: Scalability factor (e.g., elasticity or auto-scaling multiplier)

2.2. Investment Platform Fundamentals

Various account types, asset classes, withdrawal and transfer options offered through a myriad of partners, and variable fees create layers of complexity. An investment platform allows the allocation and management of funds among various asset classes based on a defined strategy and risk tolerance applicable to an individual or group—such as group insurance plans where defined contribution pension and savings plans as well as deferred profit sharing plans deposit funds for employees. An investment platform offers a range of account types, allowing members to choose their own accounts or choose a single solution for everyone.

For defined contribution pension and savings plans as well as deferred profit sharing plans, the funds must be locked in place until maturity, and funds must comply with and adhere to regulatory constraints regarding maximum allocations by asset class. Withdrawal options could include partial or full transfer to funds outside of the use of the investment platform which would have maximum withdrawal options as mandated by regulations. The investment platform is tied to both employer and employee and interaction with both parties reflects on the employer's and the employee's relationship with the investment platform. For group member employees, the use of the investment platform is passive, and choice architecture is necessary to promote usage. For the employer, they need to reflect their corporate culture through the investment platform, and in some cases also try to manage their own and their employee's relationship with the investment platform.

2.3. Customer Data Management

The final aspect of the central enterprise capabilities is customer data management; it forms the foundation upon which technology service delivery is built. Customer data management encompasses customer application management and customer account data management. Simple insurance and banking transactions are simple data processing activities. These applications are used to write first line business, add new customers, change existing customer data, and, from time to time, correct erroneous transactions. In contrast, more complex customer competencies such as group insurance underwriting, claims adjudication, and investment management are enriched through wrapping data analytics and algorithmic insights around such transaction set processing engines. It is this complex enterprise P & C campus of customer capabilities that, with sufficient scale, drives the sophisticated interaction requirements of institutional customers.

Institutional customers purchase group insurance on behalf of their employees, pensioners, or members. These institutional customers are companies, municipalities, universities, trade unions, or professional associations. Their individual employees, pensioners, or members are the customers in the conventional B & C sense, but they don't own the policy or trust. The institutional customers for group insurance pay an annual premium to maintain the policy or trust. Presented with a claim, the P & C company pays its share for the covered benefits directly to the providers of the covered services. Hence, for the life of the contract, the group insurance or investment company is engaged in a three-party contractual arrangement, with the discipline of reporting to the employer, union, or business association on a regular basis. Therefore, group insurance and investment products could be said to be wholesale insurance and investment products offered out of the backdoor of a company, union, or other such institutional customers.

3. Technology Architecture Fundamentals

This section reviews the key concepts of technology architecture, its components, and how they apply to the design of customer data architecture. The objective of a technology architecture is to ensure the applications or systems that realize a business architecture interact with the technical components and services providing the execution environment and which are needed for the applications or systems to realize the business architecture.

A technology architecture is the descriptive and prescriptive model of business and information technology relying on common technical resources. The purpose of a technology architecture is to ensure the information technology provides the common technical resources and optimized execution environment supporting the performance of the business processes realized with the applications. Business and information technology are two sides of the same coin. Indeed, information technology is created by business to support business processes, and business depends on information technology to operate. Therefore, business and information technology co-evolve, and their architecture co-evolves. The business architecture creates the framework for information technology to create and manage technology components and services. The business design is the blueprint directing the creation of the applications within their operational environment and that evolve with their environment supporting business activities.

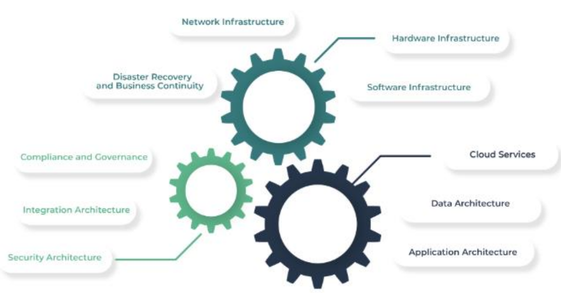

Fig 2: Technology Architecture Fundamentals.

The specification of a technology architecture focuses on the technology components and services relied upon by applications or systems to perform the business processes defined by the business architecture. A technology architecture is described in terms of a number of components, all of which are required to enable a specific application. You may think of a technology architecture as being made up of the bricks and mortar that are required to house the systems receiving and sending data for key business processes. These systems interface directly with the business.

3.1. Definition of Technology Architecture

Architecture is the science and technology which deals with the relations between interior spaces, the relations between the spaces and the exterior and the relations of various parts of the whole to each other and to the whole itself. Technology architecture is the design of complex and often difficult-to-manage things in such a way as to create a structure that helps control the complexity and difficulty of managing the things built by exploiting some typically realized sharing or separation of concerns benefits. Technology architecture is also a fundamental contributor to the value chain. Hence, it should be an integral part of any business planning exercise. Use of technology architecture principles helps managers with the realization of the business vision, strategy, and objectives through the implementation of business capabilities while satisfying stakeholder expectations at acceptable levels of investment and risk. In doing this, a shared understanding of technology architecture increases. The technology architecture design is not an isolated IT activity: it provides a foundation for the overall business operation and, as such, needs to be closely tied to such governance activities and policies in the business area as risk management, business rules, methodologies, outsourcing, data management, etc. Indeed, the technology architecture is an integral part of the physical funding foundation of the business and its strategy, objectives, and operations. Hence, technology architecture is designed in the business context with proper business behavior influencing design decisions. The technology architecture needs to be kept in sync with the business strategy and objectives.

