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GOVERNANCE

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EQUITABLE GROWTH, FINANCE & INSTITUTIONS INSIGHT

Interoperability

Towards a Data-Driven Public Sector

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Acknowledgments

This How-to Note has been developed under the World Bank GovTech Initiative by a team led by João Ricardo Vasconcelos and Youngseok Kim, both Senior Governance Specialists on the GovTech global team and Task Team leaders. Co-authors were Stela Mocan (Manager of ITSTI); Olushola Ibironke Joanne Martins (IT Officer, ITSTI); Rachel Alexandra Halsema, (IT Officer, ITSTI); Charlotte van Ooijen, Associate Director, Digital Government and Data, Alice Iordache, Research Associate, and David Osimo, Director of Research, all from the Lisbon Council. Additional contributions came from World Bank colleagues: Kimberly D. Johns (GovTech Global Lead and Senior Public Sector Specialist); Constantin Rusu (Senior Public Sector Specialist); Silvana Kostenbaum (Senior Public Sector Specialist); Do Kyu Lee (Senior Digital Development Specialist); Serdar Yilmaz (Lead Public Sector Specialist); Ildrim Valley (Public Sector Specialist); Daniel Ortega Nieto (Senior Public Sector Specialist); Huong Thi Lan Tran (Senior Public Sector Specialist); and Serena Cocciolo (Economist). Arturo Herrera Gutierrez (Global Director, Governance Global Practice) and Tracey Lane (Practice Manager) provided overall guidance for the report. Editorial services were provided by Richard Crabbe. The report leverages input from Prema Chandrashekhar and Raunak Mittal, IT Officers, ITSTI.

The World Bank GovTech team would like to highlight the relevance of having an analytical deliverable codeveloped with the Lisbon Council. This note also benefited from the valuable contributions of the Interoperability Working Group that brings around the table the following 18 governments, private sector organizations, think tanks and international organizations: Indonesia (co-chair), Portugal (co-chair), Argentina, Cabo Verde, Canada, Citibeats, Denmark, EU-DIGIT, Republic of Korea, Lisbon Council, Mozambique, New Zealand, Open Group, Public Digital, Saudi Arabia, Timor-Leste, United Kingdom and UNU-eGOV. Members of the Interoperability Working Group are listed in Annex IV. In line with the multistakeholder thinking of the GovTech Global Partnership, the engagement of these relevant partners added experience, quality insights and strategic outreach to the work developed.

This report was made possible by the World Bank's GovTech Initiative and the GovTech Global Partnership trust fund, building on the support of financial and in-kind partners that include the Ministry of Finance of Austria, the State Secretariat for Economic Affairs (SECO) of Switzerland, the Ministry of Economy and Finance (MOEF) of the Republic of Korea, the Ministry of Economic Development of the Russian Federation, the Ministry of Interior and Safety (MOIS) of the Republic of Korea, the Government of Japan, and the Federal Ministry for Economic Cooperation and Development (BMZ) of Germany.

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Abbreviations

AI	Artificial Intelligence
AMA	Agency for Administrative Modernization
API	Application Programming Interface
CTI	cyber threat information
CTII	cyber threat information intelligence
DLT	distributed ledger technology
ECLAC	Economic Commission for Latin America and the Caribbean
eID	electronic identification
EIF	European Interoperability Framework
ESB	enterprise service bus
EU	European Union
GTMI	GovTech Maturity Index
ICT	information and communications technology
IT	information technology
ML	machine learning
NIFO	National Interoperability Framework Observatory
OECD	Organisation for Economic Co-operation and Development
RNI	Register of non-residents (Netherlands)

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Executive Summary

Interoperability frameworks are a key enabler for GovTech, the World Bank's whole-of-government approach to public sector modernization, as they reduce system boundaries between government agencies by setting standards and guidelines across government systems to allow for seamless exchange of information and communication between systems. But governments may face several challenges when setting up and implementing interoperability frameworks, related to a mix of technical, semantic, legal, organizational, and cultural factors.

This How-to Note provides advice on what interoperability in the public sector is, why it is needed and how it can be implemented with various examples and a whole-of-government approach to interoperability taking into account both digital and nondigital aspects is of the essence.

What Is Interoperability?

Interoperability in the public sector is about enabling connections between ministries, departments, agencies, sectors, government levels and countries through data, information systems, legal agreements, organizational processes, and shared values and customs. For responsive and efficient public service delivery, it is crucial to move from a silo-based approach to a whole-of-government approach. Instead of every government entity working in isolation towards organization-specific goals, departments across government levels, sectors, and country borders can work together to achieve joint goals.

Setting up a basic infrastructure for interoperability may be an important enabler to advance the overall GovTech performance. On the other hand, having in place a whole-of-government approach to GovTech is likely to be favorable to the development of interoperability initiatives. As such, interoperability is considered as a multilayered concept consisting of both nondigital and digital elements, namely legal, organizational, cultural, technical, and semantic layers as well as their overall governance. This note presents 11 modules to highlight the different elements of both nondigital and digital perspectives.

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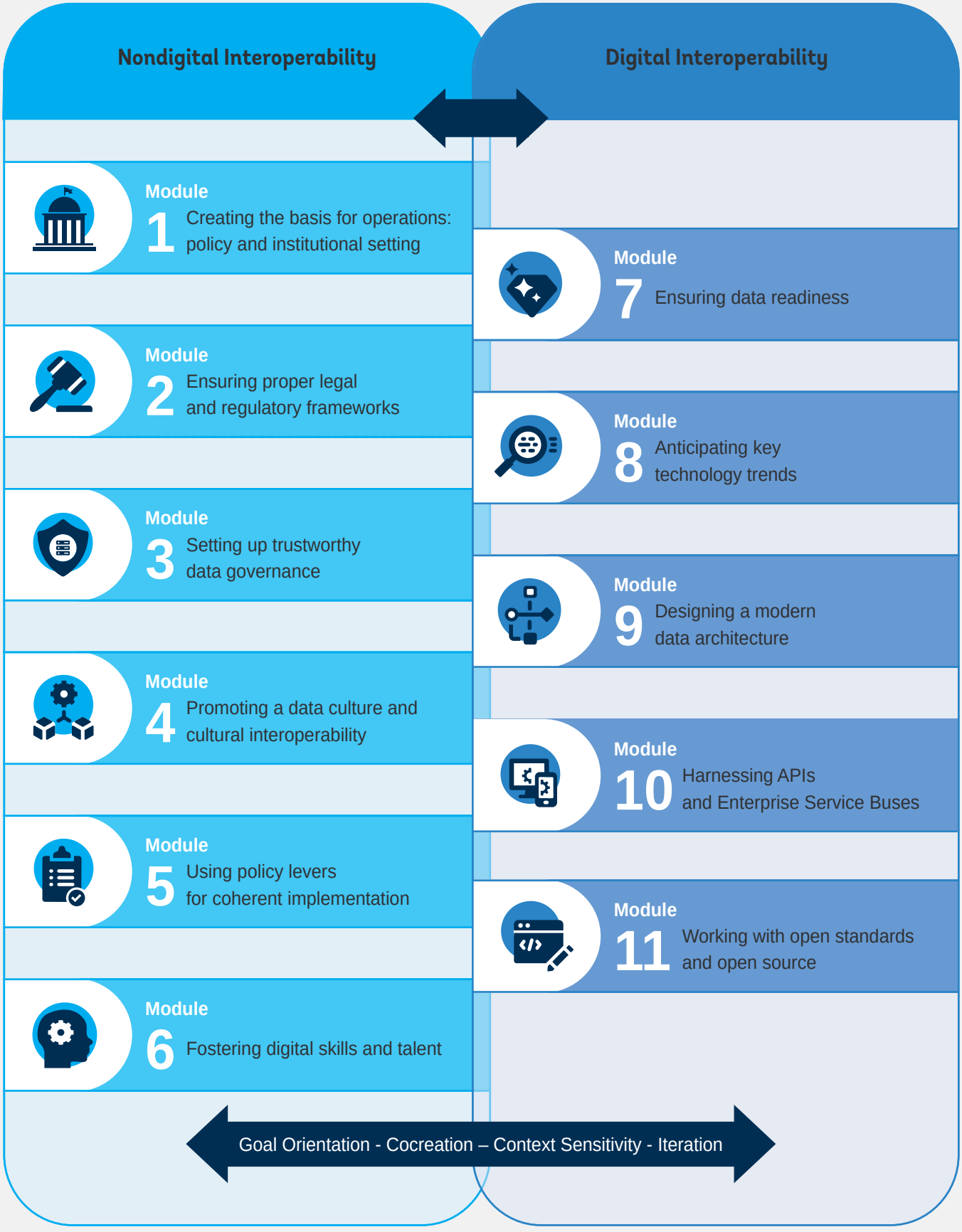
FIGURE ES.1 - The GovTech Approach to Interoperability



Why Interoperability Matters

Achieving interoperability is crucial for the delivery of integrated citizen-centered public services and the path to a data-driven public sector. The immediate effects of an interoperable public sector are an increased connectivity of information technology (IT) systems and that governments can access, share, interpret and reuse data more easily and at a larger scale. In the longer run, these developments can support governments in becoming more citizen-centered and data-driven.

The benefits of fostering interoperability towards a more citizen-centered and data-driven public sector are manifold and within reach of countries across all GovTech levels, albeit not at the same pace nor scale. It will become clear that interoperability produces benefits for both government and citizens and that most of these benefits are interrelated and mutually reinforcing. Key benefits that governments can achieve from interoperability are:

- Efficiency gains.
- The once-only principle and a focus on life events.
- Automated and proactive services.
- Omnichannel service delivery.
- Transparency, accountability, and integrity.
- Service composability.
- System resilience.
- Multiactor data-driven value creation.

Setting the Right Policy and Organizational Conditions

Whole-of-government approaches are required to secure the implementation of interoperability policies in the different sectors and levels of government. Although there are not unique models to develop these approaches, different cross-cutting policy dimensions should be considered—from setting the right policy and institutional setting to ensuring the presence of the necessary skills among the public workforce to accompany the transition to interoperable systems and ways of working.

> > >

TABLE ES.1 - Six Modules for Nondigital Interoperability

Module 1: Creating the Basis for Operations: Policy and Institutional Setting

- Embed interoperability in the overall GovTech strategy.
- Establish the institutional structure with leadership to support interoperability.
- Ensure solid coordination mechanisms to prioritize interoperability.

