Architecting Innovative Registers of the Future

A systemic view for the operation of a register

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Introduction

One of the most difficult decisions for a register, is when their systems are no longer fit for purpose and/or are too costly to maintain, and therefore a decision must be taken to buy, or build a replacement[1]. The difficult dilemma of having to choose to custom-build or procure externally the systems to support their registers is usually taken by the register alone. The authors contend that this decision is often taken without knowing the actual internal workings or the principles from which either system is derived.

The difficulty is further exacerbated in that, there is typically an absence of a defined Target Operating Model (TOM) for the register or simply a vision of where the register wants to be. Therefore, a comparison between build or buy, can never make any sense. Even within a 'Transformation' programme, a register rarely attempts to describe a future register state or register environment, that the register will be required to support. But equally then the register expects that what they have procured, or built, will be able to support an entirely different reality, any time in the future. In our last paper[2], we explained the importance of a TOM, and the need to derive a statement of best practice for registers, and how these constricts would help with this decision. It is our contention that knowing/stating the guiding principles of the architecture of your register system, gives a register the best chance of providing for the future.

The primary deficiency of an internal custom-build is that there does not have to be any TOM, any vision, any product road map, nor any architectural guiding principles, that are exposed by this effort[3]. It also means that the register must retain its own software development capacity or take on the risk of engaging with an external vendor to undertake the build. Alternatively, the primary risk of buying a register system is vendor lock in. And indeed whether a good relationship can ever be established between the register, and the vendor.

However, again it is also a fact, that the manner in which most registers, procure systems is fundamentally flawed, and contributes to the difficulties in establishing a good working relationship. Rather than the register asking the market, the art of the possible, as per a defined vision or TOM, the register delineates in a procurement process, requirement #1 to #n. Thus, in effect the register has already bounded the art of the possible of their register system, bound the scope of the vendor, increased the risk of the engagement, and created division between the vendor and the operator. It is also must be stated that it is an oxymoron for the register to mandate an agile development methodology in a procurement process but then demand a fixed price.

In our previous Paper we proposed a TOM for registers based on our outlined statement of best practice for registers. In this Paper we further refine our TOM by detailing the architectural guiding principles of a register system, that would support the statement of best practice that we have previously outlined and shown below. Our plans are to complete this series of Papers, by creating a maturity assessment model or Capability Assessment Model (CMM) for registers to suggest a more efficient operating model.

We believe that these architectural principles should be present in your system, whether the register is internally built or externally bought. The architectural principles of a register system defines the art of the possible of the register into the future. We also believe it creates a fair means of creating a comparison between the resulting systems.

[1] https://www.forbes.com/sites/servicenow/2020/12/11build-or-buy/
[2] https://www.fostermoore.com/news/proposed-new-target-operating-model-for-registers
[3] https://www.digitaljournal.com/business/key-cybersecurity-risks-to-consider-during-custom-apps-and-software-development/article

Scope

The system that operates a statutory register is no different to any other organisational system and in effect, is never excluded from the established software engineering principles of developing such systems. Architectural principles in software design are an important construct in that they:

- Provide a **shared understanding**: A set of architectural principles provides a shared understanding and common language for the design team. It helps ensure that everyone is on the same page regarding the design goals and constraints and helps avoid misunderstandings and inconsistencies.
- **Guide decision-making:** A set of architectural principles serves as a guide for making decisions throughout the design process. It helps ensure that design decisions are consistent with the overall design goals and helps avoid design decisions that may lead to problems down the line.
- **Ensure consistency:** A set of architectural principles helps ensure that the design is consistent across the entire system. It helps ensure that components are designed to work together seamlessly, and that the overall system is cohesive and coherent.
- **Improves quality:** A set of architectural principles helps improve the quality of the design by providing a framework for evaluating design decisions. It helps ensure that the design is well thought-out, well-organized, and meets the needs of the stakeholders.
- **Facilitates maintenance and evolution:** A set of architectural principles helps facilitate maintenance and evolution of the software over time. It helps ensure that the design is modular and flexible and can accommodate changes and updates as the system evolves.
- **Ensure System Efficiency:** Architectural principles help optimise system efficiency by defining the best practices for designing and organizing components. Efficiency is critical in systems like computer architectures to ensure fast and reliable performance.
- **Enable Scalability:** Good architectural principles enable systems to scale effectively. They allow for the addition of components or resources without causing disruptions or compromising performance. This is particularly important in systems that need to handle growing workloads or user bases.
- **Create Reliability and Stability:** Architectural principles help in creating systems that are reliable and stable. They promote fault tolerance and resilience by defining redundancy, backup systems, and failover mechanisms.
- **Promote Interoperability:** Architectural principles often include standards and protocols that promote interoperability with other systems and components. This is especially critical in software systems and networking, where different systems need to work together seamlessly.
- **Ensure Security:** Security is a paramount concern in many systems. Architectural principles can help establish security measures, such as access controls and encryption, at the design level, making it more challenging for attackers to compromise the system. Remember when you custom build, it is never possible to scrutinise the resulting system for vulnerabilities, like it is within a product implementation.
- **Promote Cost-effectiveness: F**ollowing architectural principles can lead to cost-effective designs by avoiding unnecessary complexity and resource waste. This is important in both infrastructure services and software systems, where cost considerations are significant.
- **Adhere to Compliance and Regulation:** In register domains, there are very specific legal and regulatory requirements that systems must meet. Architectural principles can help ensure that the system adheres to these requirements from the outset.
- **Drive Documentation and Communication:** Architectural principles often involve clear documentation and communication practices. This ensures that the design intent is understood by all stakeholders and facilitates collaboration among development teams.