3.2. Key Components of Technology Architecture

An enterprise technology architecture is a formal specification that describes the overall structure of the technology systems that support and deliver applications and services to the various failure domains of an enterprise. Multiple technology architectures may exist for each enterprise -- reflecting the evolving, early phase realization of the enterprise business strategy. Some are conceptual in nature, while others are detailed. Some are current, reflecting the enterprise as it is now, while others are transitional, describing the planned migration from one current set of systems, applications, platforms and services to a new and desired set. Some may be made available, as existing architectures are put into production and as the enterprise's business strategies and application and service delivery timelines evolve.

A technology architecture typically consists of a number of distinct structures. The collection of primary technology architecture artifacts may include the following: identification and definition of in-scope applications and services; a base technology infrastructure map; service infrastructure utilization charts; application platformization roadmap; application delivery topology mapping; migration plans; and relevant standards and principles. A technology architecture set typically also depends on what type of technology architecture the collection is related to: a conceptual architecture set versus a current or transitional architecture set.

Most organizations have artifacts that collectively represent one or more of these primary data architecture components. This might include the physical diagram of the data movement around the enterprise; data and storage hub descriptions; enterprise data model; questionnaire rules onto the logical data model; naming conventions and glossary for databases; deployment diagrams; technical standards; and so on. In that sense, a data architecture "set" of components is usually an assembly of various data architecture resources and artifacts, rather than a cohesive base architecture.

4. Scalability in Technology Architectures

Scalability is paramount in technology architecture design for customer data in group insurance and investment platforms. It is a property of a system to process increasing volumes of workloads, with improved performance or efficiency within a tolerable latency and cost, rising without bound. While there are other qualities like “supporting a number of users”, “supporting a number of transactions or messages” or “supporting the capacity of a block of data”, that may indicate scalability, computer science research has defined scalability more precisely through performance efficiency, asymptotic efficiency, and response time.

The range of performance efficiency and scalability across systems can vary by a few orders of magnitude. There are numerous factors responsible for achieving scalability: hardware architecture, the algorithm design, software design patterns, programming framework and languages, reliance on vendor systems and design strategies in technology architecture. But implementing several of these scalabilities in all technologies while meeting all other design qualities (availability, security, business rules and process management, data integrity, complexity, deployment location and patterns alignment, maintainability, trustworthiness, vendor support) is a herculean task. Often the compromises made in the other qualities, especially the vendor qualities, can prevent scalability because of vendor lock-in, dependence on third-party systems. Use of low-cost talent pools can also exacerbate the situation, as large technical projects are difficult to manage remotely. We discuss these challenges while designing technology architectures for large-group platforms in the subsequent sections.

4.1. Importance of Scalability

To become the de facto data infrastructure for the insured member throughout their lifetime, claiming to hold and manage massive volumes of sensitive data, group insurance and investment platforms must support continued business growth in volumes. Like no other data, customer data is susceptible to the natural forces of growth, in small but measurable increments, in predictable cycles and suddenly or gradually through unparalleled events. With over 1.7 billion clients worldwide, from group insurance forms, the group insurance intermediaries awaiting commission and premium payment, and from the participants awaiting payment of retirement benefits, the sheer data volumes can only be matched by the speed with which they are added.

An increasing number of organizations are coming around to the realization that their systems have to be capable of managing data that grows exponentially. Yet many are still very much in the stage of refitting, around that the reality is that their systems cannot manage that growth. Close to half of the organization's cost comes from the development and future maintenance of the system. Thus, new systems must support the organization not just today and tomorrow but well into the future. Although the IT industry is at the cusp of a huge shift, away from centralized to distributed computing, this shift will not happen overnight. Distributed processing was first offered commercially almost two decades ago and, like any technology, it too has had to weather rough storms. However, the indications are that it is here to stay. Technology architects have to think of the current need for distribution but have to ask how systems will be designed to take advantage of additional resources, either added at a later date or being tapped into by different organizations sharing a task. Sharing resources will mean sharing costs, which will make IT a far more attractive business function.

4.2. Challenges in Achieving Scalability

Achieving scalability in Insurance and Investment platforms is a significant challenge. Scalability refers to the capacity of the technology architecture to handle increased amounts of work smoothly when desired by adding servers and other resources. Scale-out enhances the performance by adding more processing units over which the amount of processing tasks is shared. Scale-up enhances the performance by increasing the power of existing processing units, without adding parallel processing units. External system factors and Internal system factors affect the scalability capabilities. Unpredictability in workload, uncontrollability in resources usage, diminishing returns, resource boundaries, resource imbalance, and transaction system using third-party resources, and such other external factors negatively affect the scalability.

However, some of these problems are created by the Internal system factors as well. On the other hand, when the systems are designed to deliver the maximum operational efficiency, some of the systems filing more than one role may become efficiency bottlenecks. Efficiency bottlenecks lead to transient priority inversion that leads to increased waiting time properties for executing jobs along the paths that extend beyond the bottleneck resources. The need to deliver high priority workloads in acceptable time increases the demand for the capacity of the efficiency bottleneck resources. The long periods of waiting time, during which no progress is being made, cause user dissatisfaction. These factors affect the scalability in the insurance and investment platform: Role specialty vs. Role Sharing; Centralized vs. Distributed; Chaotic selection vs. Well-organized selection; Efficiency sharing vs. Efficiency bottleneck; Productivity vs. Scalability; Latency vs. Efficiency; Different parts of the workflow being implemented on different platforms; Interfacing between different platforms; User Base; Kinetics of Workload; Efficient use of Processing Resources.