Module 2: Ensuring Proper Legal and Regulatory Frameworks

- Include diverse domains such as privacy and data-protection, data standards, right to information, the application of the once-only principle, and data ownership and consent.
- Secure proper regulation of the digital transformation and ensure that citizens' interests and rights are legally covered.
- Develop a proper assessment of the existing situation of the legal and regulatory framework.

Module 3: Setting up Trustworthy Data Governance

- Focus on guiding data-driven value creation.
- Enhance trust, ethics and data rights in the digital age.

Module 4: Promoting a Data Culture and Cultural Interoperability

- Ensure clear leadership and institutional coordination to promote the required systems thinking approaches for a data-driven public sector.
- Recognize the role of organizational and individual incentives.

Module 5: Using Policy Levers for Coherent Implementation

- Adopt pre-evaluation of information and communications technology (ICT) investments and public procurement.
- Implement Standard Business Cases and Agile Project Management.
- Improve capacity for monitoring and evaluation.

Module 6: Fostering Digital Skills and Talent

- Define the right option to foster digital skills from building, buying or borrowing.
- Modernize human resources management (HRM) policies and practices to assure the necessary interoperability and skills are available.

Implementing Digital Interoperability

Based on the right policy and organizational foundations, governments need to reflect some essential considerations – data readiness, key technology trends, a modern data architecture, Application Programming Interfaces (APIs), and Open Standards and Open Source – for establishing technical and semantic interoperability.

> > >

TABLE ES.2 - Five Modules for Digital Interoperability

Module 7: Ensuring Data Readiness

- Understand what data is needed, what is available, what do we want to so with this data, and why and who can and needs to access this data.
- Develop a data strategy that may require a current state baseline assessment.
- Establish data governance to ensuring data quality, integrity, availability, harmonization, legal and regulatory frameworks, and overall management of data.

Module 8: Anticipating Key Technology Trends

- Understand new technology trends and how they might change the need to rethink interoperability.
- Identify new challenges through the lenses of technology, people, process, and ecosystem.

Module 9: Designing a Modern Data Architecture

- Design a modern unified data architecture that provides the blueprint of the overall setup of a system, or a group of systems put together to manage data throughout the data lifecycle.
- Consider six steps from current state assessment of tools and systems to reporting and analysis.

Module 10: Harnessing Application Programming Interfaces (APIs) and Enterprise Service Buses (ESB)

- Adopt an API mediation approach and Service Mesh.
- Understand cybersecurity considerations for harnessing APIs.

Module 11: Working with Open Standards and Open Source

- Ensure that interoperability is open to new software modules and new providers, and avoid lock-in.
- Encourage mature GovTech countries to share their code as open source and publish their standards as open standards.
- Benefit from already published open-source material and open standards to develop interoperability initiatives.

Key Considerations

Key considerations to note for practitioners involved in designing and implementing interoperability in the public sector are:

- Critical questions for successful interoperability projects are goal-orientation (focus on the desired outcome and value for stakeholders), co-creation (co-designing and -constructing with stakeholders), context sensitivity (adapting to local priorities and limitations), and iteration (considering the different elements of interoperability in a non-linear way).

- Interoperability is one of the key enablers for a whole-of-government approach. At the same time, a whole-of-government approach that covers setting policy and organizational conditions and implementing digital interoperability is essential for sound interoperability.

- In order to establish data-driven public sectors, practitioners need to consider 11 modules of both nondigital and digital interoperability.

All modules need to considered, but the order and sequence of modules may differ from country to country depending on their baseline. To provide better understanding of prioritization, Annex I presents a checklist for sound interoperability, with suggestions regarding priority actions for each item.

1

Introduction

KEY MESSAGES

- Interoperability in the public sector is about enabling connections between ministries, departments, agencies, sectors, government levels, and countries through data, information systems, legal agreements, organizational processes, and shared values and customs.
- It is important to take a holistic, whole-of-government approach to interoperability, taking into account legal, organizational, cultural, technical, and semantic layers as well as their overall governance.
- Successful interoperability initiatives are goal-oriented, shaped through co-creation, sensitive to the overall GovTech maturity level and country context, and implemented through iteration between all interoperability layers.

1.1 Interoperability: A Key Enabler for GovTech

Interoperability frameworks are a key enabler for GovTech, the World Bank's whole-of-government approach to public sector modernization, as they reduce system boundaries between government agencies by setting standards and guidelines across government systems to allow for seamless exchange of information and communication between systems.[1] As such, interoperability is crucial in facilitating the move from a silo-based approach to a whole-of-government approach. Instead of every government entity working in isolation towards organization-specific goals, departments across government levels, sectors, and country borders can work together towards the achievement of joint goals (Figure 1). Interoperability can bring great benefits for both government and citizens and businesses as the end users of public services.

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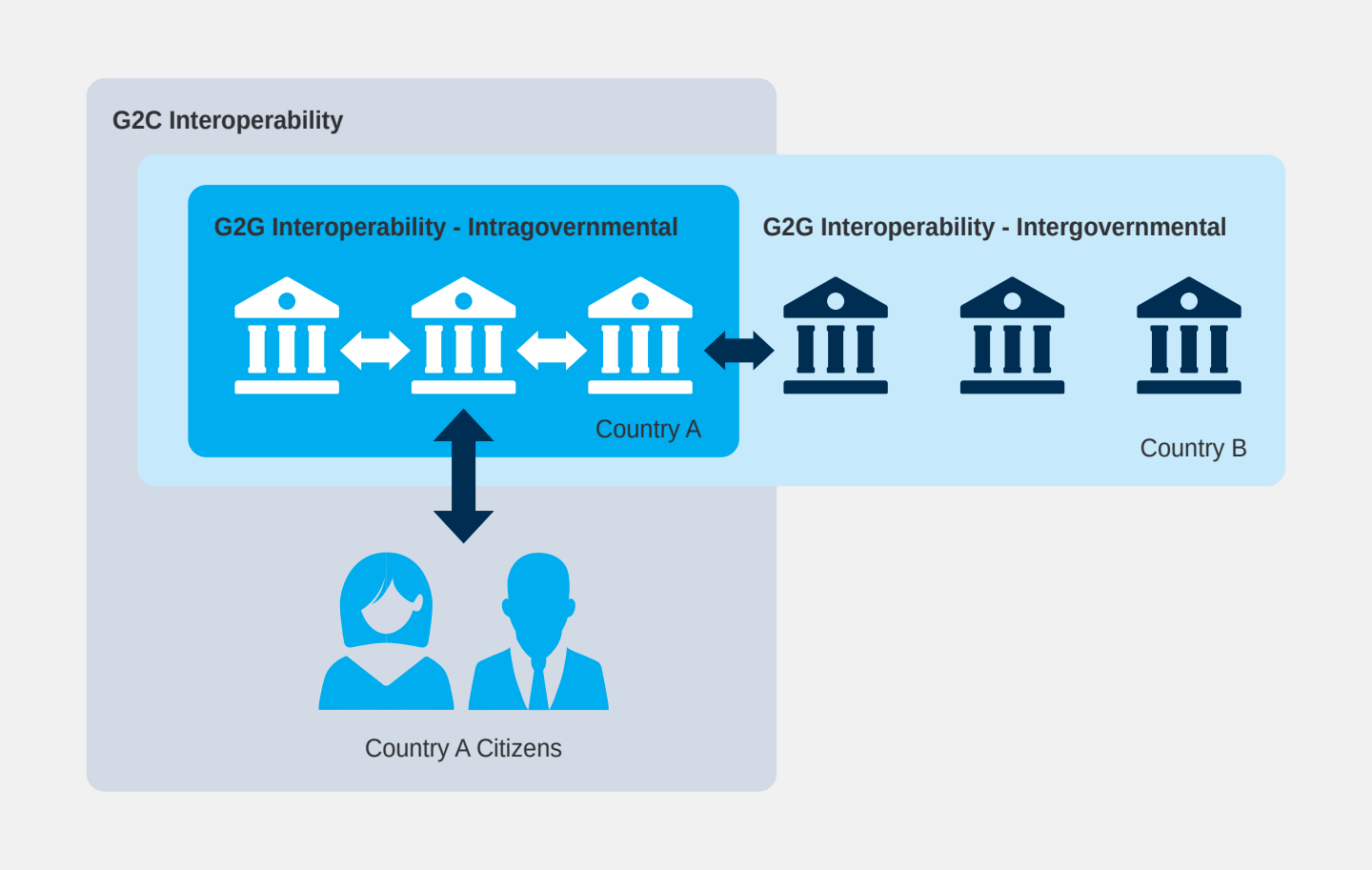
FIGURE 1 - Interoperability in the Public Sector



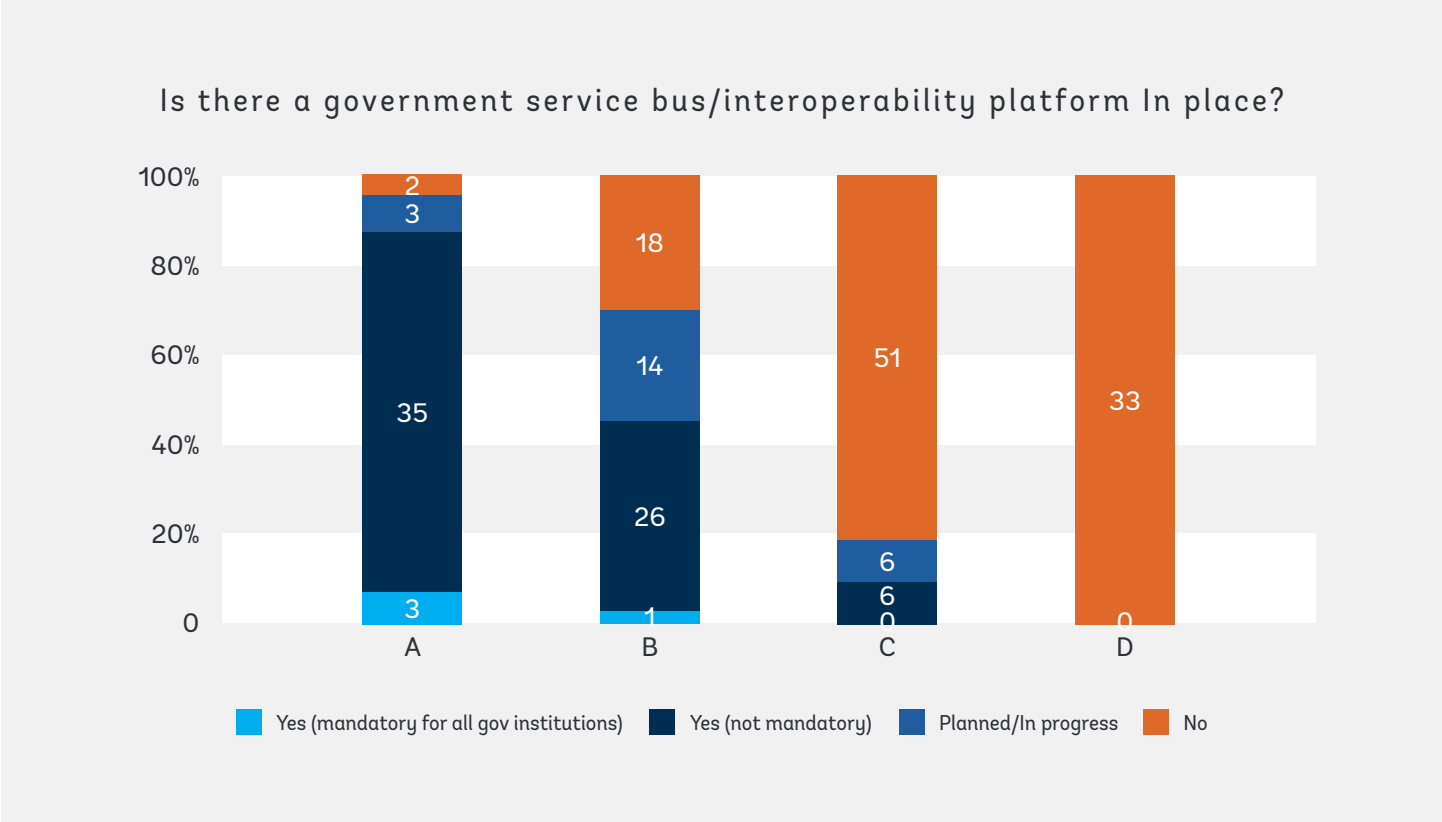
Source: Authors' elaboration.