It is the authors contention that in the absence of an accepted statement of best practice of what is a good register operation, that it is simply too easy to not expound upon or expose the architectural principles of a register system. In this paper we will for the first time, set out the architectural principles of a register. It is hoped that from this, we will be able to formulate a Capability Maturity Model for registers that will allow for a quick comparison of registers, that is domain agnostic and that creates a roadmap for improvement in register operations.

Register Domain

Current Register Trends

Registries of the future need to consider significantly transforming their processes, organisational structures, and become more adaptative to technology trends and capabilities, including ongoing enhancements to support end-to-end digital capabilities. They will need to become increasingly data and insight-driven and will need to align to become more user-centric, in line with increasing international standards which will aid the transition to the 'new normal' and help with delivering effectiveness and to navigate future technology advances. [TOM paper reference - Foreword].

There are several key trends and practices that have been on the horizon for some time as it relates to our domain and some of these we outline below have become fundamental to the ongoing transformations and architecting principles for the registries of the future.

Cloud based registry platforms

Cloud based platforms provide increased scalability and flexibility. By implementing these solutions registries can take advantage of the scalability allowing them to handle larger data volumes, increased user traffic, and varying workloads more effectively. This flexibility enables registries to adapt to changing demands and accommodate growth without significant infrastructure investments.

Cloud service providers invest heavily in advanced security measures and compliance certifications to protect data. Public cloud providers collectively invest billions in security research, innovation and protection[4]. Future trends across registries may include the use of enhanced cloud security structures around encryption, multi-factor authentication, and advanced access controls to safeguard government data.

Cloud-based registries can facilitate better collaboration and information sharing among stakeholders. With data stored in the cloud, authorized users can access and update information from anywhere, promoting collaboration and reducing barriers to interoperability. Registry platforms adopting API first principles and standardized data formats to enhance data exchange and interoperability across different registry systems will be prominent features of future target operating models.

Cloud computing often serves as a foundation for emerging technologies. The cloud has evolved from being the new technology to being the driver of other new technologies. Emerging tech would not be possible at scale without cloud computing as the enabler[5]. Cloud based registries may leverage advancements in areas such as blockchain, AI, the Internet of Things (IoT), and edge computing to enhance data integrity, streamline data collection processes, and improve real-time data availability.

As data protection regulations evolve, cloud-based registries will need to ensure compliance with applicable privacy laws and regulations. These trends will involve cloud providers offering specialized services and tools to assist registries in meeting compliance requirements, such as data localization[6], consent management, and privacy-enhancing technologies.

[4] https://blogs.oracle.com/cloudsecurity/post/7-reasons-why-the-cloud-is-more-secure
[5] https://www.simplilearn.com/emerging-technologies-enabled-by-the-cloud-article
[6] https://www.ccjk.com/data-localization-an-in-depth-analysis/#A11

Adaption and Integration of Identity and Entity Validation Systems

Registries are currently undergoing significant transformations leveraging advancements in identity and entity validation as technology and regulatory frameworks progresses. Registry platforms are being designed to seamlessly integrate with digital identity systems, leveraging technologies such as blockchain, self-sovereign identity, and decentralized identifiers. These systems provide secure, verifiable, and tamper-proof digital identities, enabling more robust validation of individuals and entities in registries. Users will have control over their digital identities and can selectively share information with registries as needed. Instead of one-time validation, registries may implement continuous validation and monitoring mechanisms. This approach involves regularly updating and verifying identity and entity information, ensuring that the registry data remains up to date and accurate. It can help detect changes in circumstances or identify suspicious activities promptly.