5. Design Principles for Scalable Architectures

Designing versatile and scalable architectures for Customer Data in group insurance and investments is no easy task. The nature of insurance businesses is such that they may need to rely on increasingly diverse partner ecosystems and distribution networks, driven by the need to deliver products that make structural differences, harness analytics to build customer loyalty and build embedded operations that are frictionless and ultra-efficient.

Customer Data, in that regard, is a very rich source of insights that can enable life insurance companies in group schemes to offer prudent advice to clients. Having systems that can integrate with these varying partners and suppliers, systems that are adapted for Life Insurance from core and vendor systems, yet able to cater to the specifics of each account is the key to these operations. The objective of this section is to discuss core design principles and strategies that we recommend for developing scalable architectures in life insurance.

Designing scalable architectures that can manage these diverse characteristics calls for a few fundamental principles. The first is Modularity and Flexibility; which allows developers to add new business lines, geographic footprints, increase transaction sensitivities, and expand to new products or partners at relatively low time and cost. Secondly, we need strategies for Load Balancing; across the varied components of the ecosystem, enabled by distribution channels, partners, third party websites, etc., which have very different transaction personas and usages. Finally, we need Data Partitioning Techniques that will enable business systems to execute synchronous transactions that need to process a large number of accounts, policies and customers without performance bottlenecks, whilst ensuring that different transactions can be serviced in parallel. In summary, we will discuss the following three functions: Modularity and Flexibility; Load Balancing Strategies, and Data Partitioning Techniques.

5.1. Modularity and Flexibility

While it is elementary to create a monolithic architecture, such structures present significant challenges when a system or platform needs to be changed. Extremely complex integration issues, automation difficulties, and high costs associated with changes are only some of the problems that can emerge from monolithic structures. The added costs, risks, and time associated with changes can compromise an organization's agility, speed-to-market, and competitiveness. Business requirements, regulations, and the competitive landscape for the group insurance and investment sectors are constantly changing. Additionally, artificial intelligence is now being used to automate certain functions in many organizations globally. Such changes can have a significant impact on the existing design and operations of a platform. To mitigate the disruption and cost associated with these inevitable changes, technology architectures for customer data must be properly engineered to accommodate change easily and with a minimal amount of disruption. Building modular architecture components is a design principle that can alleviate these issues. Such components must be engineered for flexibility and rapid change. Active and good design practice should be established to define the size of a properly defined component. If components are structured incorrectly, the ease of change advantage can be relegated to the dustbin of histories of poorly conceived information architectures. Striking the correct balance between overly complicated reengineering of current extract processes and data component redundancy resides in the organization's design practices or lack thereof. However, before building and developing a modular architecture, it is essential to examine, at a strategic level, what the business strategy and customer data strategy are. It is critical to understand the fundamental reasons why customer data is being captured and what new capabilities and functions are needed to support the business strategy. A shared business strategy can motivate the collaborative development of a modular and flexible architecture. Any modular architecture creates a repository of current knowledge of the relationship between the different business operations supported by customer data.

5.2. Load Balancing Strategies

In order to optimally share the request load across the available components and entities, applicable load balancing policies must be employed at the multiple levels of the architecture or system. The implementation of routing algorithms, traffic management plans, request distribution policies or dynamic response strategies -- each holistic approach must have the necessary intelligence to maintain high throughput and positive user experiences. The specific techniques that may be applied for distributing the load vary from static techniques to more complex dynamic intelligence offering more real-time responsive control. Static approaches tend to be simple implementation solutions with the essential control provided at introduction and in the application of trial and error models to identify and implement static load balancing techniques. Such techniques are still practiced today practised. Global server load balancing for example is one of the common approaches which are invoked for static routing of global loads to IP addresses from latency and geographical perspectives. Round Robin addresses the request routing based on a sequential algorithm.

Static solutions have their limitations with regard to load balancing. More often, active and ongoing business needs rely on dynamic load balancers operating at multiple levels of granularity. Such solutions enable more intelligence, advanced algorithms, proactive monitoring, thorough traffic metering and/or a multitude of load distribution policies. More widely available components such as web servers, switches, routers, proxy servers or individual backend application processors have dynamic load balancers embedded. Specific algorithms deployed into these components facilitate the inquiry into processor utilization, or queue length, or work particularly with transactions for deciding how to allocate or route incoming requests. Solutions of such services lend heavily from concepts, techniques and algorithms applied in previously described content delivery networks. Hardware components drive load balancer functions for example using cost-based considerations for routing globally intrinsic processes.

Equ 2: Data Reliability Equation.

$$R_{data} = \frac{I_{valid}}{I_{total}} \cdot (1 - E_{dup} - E_{lat})$$

- R_{data}: Data reliability score (0 to 1)
- I_{valid}: Valid and complete data inputs
- I_{total}: Total data records received
- E_{dup}: Duplicate entry error rate
- E_{lat}: Latency-related data loss or inconsistency rate

5.3. Data Partitioning Techniques

There are many ways in which the implementation of a system can be made scalable. In the case of a customer database, data can be patterned across separate silos that are linked to an Application Layer. These silos can be created for a number of reasons.