Governments may tackle the issue of interoperability from different starting points. These range from specific considerations regarding cost savings, more effective planning, enabling cross-sector service delivery to more general ambitions on the redesign of data management and sharing, and leveraging data-driven technologies such as Artificial Intelligence (AI) and Blockchain.

When looking at countries' progress on GovTech as captured by the World Bank's GovTech Maturity Index (GTMI), it becomes clear that interoperability is a core challenge for many countries.[2] The 2020 results suggest that countries should focus more on improving the interconnectivity and interoperability of existing systems and portals, and the benefits of having a government cloud, service bus, and application programming interfaces (APIs) as cost-effective shared platforms in future GovTech initiatives.[3] This is especially true for countries with an overall low GovTech maturity level, as the presence of a government service bus or interoperability platform is tightly linked to the overall GovTech maturity level (Figure 2).

> > >

FIGURE 2 - Interoperability Status by GTMI Group



Source: WBG GovTech Dataset, December 2020.

Only 71 out of 198 countries assessed have a government service bus or interoperability platform in place, of which only four have made its use mandatory. Not surprisingly, the majority (61) have very high (Group A) or high (Group B) overall GovTech level. Only two out of 43 A-level countries, Israel and Japan, do not have such initiatives in place or plan on developing these, suggesting that having an interoperability platform or service bus in place is an important characteristic of advanced countries. Among the economies with ongoing activities to improve some of the GovTech focus areas (Group C), only a small minority either have such initiatives in place or are planning on developing them. Iran, Kosovo, Malawi, Nigeria, República Bolivariana de Venezuela, and West Bank and Gaza all report having an interoperability platform or service bus in place, despite their moderate GovTech level and may serve as inspiration for the other economies in this group. Among the countries with a minimal focus on GovTech initiatives (Group D), no action on interoperability has been reported.

When setting up and implementing interoperability frameworks, governments may face several challenges related to a mix of technical, semantic, legal, organizational, and cultural factors (Box 1).

> > >

BOX 1 - Interoperability Challenges

- **Trust and Security:** Ensuring that data security and privacy are maintained when datasets and APIs are opened up, and maintaining the integrity of underlying systems and data.
- **Financial resources**: Limited institutional financial capacity and a potential decline in revenues due to new approaches that do not involve charging other government entities for access to data or systems.
- **Legacy technology:** Managing interoperability with legacy systems that may support only certain methods of integration or architectural approaches.
- **Human resources:** Need to upskill staff to adapt to new architectures.
- **Data quality:** Messy or incomplete datasets that require careful review and assessment before they can be made accessible to other systems and entities.
- **Data discoverability:** Difficulty knowing what relevant data are already available through APIs.
- **Process agreements and global coordination:** Inability to implement interoperability due to lack of systemic governance, shared processes, and common standards.
- **Inability to scale:** Challenges moving from small, one-off interoperability efforts to a broader and more systematic approach.
- **Varying levels of digital maturity across government:** Dealing with a heterogeneous public sector environment in terms of digital adoption and organizational preparedness.
- **Political leadership and institutional engagement:** Ensuring all related agencies' participation and budget investment.

Source: Authors' elaboration and inputs from the Interoperability Working Group.

On the one hand, setting up a basic infrastructure for interoperability may be an important enabler to advance the overall GovTech performance. On the other hand, having in place a whole-of-government approach to GovTech is likely to be favorable to the development of interoperability initiatives. Consequently, a whole-of-government approach to interoperability taking into account both digital and nondigital aspects is of the essence.

1.2 Digital and Nondigital Interoperability

In the 2021 Implementation Guide for Interoperability in Digital Government, the United Nations' Economic Commission for Latin America and the Caribbean (ECLAC) stated that most countries primarily focus on technical aspects of interoperability without a holistic vision of the needs of public institutions for public service delivery.[4] ECLAC also states that those countries fail at putting citizens and their needs to obtain solutions from the government at the center of interoperability efforts. This state of affairs is not only true for countries in Latin America and the Caribbean. Interoperability is in large part about technology and data, but it is not enough to set up middleware – an operation, process, or application functioning as a software "pipeline" between the operating system and the end user.[5] While middleware is necessary to make diverse digital systems, programs, and databases talk to each other, interoperable IT and data systems do not make for an interoperable public sector. Fundamentally, interoperability in the public sector is about enabling connections between ministries, departments, agencies, sectors, government levels, and countries through data, information systems, legal agreements, organizational processes, and shared values and customs. In line with the European Interoperability Framework (EIF), the guiding framework for European Union (EU) member states and the European Interoperability Framework for Smart Cities and Communities (EIF4SCC), interoperability can be understood as a layered concept, consisting of elements with a digital and nondigital focus (Box 2).[6] If any of these layers is missing, incomplete, or damaged, the connection between the government entities that want to interact becomes faulty and no joint benefits can be reaped. This is why the overall governance of interoperability and clear leadership to ensure coordinated action across all interoperability layers are of critical importance.

> > >

BOX 2 - Digital and Nondigital Interoperability Layers

NONDIGITAL INTEROPERABILITY

Cross-cutting governance layers

Interoperability governance concerns decisions on interoperability frameworks, institutional arrangements, organizational structures, roles and responsibilities, policies, agreements, and other aspects of ensuring and monitoring interoperability.

Integrated service governance focuses on the planning, implementation, and operation of the public services that build on integration, seamless execution, and the reuse of services and data. As such, this layer covers all of the following five specific layers.

Component-specific layers

Legal interoperability is about ensuring that organizations operating under different legal frameworks, policies, and strategies are able to work together, for example, by establishing specific agreements or putting in place new legislation.

Organizational interoperability refers to the way in which public administrations align their business processes, responsibilities, and expectations to achieve commonly agreed and mutually beneficial goals.

Cultural interoperability refers to the approach taken by individuals and organizations to align their social and cultural differences and, if applicable, organizational cultural differences, all of which can be at the root of different responses to the same interoperability challenge.[7]

DIGITAL INTEROPERABILITY

Semantic interoperability refers to the ability of different information technology systems and software applications to automatically interpret the information exchanged meaningfully and accurately to produce useful results. This layer also covers syntactic interoperability, which is about describing the exact format of the information to be exchanged in terms of grammar, format, and schemas.

Technical interoperability covers the applications and infrastructures linking systems and services, such as interface specifications, interconnection services, data integration services, data presentation and exchange, and secure communication protocols.

Source: European Commission, Directorate-General for Communications Networks, Content and Technology, Directorate-General for Informatics 2021, pp 68-74; and European Commission, n.d.

1.3 Achieving Interoperability from a GovTech Perspective

It is not easy to achieve interoperability in the public sector. As a multilayered concept consisting of digital and nondigital aspects, it requires a whole-of-government approach. At the same time, when prioritizing actions, it is necessary to take into account the different economic, social, and political contexts across World Bank countries. An additional consideration is how governments can develop an interoperability framework and approach that works for them in an often-heterogeneous public sector in terms of digital maturity.

Recognizing that there is no one-size-fits-all approach to interoperability, this GovTech How-to Note aims to:

- Empower task teams in the World Bank and government officials in client countries to determine what interoperability measures may be most relevant for their context.
- Provide practical guidance on how to develop and implement these measures.

It does so by *explaining* the different elements through a modular approach (see Figure 3 below). The whole-of-government approach to interoperability entails that regardless of a country's GovTech level, all modules must be considered. However, the order and depth of working with these modules may differ from country to country and will highly depend on the baseline for a specific module and available resources to implement the suggested measures. For instance, if a country already has a strong data culture, but is lacking supporting legal provisions, it is more pressing to work on Module 2 than Module 4. All countries are strongly advised to start with Module 1, which creates the basis of operations by determining the governance mechanisms, including clear leadership, and connecting to relevant strategic objectives and existing initiatives. Once this basis is established, iteration between modules is recommended to ensure that relevant developments from subsequent modules are taken on board in the implementation of those that had an earlier start.

Throughout the note, World Bank country examples at different GovTech maturity levels will serve to *illustrate* the modules and measures under discussion. This note's goal is to build on the wealth of previous and ongoing interoperability initiatives around the globe and provide actionable insights. Throughout the note, concrete references will be provided to relevant external documentation and available online tools that can be reused and repurposed for the specific context. To facilitate the application of the provided insights, a *checklist for a sound interoperability approach* is provided in Annex I. The checklist specifies high priority actions (must have) and lower priority actions (nice to have) for each module taking into account the GovTech maturity level of countries. Managers may use the suggested prioritization for the planning of interoperability projects. While A- and B-level countries will get a sense of how they can build on their GovTech accomplishments and take their interoperability efforts to the next level, C- and D-level countries can find an indication of how they can lay the groundwork for a particular module.