As registries become more interconnected, there will be a growing need for cross-registry data validation. Different registries, such as those for corporate and beneficial ownership, land, secure transactions across both physical and digital assets, could share relevant information to verify identities and entities across multiple domains. This collaborative approach would enhance the accuracy of validation, reduce redundant data entry and vastly improve citizen and business interaction with government.

AI and ML

The continuous integration and adaptation of Artificial Intelligence (AI) and Machine Learning (ML) will enable registries to derive meaningful decisions and insights from large datasets. Applying advanced analytic tools will help identify trends, predict outcomes, and support evidence-based decision-making. Machine learning algorithms can analyze patterns and identify anomalies, improving the accuracy and efficiency of identity and entity validation.

Registries will continue to leverage machine learning models trained on large datasets to automatically detect inconsistencies, identify potential fraud, and validate the legitimacy of individuals or entities. This can help reduce, and in some cases completely replace manual verification efforts and enhance the overall integrity of the registry data. Future trends will include the integration of AI/ML algorithms within registry systems, enabling the ability for automated data analysis and predictive modeling to enhance decision making, optimize resource allocation, and to potentially provide for early detection of anomalies and fraud within and across registers.

Leveraging Blockchain Capabilities

Future registry platforms that adapt and leverage blockchain capabilities will provide benefits in several ways. Some of the key characteristics and capabilities to assess include:

1. Data Immutability: Blockchain technology provides a decentralized and immutable ledger, where data once recorded cannot be altered or tampered with. Registry systems can integrate blockchain to ensure the integrity and immutability of critical data.[7]
2. Decentralization and Trust: Traditional registry systems often rely on centralized authorities for validation and verification. By utilizing blockchain, registries can shift towards a decentralized model, where multiple participants validate transactions through consensus mechanisms. This distributed trust model removes the single point of failure and enhances the overall resilience and security of the registry system.[8]
3. Smart Contracts for Automation: Smart contracts are self-executing contracts with predefined rules and conditions. One of smart contracts' primary benefits is their ability to automate processes and enforce agreements between different parties.[9] We can leverage smart contracts to automate processes such as registration, verification, and updating of records. This can streamline operations, reduce manual intervention, and ensure the accuracy and consistency of registry data.

[7] https://www.ejable.com/tech-corner/blockchain/blockchain-network-data-immutability-and-interoperability/
[8] https://www.blockchain-council.org/blockchain/decentralized-vs-centralized/
[9] https://financefeeds.com/smart-contracts-explained-beginners-guide-with-case-studies/

4. Enhanced Security and Privacy: Blockchain technology employs cryptographic techniques to secure data and transactions. By incorporating blockchain capabilities, registry systems can enhance security and privacy measures. Data stored on the blockchain is cryptographically secured, providing an additional layer of protection against unauthorized access and tampering.
5. Auditability and Transparency: Blockchain's transparent and auditable nature allows for easy verification of transactions and activities. Registry systems can use blockchain to provide a transparent audit trail, enabling stakeholders to track and verify the history of data changes, ownership transfers, or any other relevant actions. This transparency increases trust among participants and can be especially valuable in areas like land registries or supply chain management.
6. Tokenization of Assets: Blockchain enables the tokenization of real-world assets, representing them as digital tokens on the blockchain. It has become worthwhile for governments to explore tokenization to represent ownership, rights, or entitlements in a secure and transferable manner. This can significantly advance registries for entity classifications such as intellectual property, real estate, businesses, or even digital asset certifications, allowing for faster and more efficient transactions.

There are obviously some key benefits to be leveraged and as we consider the incorporation of blockchain capabilities. It is crucial to assess the specific requirements of the solution, the direct impact they will have when integrated into the overall design against the current characteristics of the registry system.

Consolidation of Register Types under a Single Custodian

With the ongoing consolidation of data and operations of government registries being managed under a single custodian, there is an increased focus on procuring and implementing common platforms for registers and their services, driven by the need for interoperability, efficiency, and seamless data exchange across domains and systems. The authors covered this in their previously published paper ***"Registers the New Frontier - A Proposal for the Development of a New Target Operating Model for Registers"***, noting some potential trends in this area include:

1. Integrated Data Ecosystems: Common registry platforms will provide for an integrated data ecosystems that bring together multiple registers and services under a unified framework. These platforms would enable seamless data sharing, collaboration, and interoperability across different registries. By integrating various registers, such as land, business, secure transactions, and identity, common platforms can provide a comprehensive view of individuals, entities, and assets.
2. Standardized Data Models and APIs: Common platforms can establish standardized data models and APIs to facilitate easy integration and data exchange between different registers and services. These standards would define common data structures, formats, and communication protocols, making it simpler for new registries and services to join the platform and ensuring consistent data representation.
3. Cross-Domain Interactions: Common platforms can enable cross-domain interactions, allowing registers and services from different sectors to interact and exchange information. These cross-domain interactions enhance efficiency and improve user experiences.
4. Modular and Scalable Architecture[10]: Future common platforms will seize the benefits a modular and scalable architectures to accommodate the diverse needs of different registers and services. This architecture would allow easy integration of new registers and services while supporting the growth, scalability and reduced maintenance of the platform. Modular components could be added or updated independently, minimizing disruption, reducing costs, improving the development cycles and enabling flexibility.
5. Centralized Governance and Standards Bodies: Common platforms may be governed by centralized entities or standards bodies responsible for establishing and maintaining interoperability standards, best practices, policies, and governance frameworks.

[10] https://www.harrisonclarke.com/blog-2023/benefits-of-modular-architecture-moving-from-monolithic-to-modular

Overall, these trends towards consolidation under a single register custodian should be leveraging common platforms that are highly adaptable to the advantages brought forward from integrating new technologies, and be easily configurable to revised processes and structures to maintain the efficiency, accuracy, changing legislative imperatives and the overall accessibility of government data.

It's also important to note that the realization of these current and future trends depend on various factors, including regulatory frameworks, technological advancements and digitalization of the registries, industry collaboration, and overall user adoption. Common platforms for registers and services require broad participation and cooperation among stakeholders, including government entities, private organizations, and technology providers, to create a unified and effective ecosystem.

In our previous Paper ***"Registers the New Frontier"***, we also outlined a list of characteristics of best practices within register operations (see section below). We fully acknowledge our list would require further validation by register operators of a wide range of register types (legislation) we encourage the reader to review it in the context and support of this Paper.[11]

Register Best Practice

Best practice statements, including standardisation, quality, innovation, and international harmonisation, can significantly benefit the international registry domain. While the authors recognise that a best practice statement may vary depending on the specific context, legal and regulatory environment, and, indeed, the goals and objectives of the Register, a statement of best practice for registers can be primarily grouped into six distinct efforts by the Register to maintain efficiencies in operation:

1. **Data Quality:** Registers are only as good as the data they contain, so it is essential to ensure that the data is accurate, complete, and current. This can be achieved through regular data cleansing, validation, and verification processes. Often this is supported by legislation, regulations or policy that enforce an annual review process.
2. **Data Governance:** Establishing clear policies and procedures is critical to ensure the integrity and security of the data in the Register. This includes defining roles and responsibilities for data management, ensuring compliance with relevant regulations and standards, classification of data appropriately and implementing appropriate data security measures.
3. **Stakeholder Engagement:** Effective stakeholder engagement is essential to ensure that the Register meets the needs of its users. This includes engaging with data providers, users, and other stakeholders to understand their needs and requirements and ensuring that the Register is designed and operated to meet those needs.
4. **Standardisation:** Standardisation of data elements and formats is critical to ensure consistency and interoperability between registers and other systems. This can be achieved by adopting common standards and protocols, such as those developed by international organisations like ISO or IETF.
5. **Automation:** Automation of register operations, through key tools such as AI/ML, will help to improve efficiency, reduce errors, and free up staff time for more complex tasks. This can include the use of automated data validation and verification processes, as well as the use of software tools to manage and process data.
6. **Continuous Improvement:** Registers are dynamic systems that require ongoing maintenance, improvement, and adaptation to meet changing needs and requirements. It is essential to establish a culture of continuous improvement, which includes regular review and evaluation of the Register's performance, ongoing data quality monitoring, and identifying and implementing improvements and enhancements as needed.

[11] https://www.fostermoore.com/news/proposed-new-target-operating-model-for-registers

Innovation

Innovation is defined by McKinsey & Company as the systematic practice of developing and marketing breakthrough products and services for adoption by customers[12]. For registers and regulators, their stakeholders are primarily the citizens of their jurisdictions. It is important to understand what innovations can registers and regulators provide to their stakeholders to enable them to complete their obligations efficiently and offer them value to help them do business more efficiently and profitably.

With an innovation mindset, registers can make a real difference towards services provided to their clients and, often, drive better more efficient outcomes across the economy and society as a whole. When we think about innovation ideas, we look at the who, the what and the how. The how is often financially driven, but for registers and regulators, the why could be measured in the time taken to register an entity or confidence that we know an individual's true identity.

The following innovations are either already adding value to registers or will be in the future.