Firstly, for performance reasons. When the volume of transactional data a customer generates exceeds what a single physical schema can efficiently handle, additional schemas must be added. Secondly, for geographical reasons. To reduce hops and latency for end-users, regions may require their customer data be housed in systems that are in close proximity to the Application Layer that manages this data. Thirdly, to develop upon a silo that is safely isolated from the global customer data schema. New features may have additional data requirements that are only relevant to a small subset of active customers or for a controlling beta test group. Having the ability to operate independently will allow modifications to be made with minimal disruption to the overall production environment.

When data is partitioned, the work the servers are doing is made more deterministic. For example, when a license is verified, it could easily be verified against only one of the partitions. Therefore, adding servers to that specific task will improve overall performance. However, the unfortunate consequence of patterning customer data across separate silos is that you lose the ability to aggregate results from all schemas and you cannot relate data in those schemas unless through a common parent schema. While the aforementioned statements are true, you can only expect to never have to scale to such unmanageable levels if you are fortunate enough to encounter a simple and social customer journey that is mostly homogeneous regarding the data it stores.

6. Cloud-Based Solutions for Data Management

Cloud-based solutions to build a new data mart for the group insurance and investment analytics teams have multiple benefits. They will allow these teams to immediately benefit from state-of-the-art data management solutions using low-code solutions to build data pipelines, speed up deployment of data assets with built-in version control, make data from multiple sources available on-demand through semantic layers, and make integrated data available for self-serving BI and advanced analytics.

All of these solutions are built on proven, enterprise-grade infrastructure components that are distributed for high availability and scalability, with built-in capability to elastically scale up or down based on increasing or decreasing workloads. These Cloud Data Warehouse and Data Lake solutions provide many automation features for backup, patching, recovery, and scaling that significantly reduce management effort. These solutions allow elasticity in pricing since customers are only required to pay for capacity and resources when being used, and allow data and compute workloads to be separated and scaled independently so that customers pay only for what they actually use.

The choice for the cloud service provider must be made carefully based on pricing, estimated workloads, supported data sources, analytical functions used, business areas serviced, audience accessing the data assets, integration with other data platforms and cloud services used in or planned for the organization, and data governance and security features.

6.1. Benefits of Cloud Solutions

The past decade has seen tremendous growth and innovation in Cloud computing solutions that allow companies to leverage the infrastructure, scalability, and maintenance capabilities offered by Cloud technology providers. Cloud-based solutions are easy to deploy, quicker to implement, and available on a pay-per-use basis that matches the consumption model of software and technology consumption preferred by most companies.

Data requirements of businesses and their customers are constantly evolving, making them more comprehensive, ever-growing, and frequently changing, and requiring organizations to adopt dynamic data storage, management, and analysis solutions. Cloud-based technology architectures allow businesses to modularize their data architecture and use only the components they need at any given time based on their usage. Depending on the type of deployment chosen, data storage and management may require little or no investment in physical infrastructure.

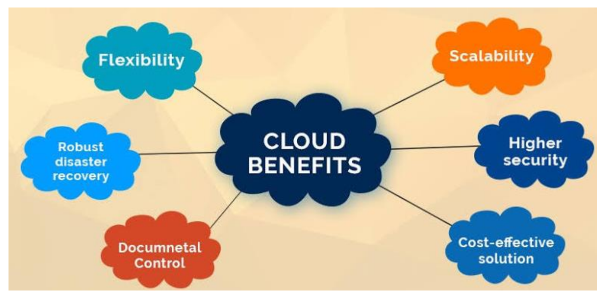

Fig 3: Benefits of Cloud Solutions.

Insurance and investment organizations are not exempt from adopting a Cloud-first approach, as their legacy model of building and maintaining on-premise technology continues to fall short of customer expectations of convenience, service, and value. On-premise technology environments have become antiquated models of thinking that require investments in upfront capital and long-term resource management dedicated to supporting the creation and maintenance of the company's technology infrastructure, rather than its technology vision. With Customer Experience fast becoming a key differentiator, companies must prioritize their technology capabilities to spend time innovating and differentiating their technology application, platform, or processes. Cloud-based infrastructure allows companies to remove this burden of infrastructure management and provide a fine level of judgment to invest where needed in technology development.

6.2. Choosing the Right Cloud Provider

One of the greater hurdles for many group insurance and investment players is to decide on the right cloud vendor. In the retail insurance and investment sectors, companies have blazed the trail for companies in specialty lines products to take the plunge with cloud solutions. The experiences facing these traditional vendors of record, however, are far more complicated than just sheer scale and legacy systems.

The services offered by some of the maturing cloud providers give companies much more flexibility on how to manage and leverage different infrastructure pieces depending on sensitivity of workloads, speed of delivery, disaster recovery capability, and security and encryption rotation processes. Some of the larger vendors make it easy to distribute different workloads across multiple clouds; this may extend not just to the maturing cloud providers but also other cloud-aware and natively distributed technology companies with their specialized data integration and observability tools.