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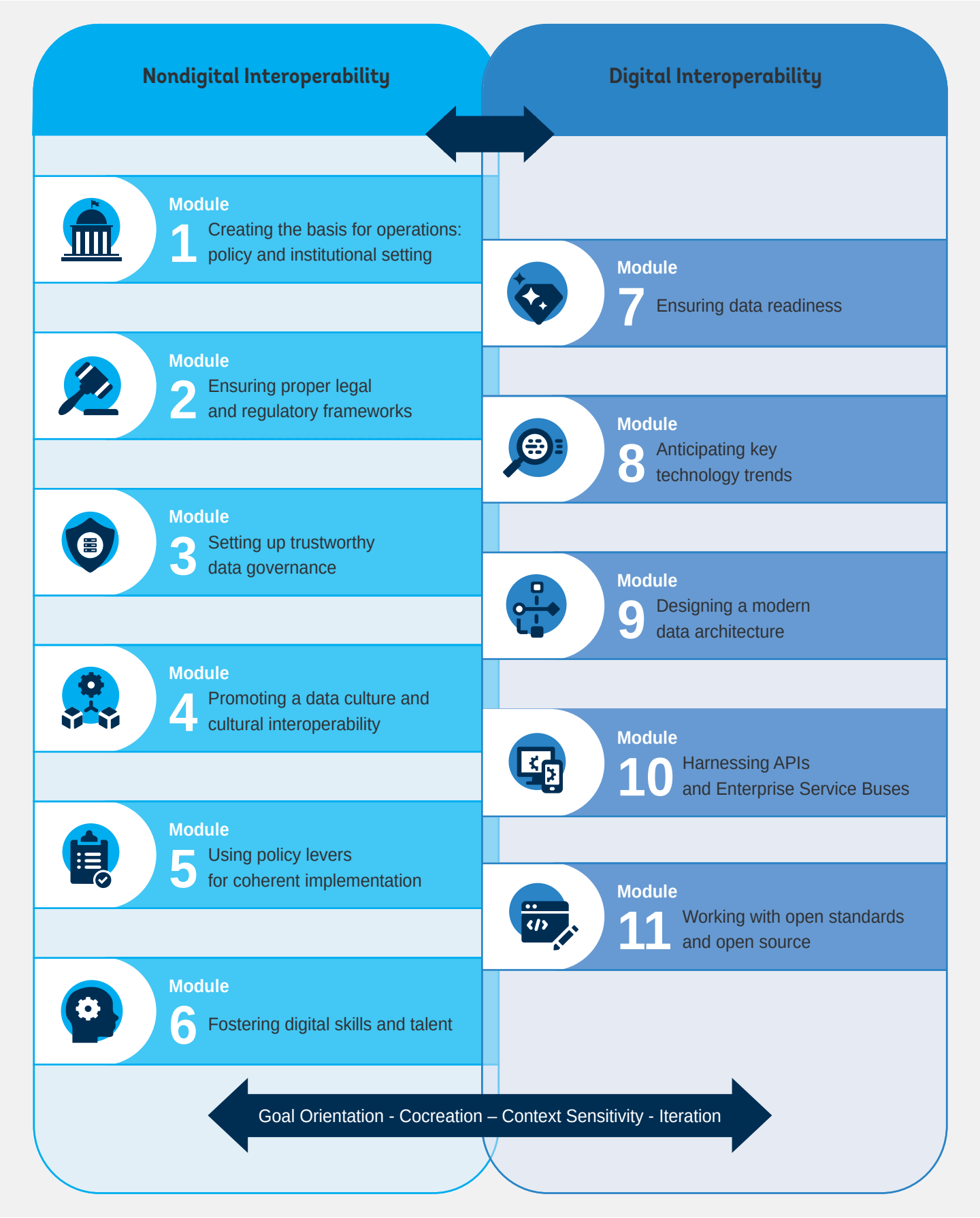
FIGURE 3 - The GovTech Approach to Interoperability



Source: Authors.

The note is structured as follows. Section 2 explains in more detail *why it is important* for World Bank countries and partners to pursue interoperability as part of their GovTech strategies and projects, focusing on the advantages in terms of more citizen-centered services and stepping up data-driven policymaking. Section 3 kicks off the guide on *how to achieve an interoperable public sector* by explaining six modules on nondigital elements of interoperability moving from setting the right policy and institutional setting to ensuring the presence of the necessary skills among the public workforce to accompany the transition to interoperable systems and ways of working. Finally, Section 4 covers technical and semantic interoperability and *explains how to implement* this digital interoperability through five modules, ranging from data readiness to working with open standards and open source.

While reading this note and then implementing interoperability in their specific contexts, GovTech leaders are advised to continuously revert to four questions, which help to prioritize specific actions proposed in the modules (Table 1).

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TABLE 1 - Key Questions for Prioritization in Interoperability Projects

Goal-orientation	What is the overall goal and scale of my interoperability project, in terms of both user needs and strategic objectives? • For example, enabling a joint policy monitoring tool between agencies x and y, developing a specific new digital service, improving proactive service delivery across the public sector.
Co-creation	Which actors should be involved to make this project a success, in terms of both expertise and support, and what are their needs? • For example, the agencies holding data, citizens as service users, legal experts.
Context sensitivity	What is the most viable course of action in light of the country context, my organization's GovTech accomplishments, and available resources? • For example, building on an existing technical infrastructure, linking to an emerging social need.
Iteration	What digital interoperability module is affected by the nondigital module I am working on and vice-versa, requiring what action? • For example, are the data holders willing to share their data (cultural interoperability) through the technical infrastructure that is under development (technical interoperability)?

2

Why Interoperability Matters

KEY MESSAGES

- Achieving interoperability is crucial for the delivery of integrated citizen-centered public services and the path to a data-driven public sector.
- An interoperable public sector entails several interrelated and mutually reinforcing benefits for governments and citizens.
- Interoperability enables efficiency gains, the implementation of the once-only-principle and a service focus on life events, automated and proactive services, omnichannel service delivery, service composability, system resilience, and data-driven value creation.

2.1 Laying the Groundwork for a Citizen-Centered and Data-Driven Public Sector

The immediate effects of an interoperable public sector are an increased connectivity of IT systems and that governments can access, share, interpret, and reuse data more easily and on a larger scale. In the longer run, these developments can support governments in becoming more citizen-centered and data-driven. While "citizen-centered" and "data-driven" may sound as buzzwords, essentially these ambitions are mutually reinforcing, helping governments to deliver services and policies of the highest quality to citizens and businesses across different GovTech levels and social, economic, and geographic settings. They are also about providing digital services that do not just look good, but that citizens actually use, increasing both uptake and the return on investment.[8]

Citizen-centered public services incorporate citizens' needs and concerns at every stage of design and delivery of the service.[9] Such needs include finding the right services for particular life events, not having to provide the same data to different administrations, and having the possibility to complete a service through any desired channel. The 2022 World Bank guidebook, *Service Upgrade: The GovTech Approach to Citizen Centered Services,* points out that developing citizen-centered services involves identifying redundancies and automating decision-making for more inclusive services.[10] Realizing a vision of services that are centered on the needs of citizens and not those of the administration requires seamlessly functioning collective systems, which can only exist through digital and nondigital interoperability. In line with this thinking, the Inter-American Development Bank developed an interoperability guide to facilitate the provision of social services in Latin American and Caribbean countries, considering that depending on the individual's stage of life, the services they require will be different, and that provision must be coordinated and personalized, ensuring that the citizen is receiving the services they need, regardless of the sector that they come from.[11]

Besides enabling the public sector to become more citizen-centered, interoperability also plays a key role in making it more data-driven. A data-driven public sector "transforms the design, delivery and monitoring of public policies and services through the management, sharing and use of data."[12] Thanks to its ability to connect data coming from different sources and from across organizational, sectoral, and country borders, interoperability supports a transition from data projects in organizational silos to a system-wide and more strategic use of data, which also supports more citizen-centered services. While interoperability is a necessary condition for countries to leverage data as a strategic asset, it is not sufficient to unlock all the potential benefits and protect against the dangers of a data-driven public sector. For instance, interoperability does not guarantee the correctness of data, it does not correct biases in artificial intelligence systems, and it does not ensure the quality of data-driven decision making.[13] Arguably, interoperability can contribute to the enforcement of data rights in a number of ways – see also module 3 on trustworthy data governance. For instance, standardized data formats and procedures enable more efficient mechanisms for logging and auditing sensitive data access, thereby fostering transparency and accountability on data sharing and use. Enhanced data governance also makes it easier to detect security risks and consequently strengthen protection mechanisms for personal data access.

The benefits of fostering interoperability toward a more citizen-centered and data-driven public sector are manifold and within reach of countries across all GovTech levels, albeit not at the same pace nor scale. It will become clear that interoperability produces benefits for both government and citizens and that most of these benefits are interrelated and mutually reinforcing.

2.2 Interoperability for...

2.2.1 ...Efficiency Gains

A core benefit of interoperable systems is that data sharing across the public sector can happen at a larger scale and become both easier and faster, which in turn contributes to significant efficiency gains in core government systems and the delivery of public services. By adopting interoperable data formats, data become immediately available and usable by any other civil servant, public administration, and digital government system. This may save time for citizens as they can access administrative data more quickly, and also reduce back-office processing and handling time for public servants, which in turn results in fewer errors and greater cost efficiency from an operational point of view.[14] For instance, a civil servant in a local administration in Denmark (Group A, GTMI 2020)[15] can check a citizen's eligibility for a specific service in real time by accessing national registers, such as the E-Income Register, without having to send a request to a national administration and waiting for the answer.[16]

Such efficiency gains are also within reach of less mature GovTech countries. For example, Moldova (Group B, GTMI 2020) through its Strategic Program for Governance Technological Modernization (E-Transformation),[17] designed a shared e-governance platform to facilitate the development of sectorial e-services, which were offered through several decentralized service portals. The information on administrative services was then aggregated in a single portal with references to other resources if needed. More than 20 sectorial e-services were implemented, which led to immediate efficiency gains in terms of a significant reduction in the number of permissive acts issued for data exchange and sharing between authorities, a simpler and faster development of new sectorial e-services and reductions in the processing payment costs on behalf of the administration, from an average 22 million MDL to 4 million MDL annually as the new portal allowed for integration of online service payments (e.g. bank cards, online banking, e-money). Additionally, the uptake index for most e-services increased to 75 percent or higher.