1. **AI, Machine Learning and Data Insights**

   AI, machine learning and data science have existed for many years. A set of factors have made the development of AI features more readily available and cost-effective. These factors include:

   - Moore's law, the continued improvement in the speed of CPU's
   - The development of deep learning or neural networks
   - Hardware improvements and the use of Graphics Processing Units (GPU) and specialized chips.
   - Collection and availability of large datasets
   - Development of LLM models that AI developers can leverage

   Some of the areas where AI can add value and innovate within the Registry Domain

   - Ability to identify fraudulent behaviour
   - Name determination modules to approve or reject name requests
   - Ability to provide much richer searching of registers using natural language
   - Intelligent workflows
   - Predict changes in markets based on historical data.
   - Registry vendors enable generating registers through GenerativeAI solutions, which enables faster registry implementations and changes for agencies.

2. **Blockchain-related innovations for the Registry domain**

   Blockchain technology is gaining momentum as people and organizations find use cases where the principle benefits of security, immutable and distributed are crucial. Innovations that may have an impact on the registry domain include:

   - **Identification** and **verification** of things. We call it things as identity verification can include both people and organizations. The shift to having verified identities for things like entities is underway, with some material benefits. The ability for entities to have their own verification and ownership credentials that can not only be verified that it is valid but who owns it will benefit the world. These systems often utilize blockchain technology with NFTs.
   - **Digital ownership** and **Non-fungible Tokens** (NFT).- Non-fungible tokens are innovations using blockchain technology that will continue and become a key technology component in the register ecosystem, not necessarily as the core register, as there are regulatory requirements that break the blockchain architectural principles. NFTs are tokenized certificates of verifiable proof of authenticity and ownership of digital or real-world unique assets. I.e. ownership of land or entities.

[12] https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/the-eight-essentials-of-innovation

- **Web3** and **Metaverse** are developing technologies that will change how people interact with government. The Metaverse is described as the inevitable evolution of the Internet. Metaverse is a digital ecosystem built on various kinds of 3D technology, real-time collaboration software and blockchain-based decentralized finance tools. Web 3.0 describes the next evolution of the Internet, the user interface that provides access to documents, applications and multimedia on the Internet. Web 3.0 will place a strong emphasis on decentralized applications and probably make extensive use of blockchain-based technologies. It will also use machine learning and AI to empower a more intelligent and adaptive web.
- A **Decentralized Autonomous Organization**, or **DAO**, is a community-led entity with no central authority that is governed by computer code. Because the rules that determine the organization's behaviour are built into its design, it can function autonomously without central leadership. Unlike traditional organizations, in DAOs, no single person or group can make and enforce decisions unilaterally. An emerging form of legal structure with no central authority, the DAO governance model relies on community members' proposals for a vote.

Guiding Principles

As per TOGAF[13], the guiding principles defines the underlying general rules and guidelines for the use and deployment of all IT resources and assets across the enterprise. These principles reflect a level of consensus among the various elements of the enterprise and form the basis for making future IT decisions. Each architecture principle should be clearly related back to the business objectives and key architecture drivers.

The following are examples of Guiding Principles:

- **Cloud-Native Architecture:** Cloud-native architecture is a design approach that is optimized for cloud-based environments. It is characterized by its use of containerization, microservices, and orchestration tools to create highly scalable, flexible, and resilient systems that can be deployed and managed easily in the cloud.
- **Event-Driven Architecture:** Event-driven architecture is a design approach that emphasizes the importance of processing events, or messages, as they occur in real-time. It is characterized by its use of event-driven patterns and technologies like event streaming, messaging systems, and reactive programming to create highly responsive, scalable, and fault-tolerant systems.
- **Domain-Driven Design:** Domain-driven design is a design approach that emphasizes the importance of modelling software systems around business domains. It is characterized by its use of bounded contexts, aggregates, and domain events to create modular, maintainable, and flexible systems that can evolve and adapt over time.
- **Serverless Architecture:** Serverless architecture is a design approach that eliminates the need for servers, infrastructure, and operating systems, by using cloud-based functions and services to provide compute, storage, and other resources. It is characterized by its use of serverless functions, event-driven triggers, and cloud-based services to create highly scalable, cost-effective, and agile systems.
- **Reactive Architecture:** Reactive architecture is a design approach that emphasizes the importance of building responsive, resilient, and elastic systems that can handle high volumes of traffic and data. It is characterized by its use of reactive programming, message-driven architectures, and event-driven patterns to create systems that can react to changes in real-time, without sacrificing performance or reliability.