The global regulatory regimes around finance and healthcare add additional complexity since a lot of innovation around how healthcare and finance can help restore customers' positions through various periods of difficulty or help build future wealth through different life stage products are constantly encumbered with regulatory barriers. Privacy and data locality requirements are extremely stringent for certain lines of business on medical history and personal financial information. These requirements could last as long as defined in regulatory provisions. When weighing off the trade-offs for the right cloud provider, it is imperative to understand how workloads could migrate from one provider to another, the security and encryption capabilities on how data could be made available and secured across different geographies, the agility of the service surrounding availability of services for enhanced disaster recovery capabilities, and whether availability zones or clusters could be placed around optimal infrastructure resources in lieu of the financial commitments.

7. Data Security and Compliance

With the increasing prevalence of cybersecurity risks, securing customer data has gained even more importance in the insurance and investment industry, which is already heavily regulated. After discussing the basic architecture and design of customer data in the platforms in question, we take a closer look at who is driving the need for compliance, the regulatory requirements, and examples of some common practices for ensuring customer data privacy. These requirements are crucial considerations, because a lack of compliance could lead to the shutting down of a business, as well as legal liabilities and penalties. Additionally, security verification is a requisite part in the technology development lifecycle.

Regulatory Requirements

Most countries have enacted regulations that require Publicly Listed Companies (PLCs) to disclose their cybersecurity risk management programs and internal control framework, as well as incidents of data security breaches. One of the most stringent regulations surrounding the handling of customer data is a comprehensive data protection regulation.

In addition to this regulation, company PLCs on international stock exchanges including the United States are required to follow specific acts. In Singapore, PLCs are required to follow the Code of Corporate Governance and Technology Risk Management and Cyber Security, which emphasizes the need for banks to validate the security measures employed by their suppliers and to require third-party suppliers to apply a comparable standard of protection.

Financial institutions are under the purview of more specific regulations or standards for protection of customer data, such as Generally Accepted Privacy Principles and Service Organization Control (SOC) 2 developed by a professional accounting organization.

Developed in the USA, these SOC 2 report standards have been adopted globally by many financial and non-financial firms. A widely adopted set of regulations for payment card companies to protect customers from fraud is the Data Security Standard.

7.1. Regulatory Requirements

The growing emphasis on regulatory considerations surrounding the use, storage, and disclosure of personal data requires technology vendors and brokers to comply with various domestic laws and overseas regulations. The proposed regulations are similar to the General Data Protection Regulation and the California Privacy Rights Act. Violations can expose organizations to regulatory and civil liabilities if there is improper use of private information. Users of such technology platforms may want certain regulatory requirements built into the platform design.

Data processing by third party vendors can also present issues. Such vendors may not have a direct relationship with the consumers whose data they process on behalf of other resources. This often creates a lack of transparency with consumers about the data processing activities which are being performed by third-party vendors on behalf of other entities. Moreover, data shared with third-party vendors is not affordable without giving a false sense of security. Regulatory requirements should ideally stipulate that access to and collection, use, and retention of data by vendors serving enterprise clients is governed by the enterprise client's privacy policies, and that such policies are consistent with the laws and regulations governing the enterprise client's data.

7.2. Data Privacy Considerations

In addition to legal, regulatory, and industry standards requirements, protecting customer privacy is a fundamental ethical imperative. In the context of group insurance and investment platforms, principles of ethical use of data should influence the design of data protection as well as the criteria used to manage customer consent. Access to sensitive data such as an individual's usage of the insurance or investment products, personal financial details and associated risks raise customer concern about the ethical use of their data by industry stakeholders with different interests. Customer reluctance to share sensitive personal information may ultimately jeopardize the value delivery of segment-of-one use cases of personalized messaging, customer engagement, and recommendation algorithms for group insurance and investment products which are dependent on data from multiple network participants.

There are four important considerations that may affect how customer concern can be addressed in practice. First, specified conditions of the customer consent logic should establish and govern data access and restrictions across all participants. Dynamic use-case based access templates with established criteria are important to incorporate specific use-case based data access and restrictions requirements to make informed and timely decisions around customer data at rest and in transit. Such logic needs to accommodate the practical reality to account for changes in customer trust in different participants in the ecosystem over time and as a likely result of emerging use cases from within the group for such information. Trust, transparency, and customer enablement to control their own privacy settings in addition to general regulatory requirements should be guiding principles around the operationalization of data user templates. To help build lasting trust and relationships with customers, group insurers and investment managers need to move beyond data collection procedures to implementing two-way, transparent communications, possibly through account portals where consumers have the ability to see which organizations have access to their data, which require authentication to reveal and set the required privacy parameters associated with access by specific organizations.

8. Integration of Legacy Systems

Among the software components identified in the previous sections, the most challenging in practice for any of the design alternatives would be the

Legacy Components. It was quite commonplace for an organization of this size and age to have Legacy Components. Decommissioning the legacy systems was often an unthinkable task. Often, business users resort to existing legacy components for fast delivery, knowledge retention at the risk of bypassing newer techniques an organization may have implemented to improve quality. This topic therefore naturally leads to a discussion on the need to Integrate these Legacy Systems with the newer Technology Architecture, along with the challenges associated with them and the strategies for integration.

Challenges with Legacy Systems

What is it about these legacy systems that make them such a major factor? Why is it so difficult to replace them and what are the factors that organizations need to consider while dealing with them? What sort of issues and risks would need to be assessed before a decision is made? As mentioned before, many large insurance companies and banks have large, monolithic, mainframe systems that handle their operations – especially transactions in the case of Banks and their Policyholders. And these are generally hard-coded, low-level business rules implemented on a methodology due to the large volumes that need to be processed at pre-defined times, mainly overnight. These could be either in a form implemented as systems or in a form where components use and are the wrappers over Services, invoking Components.