Nevertheless, when considering the cost reductions for national governments generated by a sound interoperable system implementation, it is important to keep in mind that in order to produce savings, interoperability requires an initial considerable amount of investment.[18] This initial investment is what sometimes refrains governments, especially countries with a lower GovTech level, from allocating a considerable amount of finances to the development of a sound interoperable system, which is where rethinking the business model for data-driven projects becomes extra relevant (see Module 5).

2.2.2 …the Once-Only Principle and a Focus on Life Events

The once-only principle (OOP) enables public entities to share user data with each other, so that citizens and businesses using public services only have to enter their information once. It allows public bodies to reorganize internal processes and enable cooperation, while maintaining their autonomy.[19] Investing in solutions aimed at enabling the OOP pays off, as illustrated by the benefits of the register of non-residents (RNI) in the Netherlands. The RNI is a service provided by the Dutch government to non-residents, allowing for fast and easy data sharing among the Dutch Ministries and the National Agencies, generating savings resulting from the reduced number of transactions linked to data collection and management. Non-resident citizens who register in the RNI need to share their data with the public authorities only once. As a result, a 50 percent decrease in potential transactions between users and public authorities was reported. According to estimation, the RNI generated benefits of €112 million.[20]

Interoperability enables public administrations to implement the OOP and organize and deliver services around the concept of *life events:* getting married, having a baby, retirement or opening a new business. For instance, the citizen portal of Denmark (Group A, GTMI 2020) has enabled interactive checklists around 12 life events, leaving citizens with a personalized overview of relevant information and to-dos.[21] A sound interoperability framework supports having a single point of contact consolidating the provision of such services and the exchange of data between all the involved public authorities. It ensures citizens a smoother experience in their relationship with the government evolving around their needs at a particular moment in their lives rather than the administration's needs to implement a particular service.

2.2.3 …Automated and Proactive Services

According to a 2021 US survey conducted by Ernst & Young LLP,[22] an increasing number of states are adopting new strategies which aim at reducing manual activities by exploiting data and rolling out digital initiatives. They are supported by intelligent automation tools and processes powered by a sound data architecture and interoperability standards. The benefits are astonishing in terms of speed of processing, tighter controls improved audit records, increased visibility, and enhanced data analytics and insights.[23]

Such benefits can also be reaped across borders, as illustrated by the automated data exchange that has been in place between the population registers of Estonia (Group A, GTMI 2020) and Finland (Group A, GTMI 2020) since 2020.[24] Instead of manually implementing updates shared by the other country in their respective registers, this is now done automatically. As a result, there is a decreased manual workload and reduced room for human error, thereby improving data accuracy and security. The data exchange is enabled by a technical interoperability layer, the X-Road infrastructure set up in 2018 and a legal one, the collaboration agreement between the countries, dating from 2005. Besides efficiency, quality and security gains, automation can also enable a more proactive service delivery.

Interoperability also enhances a proactive service delivery by allowing different departments and agencies to exchange information about citizens, carefully evaluating them and planning ahead from several perspectives. Providing services in a proactive way can dramatically increase the uptake, and thus experienced benefits by citizens, as is demonstrated by the case of the Social Energy Tariff in Portugal (Group A, GTMI 2020). When the Portuguese government decided to use the Interoperability Platform for the Public Administration

to automate data exchange between Directorate General for Energy and Geology, energy companies, the tax system, and the social security system, detect and award eligible households, the number of households receiving the tariff increased from 154,648 to 726,795. This meant that 7 percent of the Portuguese population received financial support for the cost of their energy without requiring them to validate their eligibility.[25] Similarly, in Canada (Group A, GTMI 2020), when a person's birth is registered, the government allows for this information to be shared with the Canada Child Benefit program and other programs.[26] In order to activate the application, the mother must grant permission at the civil registration office to allow for the data to be shared by the corresponding Registry Office in the residence province with the Canada Revenue Agency. After that eligibility for the available programs is evaluated and, if applicable, the benefit is automatically activated.

2.2.4 …Omnichannel Service Delivery

To meet citizens expectations, governments need to study and evaluate user journeys and experiences across multiple channels. A citizen may pick up the phone to ask where (s)he can request child benefits, receive a personalized activation link by email and then follow the progress of the request through a mobile app. To ensure the best experience on all levels, interoperable systems are needed to integrate information and process them, allowing citizens to easily move across different contact points. Governments are gradually switching to omnichannel public services provision, leveraging seamless experiences with integrated channels and focusing on design and efficient delivery. An omnichannel approach "allows online and mobile services to co-exist with face-to-face or over-the-phone service delivery, ensuring that underlying processes are digitally coherent and integrated".[27] This means that public service delivery should be equally valuable and effective via any channels preferred by citizens, regardless of which channels they use most. The added value is offering citizens a seamless user-experience and personalized actions.

Switching to a citizen-centered approach, including an omnichannel service delivery has made governments understand the importance of investing in interoperability frameworks. For example, the municipality of Milan's Connected Newsstand project, launched in 2020 during the roughest period of the COVID-19 pandemic, enables newsstands around the city to issue general registry office certificates for citizens and their families. Connecting totems cleared by the municipality via ad hoc designed APIs to the General Registry Office and after successfully completing a training program, newsvendors are authorized to print certificates for citizens requesting them. In addition, citizens can benefit from the same service either scheduling an in-person appointment at one of the registry offices in town or via the online portal of the municipality.[28]

2.2.5 …Transparency, Accountability, and Integrity

Siloed information systems constitute a clear obstacle to improve trust in the public sector. The lack of data exchange and the maintenance of fragmented social and economic public registers determine additional difficulties for the creation of an open government where cross-cutting transparency is determinant for improved accountability towards citizens. Otherwise, without the proper data exchange, public sectors present themselves to its constituents as a disintegrated fabric, difficult to understand, tending incoherence and unreliability. The absence of data exchange also constitutes a problem for integrity and law enforcement as the multiplication of unconnected data sources creates serious difficulties for data checking and traceability. For instance, the integration of public procurement with other public sector data – for example, tax administration, budgeting, public finance management, and auditing – can increase accountability and support governments to develop innovative and impactful procurement strategies.[29] Interoperable information systems can also be critical for improved anti-corruption policies, allowing law enforcers to enhance data to better safeguard the social contract through the use of disruptive technologies such as data analytics or artificial intelligence.

Several examples can be found worldwide on the benefits of interoperability for improved transparency, accountability, and integrity. In Brazil (Group A, GTMI 2020), the World Bank provided technical assistance to the government of Brazil for building a governance risk assessment system with a concrete whole of government approach. The system integrated datasets such as public sector payroll, data of government transfers and social benefits, procurement contracts, e-invoices or the list of banned companies, generating indicators that can raise red flags on potential fraud or misuse of public funds.[30] In Romania (Group B, GTMI 2020), a World Bank supported project is using procurement and justice data to assess the public procurement system. In Senegal (Group C, GTMI 2020), an ongoing project of the World Bank is building a beneficial ownership database and connecting it to financial statements. This will allow to identify fraud risks by looking at the irregularities and incongruences between beneficial ownership and financial statements.[31]

2.2.6 ...Service Composability

Interoperable service modules, powered by open standards (see Module 11) allow for composability of services: adding different components and modules to a service. For instance, interoperability standards allow local authorities to use payments or identification solutions as part of their online services: the local authority can maintain the full end-to-end user experience so that citizens only seem to interact with the local authority website, but some part of the services (e.g. payments) are delivered using components developed by the central government or private actors. In simple terms, interoperability standards allow for a much wider choice between different service modules, and facilitate the integration of these components (plug-in).

Moreover, open standards increase the opportunity to involve external actors, including private service providers, enhancing the flexibility of decoupled elements while remaining connected and integrated to a main element. They help to refer to file formats and interfaces that can be easily shared and implemented by everyone, because of their features. They are of particular importance as enablers for government agencies, allowing them to interact in a beneficial way to ensure the maintenance of common references. In Italy (Group A, GTMI 2020),[32] is an initiative that allows citizens and businesses to realize electronic payments to the public administration on the basis of rules, standards and tools defined by the Agency for Digital Italy (AgID) and accepted by public administration bodies, banks, post offices and other payment institutions. The privately developed national ePay system is adhered to by Italian public institutions at both the national and local levels of government, enabling a smooth payment experience for Italian citizens irrespective of the public entity that they are dealing with. Businesses may also benefit from enhanced government interoperability when plugging nationally recognized service components into services for their customers. For example, in Denmark citizens may use the public-privately developed national electronic identification system (eID) to fill out their tax forms, for online banking and many more public and private services.[33] The encompassing benefits of service composability, such as time saved, error reduction, process simplification and increased user satisfaction are thus not only bestowed on public authorities, but on private service providers as well.

2.2.7 ...System Resilience

System resilience is the ability of systems to withstand disruptive conditions, to promptly respond to them and to recover from the damage they may cause. Resilient digital systems are capable of isolating and manage potential malfunctions that are crucial for ensuring the continuity of core government operations and the security of remote access for government officials, supporting vulnerable people and businesses, and deploying less expensive and more reliable ICT infrastructure solutions, such as a government cloud and mobile or portable data centers, for rapid modernization of existing systems and services.[34] This is particularly relevant in light of the worldwide increase in cyberattacks and data breaches.[35] With sound interoperable systems in place, governments are affected less profoundly by such disruptions as government operations can be organized in a decentralized and remote way.

The introduction of data embassies (also called e-embassies) demonstrates how important technical and legal interoperability are for the resilience of government operations. Being an extension of a country's cloud including its most sensitive and confidential data, a data embassy constitutes server resources outside its territorial boundaries, but legally under its jurisdiction. Launched in 2015, the Estonian data embassy in Luxembourg was the first of its kind, providing the necessary technical *and* legal interoperability with the systems at home that a public/private cloud computing deal couldn't.[36] In case of a cyberattack or crisis situation affecting its home servers, the data embassy ensures continuity of operations through data backups and the functioning of critical services. In July 2021 the Principality of Monaco followed in Estonia's footsteps by establishing the world's second data embassy in the Grand Duchy.[37]

2.2.8 …Multiactor Data-Driven Value Creation

A final and cross-cutting benefit is that interoperability will allow to scale up data-driven value creation by increasing the accessibility and linkability of previously isolated data assets, both retrospectively and in real time. This will enable more actors than ever before, including those from the private sector to participate in value creation involving public data, also repurposing data originally collected in another context. For example, in Norway (Group A, GTMI 2020), the case of the Norwegian Knowledge Bank showcases how loss data collected by insurance companies made interoperable with municipal geo-information systems are highly valuable in understanding the risks linked to potential natural disasters.[38] Powered by analytical tools and monitoring dashboards, interoperable data facilitate evidence-based public policymaking and first response in real time.[39]

Interoperability also contributes to the adoption and provision of open data by governments, for instance regarding government budgets, greenhouse gas emissions or mobility. By opening up public data trapped in organizational siloes, collaboration can be increased and the duplication of work can be avoided both within the public sector and in relation to the private sector and civil society. To make sure that data can be easily shared, accessed and reused, interoperability standards need to be adhered to. Data need to be published in human-editable and machine-usable and readable formats, and obtain open licensing.[40]

A key driver of the open data movement is the potential of public sector data published in open format to stimulate private sector innovation and provide opportunities for the economy at large. Companies transform open data into economic and social value through direct monetized benefits in the form of market transactions and indirect ones.[41] In 13 years' time the European open data market value had almost quadrupled from EUR 48 billion in 2006 to EUR 184 billion in 2019.[42] According to the GTMI a little over half (106) of the 198 countries reviewed have a dedicated portal providing access to data.[43] While this is a good starting point, actions aimed at supporting the reusers of open data are crucial to have real impact.[44]

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Setting the Right Policy and Organizational Conditions

KEY MESSAGES

- Whole of government approaches are required to secure the implementation of interoperability policies in the different sectors and levels of government. Although there are not unique models to develop these approaches, different cross-cutting policy dimensions should be considered.