[13] https://pubs.opengroup.org/architecture/togaf8-doc/arch/chap29.html

Architectural Guiding Principles

The authors describe the following as architectural guiding principles that are important to the register domain:

- **"Modularity"** – Register requires that systems are designed in a way that allows different components or modules to be developed, tested, and deployed independently. This means that the functionality is modularised logically. This facilitates the register easier maintenance and upgrades.
- **"Scalability"** – Registers must rely on systems that can adequately support a varied level of transactions without requiring major changes to the underlying architecture. This includes flexibility in the infrastructure services that support the systems managing the transactions.
- **"Resilience"** – This principle emphasizes the importance of designing software to be resilient in the face of failures or other disruptions. This involves designing systems with redundancy, fault tolerance, and self-healing capabilities, so that they can recover quickly from failures and continue operating smoothly.
- **"Performance"** – Register systems should be designed that can handle high volumes of data and users, while minimizing the use of system infrastructure services, but delivering rich services to customers in a timely manner.
- **"Auditable"** – Ability to track when and who performed which activity on the register, which cannot be altered by application logic.
- **"Maintainability"** – Ease of maintenance, ability for the register to propagate changes in a consistent and immediate manner across all customer channels.
- **"Multiple Registers"** – a single register platform providing a plethora of common shared services upon which individual customised register products are deployed. The common shared services are domain agnostic.
- **"Interoperable"** – an innate means to interrogate and reference other registers to allow for the canonical nature of a register and that a register does not duplicate data.
- **"Register Products"** – domain specific register products that are customised for the legislation/jurisdiction/ecosystem are used and deployed onto an integrated register platform.
- **"Service-Oriented Architecture"** – deploy a service layer that derives the greatest business value to the Registration Authority by implementing share services, that are flexible and are consumed through an interoperable layer of defined services that evolve and are refined.
- **"API- First"** – Registers are live lists and must be searchable both by human and machine. Architecting the system 'API First' demands the applications that use the register, consume a standardised set of services across the entire ecosystem of the register. This means change is singular. Thus, it is straight forward to in turn natively expose these APIs to the external stakeholders.
- **"Configurable" –** the ability to effect change on the register quickly and easily is of paramount importance. This includes changes to external forms and configuration parameters of defined processes and/or complex workflows. Complex processes should not mean customisations.
- **"Multiple Channels"** – services deployed can be consumed in a multiple of channels with a consistent UX rendered for that user.
- **"Evergreen"** - Evergreen IT systems are software solutions that are regularly refreshed with small iterative updates at frequent intervals. Compared to traditional software solutions that are typically replaced every three to five years with entirely new versions, Evergreen solutions are enhanced with new features and security patches on a routine basis to always remain updated.

- **"Consistent Applications"** – applications across all registers and for all external stakeholders exhibit and provide a consistent UX that can be customised and consumable by third party applications.
- **"Straight-Through-Processing"** – end to end processing with processes automated to an extent that there is no manual intervention in the process – self maintaining register.
- **"User-Experience (UX)" –** Develop and deploy user interfaces that use the latest technology to deliver state of the art interactions that afford great levels of usability within an intelligent and intuitive UIs. The look and feel as in the presentation layer should be refreshed/changed with ease.
- **"Help Support Systems"** – deploy an array of context-sensitive help, online videos, and online support within the UX to enable the 'self-service' of customers.
- **"Flexible Deployment Options"** – an array of configuration management options of the cloud infrastructure to support the register systems to maximise efficiencies and UXs.
- **"Security"** – deploy the latest security protocols and processes to protect the register data and the reputation of the of custodian/registration authority.
- **"Suppression"** – Provide custodian/registration authorities with the ability to suppress public information under the appropriate circumstances.
- **"Correcting the Register"** – Correct information on the register while retaining all the auditing, versioning and suppression information.
- **"Identity Management Services"** – identity services being as important as register services.
- **"Linking and Cascading"** – It is common that due to legislation and regulatory requirements, individual information, including addresses, needs to be stored within the registry domain data set. Ensuring you can link these individual registry records together when they are the same person and then cascade changes within a register and across different registers provides a much better user experience and higher-quality data.
- **"Filing Management"** – The process of performing digital transactions, such as registering or maintaining a company, is often hampered by a physical document/form-centric world because all filings are historically paper-based and part of the legislation. Sometimes a digital transaction may have a few forms associated with these and then need to be recorded on the registers as separate filings. Ideally, registers will move from a document/form-based model to a data-centric model.
- **"Trusted"** – ensuring people's privacy is a primary principle in providing confidence and trust in giving private information to a register.
- **"Interface Layer"** – payment gateways, ERP systems, identity validation providers and/or other external services and or data sources are integrated in a consistent manner.
- **"Entity/Thing Versioning"** – Ability to record the complete state of an entity or thing being registered at any time and retrieve this data, including all the data and supporting the legislation in practice, at that time down to the second.
- **"Accessibility"** – Ensuring that people with disabilities can access and use the registries and adhere to global accessibility standards.
- **"Multi-lingual"** – Provide the ability to view user interfaces, help content and correspondence in different languages. Storing of the registry data is user-defined.