8.1. Challenges with Legacy Systems

Legacy systems are critical for the operations of many large and medium-sized organizations in the group insurance and investment sectors but, like it or not, they are a significant bottleneck for the deployment of new IT systems and applications. IT legacy systems generally evolved decades ago, often in parallel islands of organizational functions, business domains, product lines, and geographies, without deliberately architecting the systems for extensibility, interoperability, or scaling-up. In addition to losing deprecated technical capabilities or becoming obsolete, legacy systems are often missing business functions needed to capture the opportunities from recent trends such as the explosion of customer data, consumerization, personalization, direct-to-consumer business models, and enhanced customer engagement. However, the potential business benefits of replacing legacy systems with new core applications from major software or cloud vendors are most often negated by the prohibitive costs and risks of replacing these mission-critical systems, and deploying state-of-the-art new business or enabling functions, while risking disruption of daily operations or the smooth running of other interdependent systems. Instead, such risks and costs are often more than balanced out by investing for the near to medium term in technologies and architectures that integrate mobility, SaaS, APIs, in-house rapid app development, and data from core and other legacy systems with functions from other business units or third parties.

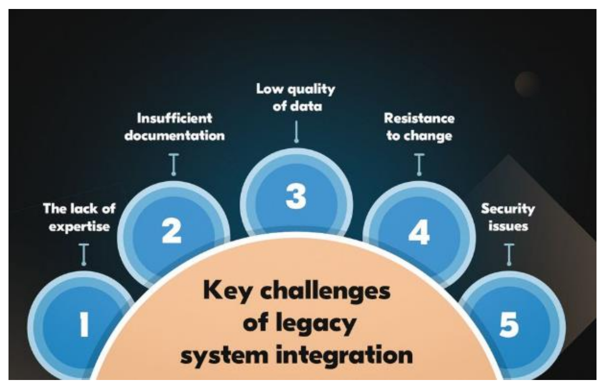

Fig 4: Challenges with Legacy Systems.

To give a concrete business example, the technology architecture implemented by an enterprising bank engaged in desperately needed backoffice modernization, to better compete with agile fintech challengers and continue servicing its corporate clients. Like most banks, this one had huge backoffice operations volumes, supported by complex legacy technology infrastructures, and was also under constant pressure to pocket hefty revenue from an array of cross-selling and up-selling opportunities, and business relationship fees that were significantly dragging down customer engagement and satisfaction.

8.2. Strategies for Integration

In the previous section, we covered the key challenges that legacy systems can pose to the integration process. Here, we discuss the seven integration strategies we have adopted to integrate these legacy systems in addition to the common industry integration approaches, such as Real-Time, Batch, Business Process Management, and Enterprise Service Bus. Common architecture integration strategies involve putting together the various application components and business processes that accomplish the enterprise goals in such a way that these components perform their specified roles, data is routed or shared where needed, and the behavior of the overall application works correctly.

These strategies dictate how to structure enterprise application systems and how to distribute data and processing functions across the various enterprise data repository sites and application processes. We have synthesized a set of integration strategies that takes into account the archetypes of the legacy systems typically found in group insurance and asset management organizations. Our strategies overlap and may even conflict with one another, depending on the requirements of the applications being integrated. In contrast, industry-standard approaches tend to be structured around a common set of principles that make them easy to implement but at the cost of flexibility in choosing how data sharing and transactions are to be organized.

The integration of legacy systems typically requires that we integrate existing modules that are usually loosely related to each other. The integration needs may vary from distributed access to one or more modules to true integration where different modules share some common data elements or execute parts of the processing function of another module. Depending on the integration requirements, various integration strategies may be selected, including the following. Data Sharing Strategy, Transaction Strategy, Controlled Sharing Strategy, Operations Strategy, Federated Strategy, Coarse-Grained Strategy, and Enterprise Architecture Strategy.

9. Emerging Technologies in Data Architecture

Future architectures for hosting enterprise customer data will likely include many emerging technologies; their topics are examined in this section. Customers expect experiences that are satisfying, useful, and seamless. Delivering on these expectations requires that organizations embrace Artificial Intelligence and Machine Learning. Essentially, modern AI and machine learning capabilities augment existing data sets with unique insights that vastly improve the interaction between people and technology. Data architecture provides the means for arriving at relevant AI-based customer interactions by making appropriate customer and product attributes accessible. AI will play an important role in achieving the goals of meeting seamless customer expectations and providing financially sound experiences.

In this section, we will examine the two capabilities of AI and ML and the technical realities of implementing these, including emerging technologies such as Data Lakes, Data Mesh, Data Fabrics, Graph Databases and NoSQL. We also touch on other emerging technologies in the world of enterprise IT that are supporting next generation architecture. Organizations with sizable investments in enterprise architecture need to make sure that their enterprise architecture strategies for the next decade work with these solutions and capabilities, and do not become prepared for obsolescence. When it comes to enterprise customer data, the goals are similar to other aspects of enterprise investments, and that is to reduce complexity and to improve business resilience and agility.

While many of these technologies have been part of enterprise architecture options for several years now, they appear in the market quickly with innovative solutions and capabilities that are relatively heterogeneous and vendor-specific. These technologies are increasingly coming together into packaged solutions. It would clearly not be possible to always build stack solutions using only the topic-specific technology components.