- Assuring an appropriated policy and institutional setting is critical to achieve interoperability governance in the public sector, namely attributing the appropriate relevance to the topic through the national GovTech strategy as well as the institutional leadership and coordination mechanisms in place.

- Updated and agile legal and regulatory frameworks are necessary to navigate the fast-paced digital transformation underway, enabling the fundamental legal interoperability required for governments to enhance the benefits and tackle the challenges of public sector digitalization.

- Trust, ethics, and data rights should not be an afterthought, but should receive consideration from the start of an interoperability project.

- Promoting a data culture through a value-based and cocreation approach supports cultural interoperability.

- Interoperability requires policy levers – coordinated public procurement, preevaluation of ICT investments, standard business cases, monitoring mechanisms – capable of overcoming the siloed data management scenario that public administrations frequently face, and securing coherent and sustainable implementation across the administration.
- Specialized data skills to promote interoperability in the public sector are at the core of coherent and sustainable digital transformation in administrations.

Although the digital transformation of the public sector has been progressing at an accelerated pace all over the world in the last few decades, horizontal integration is one of the key challenges governments continue facing nowadays. Whole-of-government approaches are required to secure coherent and sustainable approaches able to generate the full benefit of the digital revolution. Specifically on data integration and exchange domains, how do project teams ensure that the same standards and architectures are applied across different sectors and levels of governments? What building blocks do governments need to have in place to properly implement a sound interoperability policy across the public sector?

Countries' progress in building data-driven public sectors has revealed several issues that they should address to take full advantage of the potential of data to drive policy making, service delivery and organizational management across the public sector. These issues touch upon cultural, organizational and legal interoperability. It is necessary to build an appropriate data culture, reflect on new business models, foster open collaboration with the private sector, and consider issues of trust, ethics, and digital rights.

There is not a one-size-fits-all approach to support a cross-cutting interoperability policy. Different contexts determine varied whole-of-government approaches. Very diverse variables such as the administrative organization of the country, the legal and regulatory culture, or the level of digitalization of the administration determine specific and customized policy approaches. Nevertheless, there are some important building blocks that should be considered to support an effective and sustainable interoperability policy. As underlined by the ECLAC interoperability guide, any country that wants to take a holistic approach to interoperability should take its governance of digital government as a starting point, since this defines the relevant policy, strategy, resources and institutional support.[45] The institutional setting of the country, the policy levers available, the legal and regulatory frameworks being applied and the digital skills and talent policy are critical policy instruments that should be framed and aligned to support the adoption of interoperability architecture and standards across the public sector.

The current chapter will present and suggest six modules based on the framework of building blocks.. It starts by focusing on the policy and institutional setting, highlighting important elements such as the national GovTech strategy, the important role of the public sector institution responsible for the national GovTech policy, and the existing coordination mechanisms across the public sector for data governance. The chapter will then discuss the required legal and regulatory framework capable of supporting interoperability across the public sector. The chapter will be followed by setting up trustworthy data governance, cultural interoperability, policy levers for coherent implementation, and digital skills.

3.1 Module 1: Creating the Basis for Operations: Policy and Institutional Setting

3.1.1 Embed Interoperability in the Overall GovTech Strategy

A national GovTech or Digital Government strategy is a fundamental policy instrument to define the vision and goals, frame the purposes and objectives, identify the priorities and the necessary actions or initiatives the government will embrace during a certain period of time. The strategy has a fundamental role to support a system-wide coherence across the public sector.[46] It helps to overcome siloed approaches by the machinery of government that lead to isolated, compartmented, and non-interoperable solutions incapable of sustaining efficient operations and user-centered services in the public sector. The strategy should in this sense recognize the role of interoperability as the backbone of a digital government capable of sharing and reusing data in an efficient and sustainable way. In order to be truly embedded by a whole-of-government approach, the strategy and its

interoperability component should also be properly linked and make the necessary bridges with other government agendas underway – for example, education, health sustainable development, climate change – enabling the creation of the proper policy ties and foundations for transversely articulated implementation in the government.

The GTMI indicates that almost all countries in the world have a GovTech or Digital Government Strategy – 174 of the 198 economies analyzed – without significant differences identified between different regions.[47] Given the relevance of interoperability and data exchange as fundamentals for the digital transformation of the public sector, these topics typically have a significant relevance in GovTech or digital government strategies. Whether more focused on technical, organizational, cultural, legal, or semantic interoperability, governments use these mobilizing policy instruments to prioritize the adoption of common data exchange standards, for example, and the use of an interoperability hub or platform.

Estonia (Group A, GTMI 2020) explicitly states that all national digital initiatives, including interoperability, stem from the national digital agenda and must be in alignment with it.[48] In the updated Digital Government Strategy, the Government of Brazil (Group A, GTMI 2020) reinforces the data exchange objectives of its systems, setting ambitions of interconnecting federal IT platforms to secure the automated prefilling of forms using the Citizen's Base Register or the Postal Address Register.[49] In the Republic of Korea (Group A, GTMI 2020), the Digital Government Master Plan 2021–2025 places data at the center of government transformation. In order to provide personalized service delivery channels asking citizens information only once, the mission of the master plan is to facilitate a data-based government namely through initiatives such as opening both public data and service APIs to collaborate with the private sector or using data from Internet of Things (IoT) sensors for disaster prevention and response.[50]

Timor-Leste (Group C, GTMI 2020), even though it does not have an interoperability platform in place, is undertaking efforts through its National Connectivity Project to improve the connectivity between the central government and the local administration offices, and set up a root information system.[51] Similarly, in Lesotho (Group C, GTMI 2020), interoperability efforts are linked to a specific problem and broader digital initiative, the reduction of paperwork and fraud in the context of setting up a national identification system.[52] As such, pursuing interoperability is not an isolated technical endeavor, but part of a broader agenda.

Considering the experiences observed in different countries around the world, digital government or GovTech strategies should prioritize interoperability across sectors and levels of government as a fundamental building block for public sector transformation. Different approaches can be followed considering contextual factors such as the administrative culture in place, the existing IT legacy, or the level of digitalization of the public sector. Governments should also leverage the policy strategy to guide the different drivers for prioritizing interoperability in order to mobilize the different stakeholders towards a common goal, such as the basic and efficient reuse of information across different ministries or more advanced objectives such as enabling data and evidence-based policy making, decision making and evaluation.

3.1.2 Establish the Institutional Structure with Leadership to Support Interoperability

Defining the right institutional structures that can support a whole-of-government approach for digital government is one of the critical tasks countries face, independent of their level of digital development. Since there is not a unique solution to secure institutional alignment and coordination, different options can be followed depending on contextual factors such as the institutional culture of the administration or the relative strength of vertical and horizontal structures. Nevertheless, the existence of a public sector organization responsible for leading the digital government or GovTech policy is clearly an institutional asset for coherent and sustainable policy implementation.[53] The promotion of a cross-cutting interoperability policy in the public sector is favored by this organizational leadership.

The institutional consensus about the need for a lead public sector body for digital government development is empirically demonstrated in different international monitoring instruments. According to the GTMI, 80 of the 198 economies analyzed have a public sector organization responsible for leading the digital government or GovTech policy.[54] The 2020 edition of the OECD Digital Government Index indicates that all the 34 countries that participated in the survey have a public sector organization responsible for leading and coordinating decisions on digital government at the central/federal level of government.[55] This institution is normally located in the center of government (for example, in Chile, Portugal, UK) in a coordination ministry such as finance and public administration (for example, in Denmark, Korea), or in a line ministry specifically dedicated to telecommunications, information and

communication technologies, or digital transition (for example, in Austria, Colombia, Greece). The institution can also have different models such as a public sector agency (for example, in Australia, Panama, USA) or a direction within a specific ministry (for example, in Colombia, Slovenia).

In Colombia (Group A, GTMI 2020), the Directorate of Digital Government *(Dirección de Gobierno Digital)* in the Ministry of Information and Communication Technologies (MinTIC) is responsible for the national digital government policy. The management of different cross-cutting initiatives, such as the unique portal of the Colombia State GOV.CO, requires MinTIC to place interoperability in the public sector at the center of its mandate. The Interoperability Framework *(Marco de Interoperabilidad)* and the Guide to Quality and Interoperability Standards *(Guía de Estándares de Calidad e Interoperabilidad)* reflect the commitment of the Government of Colombia to widespread interoperability across the different sectors and levels of government. In Japan (Group A, GTMI 2020), the Digital Agency is the new public sector organization leading the digital government policy. Launched in September 2021, the agency has significant coordination competences and demonstrates the Japanese government's intent to reform the culture of administration in a user-driven manner through digitalization. One of the top priorities embraced is the implementation of the national data strategy, considered a cornerstone of the digitalization of the public sector.[56]

The existence of a leading public sector organization that embraces interoperability as a priority is a fundamental requisite for cohesive digital government development. The institutional location and shape can be different from country to country, but its mandate, policy levers (see Module 5) and recourses are crucial for securing the adhesion of the public sector to the national/federal interoperability policy. Governments should therefore continue strengthening institutional and organizational policy leadership capable of strongly promoting cross-departmental adoption of interoperability standards and architectures, in line with the national/federal digital government or GovTech policy. Furthermore, to address limited resources, governments need to consider developing adequate funding models to implement interoperability initiatives.[57]

3.1.3 Ensure Solid Coordination Mechanisms to Prioritize Interoperability

Institutional coordination across government ministries and agencies, as well as involving different levels of the public sector, is critical to avoid siloed policy design, development, delivery, and monitoring. Also, governments can meditate competing situations that arise when multiple agencies are trying to implement the interoperability standard based on coordination mechanisms. Cross-governmental coordination mechanisms support the creation of a digital culture among the different stakeholders, and fosters joint ownership and shared responsibility for the GovTech policy agenda, enabling a shift from agency-centric models to systems thinking approaches. Sound coordination dialogue with a whole-of-government approach can contribute to addressing difficulties caused by different maturity levels of government organizations. Countries tend to establish inter-ministerial committees or councils for the digital transformation of the public sector in order to accomplish this required cross-governmental cooperation. With a more high-level or operational profile and mandate, these mechanisms contribute decisively to assure that the GovTech and Digital Government policy, particularly its interoperability components, is not only the responsibility of one agency or ministry, but a whole-of-government priority.