- **"Relationship Management"** – The ability to assign access and privileges to users based on relationship records that reflect the roles that the people or entities represented by that user play.
- **"Intelligent Features"** – Registry features utilise smart logic, machine learning, data science and AI to enable regulators and regulator clients to make informed decisions and automate manual decision-making.
- **"Concurrency Management"** – Digital transactions introduce changes to the data of a specific entity on the register. The term "merge changes" refers to managing the situation whereby two concurrent change processes are in action simultaneously on the same baseline set of data. Once one of the change processes is applied to the baseline data set, the second process needs to be refreshed with those changes to ensure that the changes being made are still appropriate.

The architectural guiding principles outlined above serve as the foundational pillars upon which the register domain is built. These principles encapsulate the essence of a modern, efficient, and responsive register system. By emphasizing modularity, scalability, resilience, performance, and maintainability, we ensure that registers can adapt to evolving needs and technological advancements. Moreover, principles such as audibility, interoperability, and security uphold the integrity and trustworthiness of register data. The incorporation of user-centric features, multi-lingual support, and accessibility underscores inclusivity and usability. Furthermore, the commitment to evergreen solutions and intelligent features enables continuous improvement and innovation.

With these principles in mind, the register domain stands poised to meet the challenges of the future, providing reliable, secure, and user friendly services while safeguarding privacy and data quality.

Conclusion

In today's dynamic landscape of register operations, the choice between leveraging an existing and proven Registry Aware platform or embarking on a custom build stands as a pivotal decision for the future success and reputation of the operator. Our paper addresses the critical decision-making process faced by registers when deciding whether to custom-build or to procure a registry aware platform to support their operations. The authors emphasize the importance of having a clear Target Operating Model (TOM) and architectural guiding principles for register systems to ensure future sustainability and effective decision-making. We argue that both custom-built and externally procured systems should adhere to these principles, providing a fair basis for comparison.

We underscore the significance of architectural principles and a well-defined Target Operating Model (TOM) in guiding the decision-making process for register systems of the future and we strive to point out the deficiencies when these principles are absent.

By providing a comprehensive overview of architectural principles and the latest trends in register domains, we have attempted to offer valuable insights into the evolving landscape of register operations. The trends discussed, such as cloud-based platforms, identity validation systems, AI and ML integration, blockchain capabilities, and the consolidation of registers, highlight the need for registers to adapt to modern technologies and regulatory changes. These trends are not only transformative but are also essential for improving data integrity, security, interoperability, and efficiency in register operations.

Our intention in writing this Paper is to provide a key technical resource for registrars, IT and cross business-organizational participants involved in register development and ongoing operations, emphasizing the importance of architectural principles, the adoption of emerging technologies, and the need for collaborative efforts to create unified and effective ecosystems. Registers that embrace these principles and trends will be better equipped to navigate the challenges of the digital age and will ultimately provide more efficient and user-centric services to their stakeholders.

This Paper has also shed light on the fundamental principles of innovation that should guide registers and regulators as they strive to deliver efficient and valuable end-to-end digital services. It has unraveled the "who, what, and how" of innovation, underscoring how innovation within the registry domain can yield substantial improvements in efficiency and productivity across entire economies. Notably, blockchain technology has emerged as a game-changer, enabling secure identity verification, digital ownership, and paving the way for novel paradigms like Web3 and Metaverse, which could revolutionize government-citizen interactions. Throughout this Paper, we have explored these and many other innovations, all of which hold the potential to reshape the registry landscape. The key significance of these innovations lies in their capacity to identify fraudulent activities, drive interoperability and data exchange, promote improved operational governance, enhance search capabilities and promote API first principles, streamline workflows through automation, and provide more secure and efficient interactions with registry systems.

Our outline around Guiding Principles have been at the forefront of shaping the architectural foundations of our register platform. These Principles serve as the bedrock upon which modern register systems should be constructed, ensuring that they are modular, scalable, resilient, and high performing. They champion the transparency and auditability of transactions, encourage seamless interoperability with other systems, and fortify security measures. Moreover, these Principles empower registers to offer consistent user experiences, accommodate diverse users with accessibility and multi-lingual support, and continuously enhance their capabilities through evergreen solutions and intelligent features.