9.1. Artificial Intelligence and Machine Learning

A systemic impact of deep learning on the development of artificial intelligence occurred during the late 2010s. Conventionally, the design of intelligent systems is based on coding of knowledge. In the case of expert systems, specialist designers encode indirect knowledge, the rules that should be followed for solving problems. Such an approach is often difficult, if not impossible, because of the uncertainty and complexity of real-life problems, which address uncertain environments. Such coding requires tacit knowledge, the knowledge that an intelligence system must acquire by practicing skills to perform certain tasks. This effort is time-consuming, expensive and prone to failure. The supervised learning scientific paradigm emerged in the late 1990s, with the use of computer vision systems for facial recognition. A grand increase in the availability of digital data, along with the use of large cloud computing systems equipped with highly parallel graphical processors devoted to deep learning tasks, has enhanced pattern recognition in computer vision, speech transcription and video classification. The subsequent surge in the availability of tacit knowledge has allowed deep learning to gradually replace classical coding-based techniques for enabling artificial intelligence with seemingly more significant accuracy, low error rates and increased automation.

The engineering of intelligent systems devoid of such tacit knowledge is an exciting endeavor that is now being actively pursued. In fact, from the initial purpose of designing intelligent systems that can perform human-like intelligent tasks, such systems could be specifically engineered to perform much more complex intelligent tasks, in a fraction of a second, and at a level of performance that entirely exceeds human skills. Since products in life insurance and investments are designed depending on the unique characteristics of customers, their insurance companies and investors would essentially require tailored features in risk coverage, asset class selection, portfolio weighting, income tax optimization and investment horizon. The availability of such tacit knowledge could be a significant asset in the design of next generation products and customer experience.

9.2. Blockchain Technology

The information architecture within Group Insurance and Investment platforms is constantly fragmented, resulting in a complex and challenging environment for Corporate Data, Regulatory Compliance, Business Functioning, Business Strategy, Client Service and External Agents. To overcome these complexities, Blockchain technology – as an emerging technology for data sharing – is becoming instrumental to make available trustworthy bona-fide data. Both implementations rely on Blockchain technology adoption over a greater set of Policies across the insurance or investment business, shared amongst mutual interests parties. Enabling Smart Contracts to make automation possible for those policies. Permitting a connected environment between each party representative.

Fig 5: Blockchain Technology for Group Insurance and Investment platforms.

For Group Investment: Earning calls are yearly (sometimes quarterly), making the time for contribution investment direction dummy. Being right on the investment manager performance, while not aligned on profit share impact, could become a bottleneck on the shareholder long-running strategy. Blockchain would provide a trigger to act faster on that. Short-cutting the consequently front-office users, as the Smart Contract responsible for profit share computation would initialize the start of the redistribution process straightaway to back-office and ground-office users.

In Group Insurance: Policies surrender value, while the employer doesn't need to retire, would be part of the overall capital directed. Whether worker and job executive time are not aligned – time to cash – the ledger would provide a data copy to be recognized as bona-fide and to self-advocate in the demand either pro or con. With a Contract Smart determine how and when respective wallet preparations will be set.

10. Case Studies

With organizations becoming more reliant on technology in their everyday operations, it is essential that technology architecture provides solid support for current needs and is also scalable to address future growth. While the principles for designing and implementing technology infrastructure apply across industries, this section will present information concerning specific examples in the insurance and investment industry. It is hoped these examples will present both insight into implementing these principles and a roadmap for stretching current infrastructure.

10.1. Successful Implementations

While it may be fashionable to say that no organization is competent enough to ever perform implementation perfectly and that failure is the mother of learning, this paper did discover several organizations who had successfully implemented; especially in the area of customer data architecture for multiple agencies, multiple product lines, and group situations. Their success provides valuable constructive building blocks for other organizations. In addition, working with multiple agencies represents the first steps for many organizations involved in rolling out a common systems infrastructure.

Insurance is a complex product, sold locally by a large number of agents and brokers, is usually needed by all individuals at each stage of their lives, and involves many transactions. While the product is complex and there are many brokers, agents, and insurance companies involved, every organization has found it is extremely important to have a single view of the customer at the organization level. While there are many solutions available from the major vendors, insurance companies who have used these vendors have found that their customer term is not sufficient for key system functions such as customer segmentation.

10.1. Successful Implementations

The development of a scalable customer data architecture, consolidating group and individual data in a single view, has proven to be useful to drive strategic decision making and improve both the customer experience and the data management process in several North American life insurance and investment organizations. One of the first implementations of a customer data architecture, focused on a scalable view of both group and individual data, was completed by a financial organization in 1983. The architecture supported the definition of over 5 million customizable reports that drove strategic communications, driven by integrated marketing efforts of different product silos. The architecture supported the centralized management of personalized communication programs and their electronic production to a multi-channel distribution system since 1996. The architecture provided a single view of 140 million member accounts and a scalable platform supporting 60 million annual batches for issuance and annual reminders. The architecture comprised systems conceived for the growth and utilization of customer data, as opposed to transaction systems optimized for transactional volume only. Transaction profiling supported activity monitoring and communication. These customer communications were managed centrally. Daily reports of members requiring a communication were produced and archived for business units to initiate their distribution. Centralized management allowed for effective coordination of communication and mitigated redundancy in communication efforts. A similar architecture was developed in the late nineties. Marketing Communication responsibility was centralized in Marketing Service and approval was required from Marketing Service for any communication material for customers.