The GTMI found that 49 of 198 economies in the world have a government entity in charge of data governance or data management in place.[58] On the other hand, 70 percent of the countries that responded to the OECD Digital Government Index 2019 confirmed having a coordination body / mechanism responsible for government IT projects (for example, a Council of Chief Information Officers).[59] Different examples can be found around the world that prioritize digital government cross-governmental cooperation. In Australia (Group A, GTMI 2020), the Digital Transformation and Public Sector Modernization Committee is composed of ministerial representatives from each state and territory responsible for the digital and data policy.[60] In Spain (Group A, GTMI 2020), the Central Administration Coordination Commission for ICT Strategy brings together representatives of all ministries, being responsible for the design and development of the digital government policy. Additionally, Ministerial Committees for Digital Government are responsible for promoting the digital government and implementing the action plan for digital transformation in their own Ministry.[61]

Having in mind the cross-cutting nature of interoperability policies in the public sector, solid coordination mechanisms are a requisite for coherent and sustainable policy implementation. Whether with a high level or technical profile, the existence of coordination councils, committees, or networks that prioritize interoperability and bring together representatives from the different sectors and levels of government is fundamental to promote systems thinking approaches capable of elevating data exchange and reuse as critical foundation of a transformed public sector. Also, ensuring Business Process is useful to identify needs of interoperability in public institutions and simplify the way of public services through interoperability.[62]

3.2 Module 2: Ensuring Proper Legal and Regulatory Frameworks

The current context of permanent digital change requiring constant cross-governmental coordination invites governments to maintain the necessary legal and regulatory frameworks properly updated, ensuring legal interoperability. GovTech policy efforts need to be in place to secure that the digital transformation is properly regulated, providing legal validity to digital objects, transactions, and approaches, and also fundamentally guaranteeing that citizens' interests and rights are legally covered. The digital benefits brought by the transformation underway need to be seized, but its risks should also be tackled. Governments should seek to create an environment where bureaucratic resistance to digital change is avoided though a seamless enhancement of its benefits across the economy, society, and public sectors.

To promote this digital transformation of the public sector, updated legal and regulatory frameworks are commonly used by governments to support complex cross-government architecture involving common ICT standards, interoperability frameworks and common data management systems. In fact, data management and exchange are at the core of the legislative and regulatory work required by the digital revolution underway. Digital rights in the areas of personal data protection, cybersecurity, access to information, or the value of communicating digitally with the administration are also important drivers of these ongoing efforts to legal and regulatory frameworks to respond in an agile way to evolving needs.

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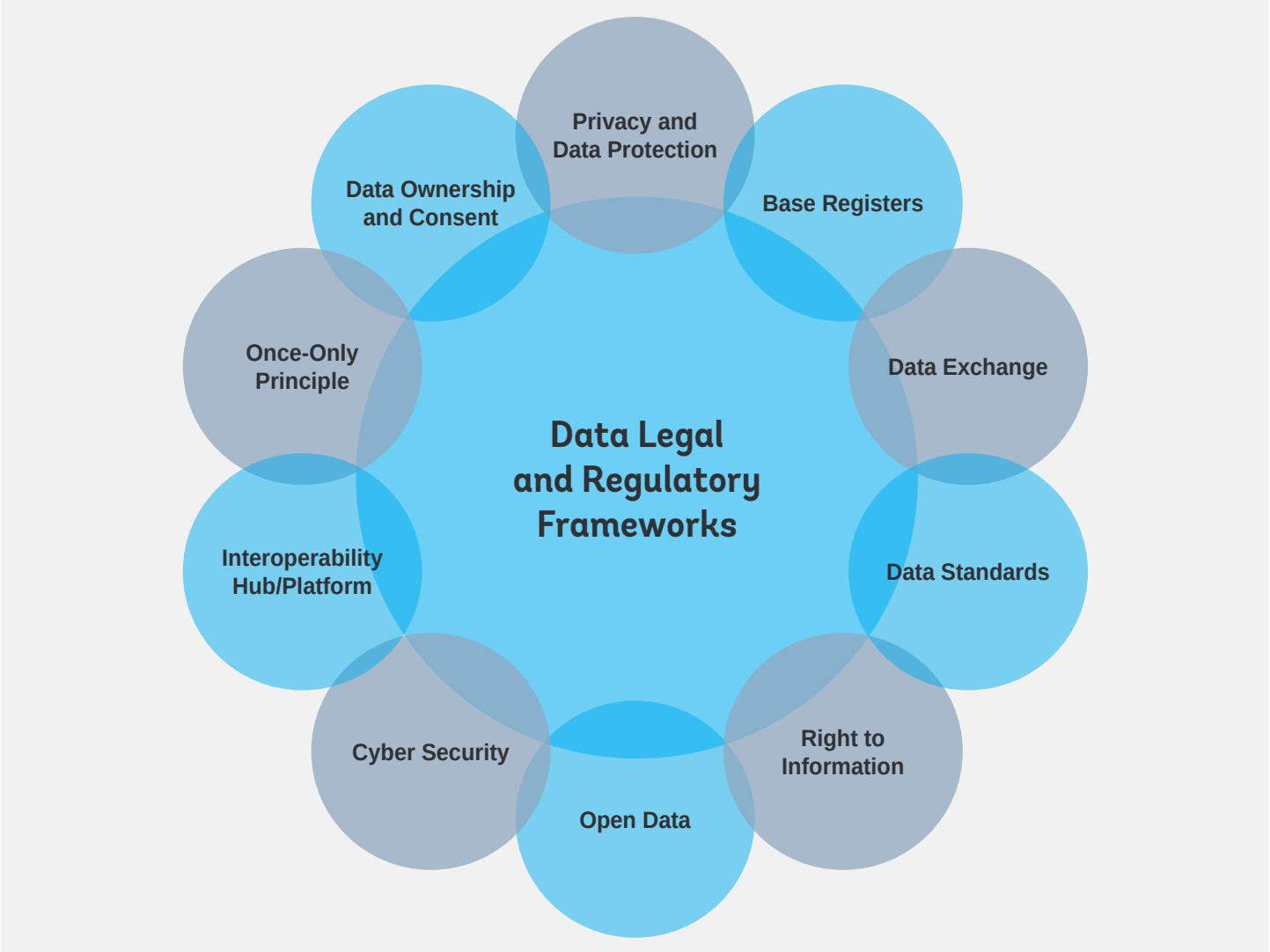
FIGURE 4 - Data Legal and Regulatory Frameworks



Source: Author.

Figure 4 presents a list of legal and regulatory pieces that countries use, in the form of laws, decrees, acts or regulations, to frame and influence their interoperability policy. Although not exhaustive, the list demonstrates how cross-cutting interoperability issues can be, touching on very diverse domains such as privacy and data-protection, data standards, right to information, the use of interoperability hubs, the application of the once-only principle in the administration, or increasingly important issues such as data ownership and consent. There is not a one-size-fits-all approach about how countries legislate in this area; it will depend on different contextual factors that are country-specific, making legal interoperability especially challenging in cross-border contexts. The institutional and administrative culture in the country can determine different approaches to regulating or legislating interoperability issues. For instance, countries with a more legalistic administrative culture based on a Napoleonic Code, such as in the South of Europe or Latin America, tend to legislate or regulate more extensively and in a more detailed way to secure effective implementation and compliance across the administration, economy, and society. Other countries typically follow a more consensus-based approach based on a Common Law tradition, building on an institutional culture that regulates less and uses more instruments such as guidelines and standards. Anglo-Saxon or North of Europe countries traditionally tend to use a more consensus-based approach. Whether following a more legalistic or consensus-based approach, the agility and responsiveness of the legal and regulatory building of the countries responding to the fast-paced digital transformation is critical.

Countries have been progressing significantly during the last few decades updating their legal and regulatory frameworks to properly respond to the digitalization underway. In the area of data management, according to the GTMI, 130 of a total of 198 countries have national laws, statutes, or regulations to make data available digitally to the public. The GTMI also indicates that 132 countries have data protection/privacy laws in place, corresponding to 67 percent.[63] The OECD survey on Digital Government provides equally some interesting insights. Eighty percent of the countries that answered the survey confirmed having in place legislation on sharing of government data across the administration. And almost 60 percent confirmed the existence of laws at the federal/central government level covering the topic of interoperability.[64]

Confirming this trend, several country examples demonstrate the substantial relevance of interoperability in their GovTech legal and regulatory framework. In Austria (Group A, GTMI 2020), the eGovernment Act approved in 2004 underlines its purpose to promote legally relevant electronic communication. It accords substantial importance to data governance and exchange between public sector organizations, provided that the privacy rights of the citizens are respected. The eGovernment Act contains provisions on the application of the once-only principle, where the application of the Austria Interoperability framework assumes particular relevance.[65] In Finland (Group A, GTMI 2020), the Public Administration Act empowers the Ministry of Finance to coordinate the interoperability of public sector datasets, indicating also that public sector organizations should reuse datasets within the administration whenever possible.[66] In Ireland (Group B, GTMI 2020), the Data Sharing and Governance Act approved in 2019 provides legal basis for the sharing of personal data across certain circumstances across public sector organizations, provided that their privacy is secured. The goal of the act is to substantially reduce the burden to citizens associated with the provision of their personal data to numerous public bodies.[67] In Portugal (Group A, GTMI 2020), a resolution adopted by the Council of Ministers in 2015 foresees the preferential adoption of the Interoperability Platform for the Public Administration (iAP) as the primary means of exchanging information among departments and entities of Public Administration.[68] Croatia (Group A, GTMI 2020) has defined technical standards for interoperability through the 2017 Decree on Organizational and Technical Standards for Connecting to the National Information Infrastructure.[69]

A particular challenge in countries with a highly decentralized government structure is to provide a seamless experience to citizens by ensuring interoperability between the different levels of government. Spain (Group A, GTMI 2020) addressed this challenge by jointly addressing legal and technical interoperability. Through Law 39/2015 on Common Administrative Procedure of Public Administrations and the Law 40/2015 on the Legal Regime of the Public Sector, the country made it mandatory for central, regional and local public administrations to ensure compatibility and interoperability of their systems and enablers, and cooperate to ensure clear information provision. These legal provisions are accompanied by a series of shared solutions, infrastructures and services.[70]

As shown below in Box 3, the role of the European Union in promoting the update of its member-states legal and regulatory frameworks in the area of interoperability is very significant. At the European level, an “Interoperable Europe Act” is under development to support a smooth, interoperable implementation and delivery of digital services enabled by a more structured and pragmatic cooperation between member states at a horizontal level, and between different European services and policies at a vertical level.[71] The new act will complement existing European regulations and initiatives.