In conclusion, the decision to leverage existing and proven COTS registry aware platform or pursue custom-built solutions should be anchored in these principles of innovation and architectural guidance. Leveraging a registry aware platform holds the promise of efficiency, cost-effectiveness, and the integration of state-of-the-art technologies with the commitment to ongoing innovation investment across the solution. Conversely, custom builds may deliver tailor-made solutions fit for purpose (i.e., only at the point of go-live), but also entail significant challenges of ongoing development, limited R&D focus, lack of intuitive knowledge base incorporated into the solution and extremely high maintenance costs.

The key to success lies in striking the right balance between innovation, adaptability, and cost-efficiency, ensuring that registers and regulators persist in delivering valuable services to their stakeholders while remaining responsive to the ever-evolving demands of society. Ultimately, the choice should align with the overarching mission of efficiently serving citizens and businesses.

Foster Moore®, a Teranet company, – is a global leader and specialist registry software company focused on digital services for modernizing government.

For two decades the team at Foster Moore has developed and maintained online business registry systems, and a host of other smaller electronic registries across the globe. Foster Moore's registry solutions power business registries in twenty-one jurisdictions across the globe. We have implementations in North America, Southeast Asia, the Middle East, Africa, the Pacific and New Zealand.

Verne® is a cloud-based Registry Aware® platform that delivers a powerful suite of tools to all government registries, enabling them to be interoperable, to provide accurate, timely and trusted data on behalf of government to citizens and business. Verne® is an extremely flexible platform that has a set of core products that interact with each other to deliver the business functionality required to operate online registries such as land, business registries, secured transactions and occupational registries.

Teranet® is Canada's leader in the digital transformation, delivery, and operations of statutory registry services with extensive expertise in land and corporate and personal property registries.

For more than three decades Teranet has been a trusted partner to governments and businesses in building stronger communities and economies. Teranet developed and currently operates Ontario's Electronic Land Registration System and Writs System, Manitoba's Land Titles and Personal Property Registries and Canada's largest integrated Collateral Management System

Glossary

Application Programming Interface (API) – a means by which two or more computer programs can communicate with each other.

Artificial Intelligence (AI) – leverages computers and machines to mimic the problem-solving and decision-making capabilities of the human mind.

Blockchain – A digital ledger that keeps a record of all transactions taking place in a peer-to-peer network. All information transferred via Blockchain is encrypted and every occurrence is recorded, meaning that the information cannot be altered.

Current Operating Model (COM) is the current operating model instituted in terms of the configuration of people, processes, and technology to achieve the organisation's objectives.

Data Immutability – Data immutability is the idea that information within a database cannot be deleted or changed.

Decentralized Autonomous Organization (DAO) – A decentralized autonomous organization, sometimes called a decentralized autonomous corporation, is an organization managed in whole or in part by decentralized computer program, with voting and finances handled through a blockchain.

Digital Immune System (DIS) – a digital immune system is a set of technologies and processes that help an organization protect its information and systems from continual attack and exploit.

Electronic Collateral Register (ECR) – an asset register defined under the Cape Town convention.

Internet of Things (IoT) – describes the network of physical objects— "things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

Interoperability is the ability to share information and services or the ability of systems or components to exchange and use information or provide and receive services from other systems.

Machine Learning (ML) – is an AI technique that teaches computers to learn from experience.

Open Data – is defined as structured data that is machine-readable, freely shared, used and built on without restrictions.

Operator – the custodian of a register.

Register – a statutory register that persists legal entity records within a legislative base.

Registry Domain – a single grouping of similar legislative bases of register operators such as Land or Business.

Robotic Process Automation (RPA) – is an optimisation method that uses AI, machine learning, or virtual bots to execute tasks humans would otherwise handle.

Smart Contract – A smart contract is a self-executing program that automates the actions required in an agreement or contract. Once completed, the transactions are trackable and irreversible

Target Operating Model (TOM) is a high-level blueprint that outlines how an organisation intends to operate in the future to achieve its strategic objectives.

Tokenization – refers to a process by which a piece of sensitive data, such as a credit card number, is replaced by a surrogate value known as a token. The sensitive data still generally needs to be stored securely at one centralized location for subsequent reference and requires strong protections around it.

XML – stands for eXtensible Markup Language · XML is a markup language designed to store and transport data.

Keywords

Target Operating Model; Register; Registry Domain; Transformation; Reference Architecture; Architectural Principles; Registry Platforms; Cloud Based Registries; Best Practices; Digital Government; Common Platforms and Registry Aware.