Equ 3: Architecture Cost-to-Performance Ratio.

$$CPR = \frac{C_{total}}{T_{throughput} \cdot A_{avail} \cdot S_{scale}}$$

- CPR: Cost-to-performance ratio (lower is better)
- C_{total}: Total operational cost (infra + maintenance + licensing)
- $T_{throughput}$: Transactions or data operations per second
- A_{avail}: System availability (uptime as a percentage)
- S_{scale}: Architecture's elasticity or ability to scale horizontally

10.2. Lessons Learned from Failures

In addition to the positive experience in successfully implementing reusable and scalable components, there were failures in implementing some of the desired components that will be outlined in this section. The implementation of scalable data amplification techniques such as Consolidation into Master Aggregates were tried. However, these efforts were abandoned and these techniques were never implemented, and subsequent data pipelines managing the same data domain ended up independently implementing their own data amplification techniques. The primary reasons for these failures, and additional comprehensive and sensible design techniques to design and build reusable and scalable architecture components are discussed in this section.

Master Aggregates for consolidated data and reporting aggregations are the gold standard designs in the data amplification domain as consolidated data such as consolidated account total values for customer reporting, and reporting aggregation data such as operational KPIs of the business, and regulatory and compliance reporting data, do not change often, are of interest to business stakeholders across the enterprise, have large read-only transaction volumes, and have large database storage space volumes, that strongly favor the Use once, Read Many times, and Storage Size Optimized design. The transactional data from the source systems that support and feed these types of data remains unchanged during the natural history of transactional data, and are rarely purged or invalidated. Despite these attributes, design attempts to implement Master Aggregates have largely failed and been abandoned. These important but complex designs remain on the wishlist for many organizations without initiation, motivation, and clear focus.

11. Conclusion

In the contemporary landscape of insurance and investment, organizations face the unique challenge of managing and reconciling customer data from multiple sources, both internal and external. For Group Insurance and Investment Platforms, centralizing and owning customer-related data has tangible advantages regarding both commercial success and risk management. By building scalable technology architectures for customer data, organizations will be on the forefront of better servicing clients, improving trust and transparency, and growing ancillary revenues. The foundational aspects of centralized, proprietary technology architectures certainly cannot predict accurately the future of analytics or data management technology stacks when considering the speed of innovation we have witnessed lately. They are however based on immutable principles of conflict management, auditability, clear responsibilities and, as a consequence, dependence minimization. As such, they will continue to have relevance as organizations design and assemble their future technology stack for their services.

In addition to being a foundation for better servicing clients, scaling technology architecture for managing customer data will allow organizations to offer multiple data products externally, addressing a multitude of prospective clients' needs. Clients using employee engagement products would have access to unmatched expertise on deep partner employee data. They would receive a more secure external technology handle for their public companies' data pipelines, as well as enable a new revenue stream together with the public company for the data service at the heart of the analytics. Clients using employee engagement services products would have access to unmatched expertise in multiple partner employees' equity portfolios. They would benefit from a more secure, external pot-lighting externality management process offered for any kind of events involving partner companies, especially those around key dates related to employees, as well as enable a new revenue stream together with the partner public company for the communication service at the heart of the customer offering.

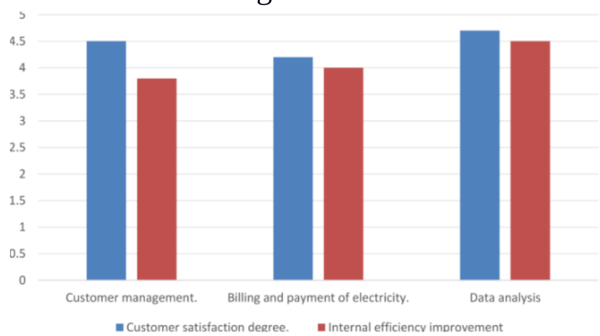

Fig 6: Design and optimization strategy of electricity marketing information system

11.1.Future Trends

1. Major user group geographies For the past few years, large technology players have been getting into the consumer insurance and investment spaces. With upcoming changes to monetary policies, more people will likely become first-time investors. The industry has to prepare for millions of new users on their platforms and devise better, simpler ways to share and manage their data. However, this sudden influx of customers will likely come from emerging geographies such as China, Africa, and South America. A focus on these geographies means that products need to be built using locally relevant contexts. Conditions likely caused the failure of several fintech platforms in Asia and Europe. The dominant paradigm has been for companies to use their fintech platform hosted in the US or Europe. Local data regulations likely played a role in limitations. The introduction of regulations in countries in these geographies has simplified access to local data sources. Emerging platforms now need to build customer journeys that reflect local collection contexts and risk appetite.

2. Data privacy & trust Consumer awareness of how companies collect, manage, and leverage data will increase. Companies need to build strong communication strategies. There will be discussions on how to balance privacy and trust with risk/return.

3. Evolution of technology architectures Technology architecture landscapes will also evolve. In a way, tech stacks have been vertically integrated in the past. Monolithic cloud giants would build purpose-built feature stores. There has been an explosion of niche feature stores outside of the giants. Similarly, niche identity solutions will evolve. Hybrid cloud/edge architectures will evolve.

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