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BOX 3 - Regulating Data: The European Union Example

The European Union provides an inspiring example of multilateral coordination envisaging cross-border data exchange among its member states. European legislation and regulations in different domains are critical policy instruments to secure cohesion across borders and synergies among governments. The following examples can be highlighted considering their influence in shaping the European Union Interoperability policy:

- **European Interoperability Framework** – Implementation Strategy - COM(2017) 134 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions
- **European strategy for data** – COM/2020/66 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions
- **Directive on open data and reuse of public sector information** (European Parliament and Council, 2019).
- **General Data Protection Regulation** (European Parliament and Council, 2016).
- **eIDAS Regulation** – Electronic Identification, Authentication and Trust Services (European Parliament and Council, 2014).

As well as influencing the legal and regulatory frameworks of its member states, these and other directives and regulations also have a substantial role beyond European borders, considering the role of the European economy worldwide, as well as the legacy, influence, and inspiration provided by institutions of member states in different geographies.

Several countries specifically pay attention to cross-sector and cross-border interoperability in their national frameworks. Cyprus (Group B, GTMI 2020) has taken concrete action to facilitate the cross-border exchange of health data and provide interoperable eHealth services. In 2019, the country launched the Electronic Health Act to align the Cypriot health infrastructure with European standards.[72]

In the digital age, there is the need for continuous adoption and update of legal and regulatory frameworks to respond to the fast pace of technological innovations and increasing expectations from citizens and companies. Governments are required to create the foundations for a digital environment and culture through updated legal and regulatory frameworks. As shown in Figure 5, different pieces of legislation can be developed or updated to meet the needs countries face, depending on contextual factors such as the existing legal and regulatory legacy, the administrative culture, and the GovTech policy priorities in place. Policy makers are required to develop a proper assessment of the existing situation in order to determine the updates required for the legal and regulatory framework.

Additionally, three other recommendations can be considered. Promoting a digital-by-design culture among policy makers that can properly consider the value of interoperability would be an asset. This mindset can enable the law-making processes to integrate from start the benefits of digital and interoperability in new or updated legal and regulatory pieces, with clear advantages in terms of policy efficiency and cohesion. Additionally, adopting a digital rights approach to updating the current legal and regulatory framework should also be prioritized. Legislators should consider from start this citizen-centered approach where data rights such as privacy, once-only, consent, and ownership in new legislative pieces are at the core of the GovTech legal and regulatory framework. Finally, sound interoperability reforms need to go beyond isolated or non-articulated mechanisms to achieve useful whole-of-government approaches. A clear coordination of the different dimensions of nondigital interoperability – leadership, coordination, and policy levers – is required. Otherwise, the formality of the legal and regulatory frameworks will not effectively contribute to the necessary transformation towards a data-driven public sector.

3.3 Module 3: Setting up Trustworthy Data Governance

3.3.1 Focus On Guiding Data-Driven Value Creation

Interoperability and data governance are closely intertwined. Without a clear strategy, leadership, and coordination regarding the generation, processing, sharing, and reuse of data throughout the public sector, it is virtually impossible to realize interoperability at a scale where it truly benefits citizens. At the same time, having a clear interoperability framework with proper standards and understandable guidelines can provide a good starting point for scaling up data governance efforts. For instance, an OECD report on digital government in the Middle East and North Africa region demonstrates that the lack of data governance in Egypt, Jordan, Lebanon, Morocco, and Tunisia has translated into a lack of interoperability, digital fragmentation of the public sector, a lack of efficiency, the duplication of efforts, and a significant number of untapped opportunities.[73]

When looking at the state of data governance across World Bank economies and regions, it becomes clear that the efforts in this domain need to be ramped up in order to reap the benefits from interoperability initiatives. Only 16 countries have a whole-of-government approach for it, 68 are planning on it or have it in progress, and a whopping 114 countries have not taken any action in this area. Many of the discussed benefits of interoperability in government (see Section 2.2), are lost on the majority of low- and middle-income countries as "data systems that facilitate the safe flow of data in formats that make the data valuable to many users [..] typically do not function well."[74] At the same time, many of these countries do not have the burden of legacy IT systems, allowing them to implement interoperability by design.

To provide a strong foundation for interoperability efforts, data governance needs to be in place. Key issues to address through regulation, data governance bodies, policies, and initiatives include data ethics, data privacy and anonymization, data-sharing and data interoperability, data protection and security, and responsible innovation.[75] Supporting these efforts are data governance principles, design guides, and metamodels. An emerging model for data governance is the concept of a data trust, an entity that is responsible for managing and protecting the data of an individual or group of individuals.[76] Involving citizens in data governance efforts can help policy makers to understand attitudes towards use of government-managed data.[77] Data literacy within government is also an important consideration.[78]

The OECD government data value cycle displayed in Figure 5 helps to understand the process through which raw data can lead to public value.[79] It is composed of four phases: (1) the collection and generation of data; (2) the storing, securing and processing of data; (3) the sharing, curating and publishing of data; and (4) the use and reuse of data, which can lead to public value creation and to the generation of new government data ready for further processing.

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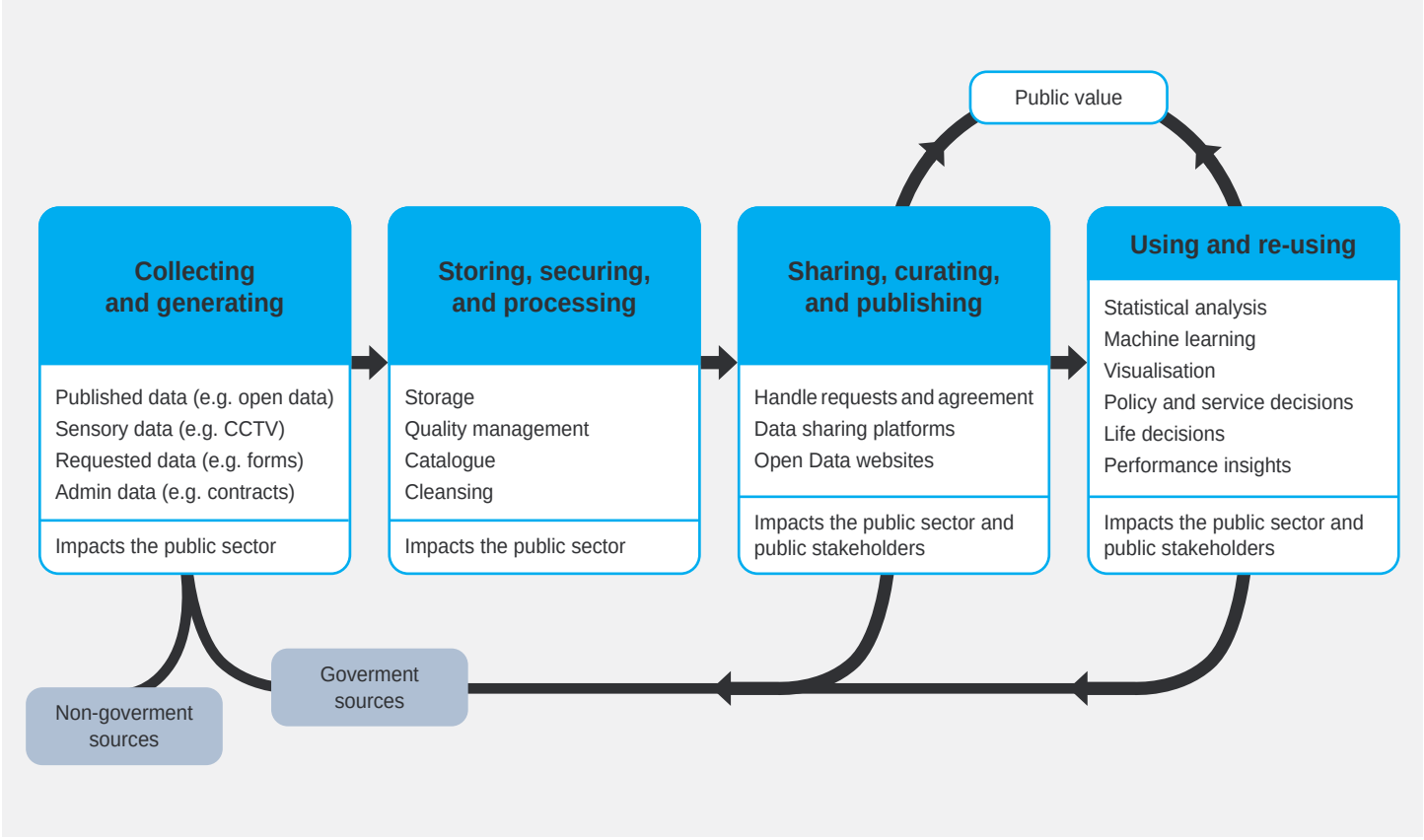
FIGURE 5 - OECD Government Data Value Cycle



Source: Van Ooijen et al., 2019.

Besides the data management process, data governance is crucial to ensure that the proper conditions are put in place for the government data value cycle to function properly. As such, the *World Development Report 2021: Data for Better Lives,* highlights that data governance and data management are both crucial to create value and support social trust, as shown in Figure 6. They are necessary insofar as they help governments to structure decisions and shape their objectives to create data value. Together, well-structured data management standards and a robust data governance framework eventually help users to better harness the value from data in a safe and equitable manner.[80] It is important to prioritize key data sets for interoperability, considering what will bring the most value with cross-government perspective.[81]

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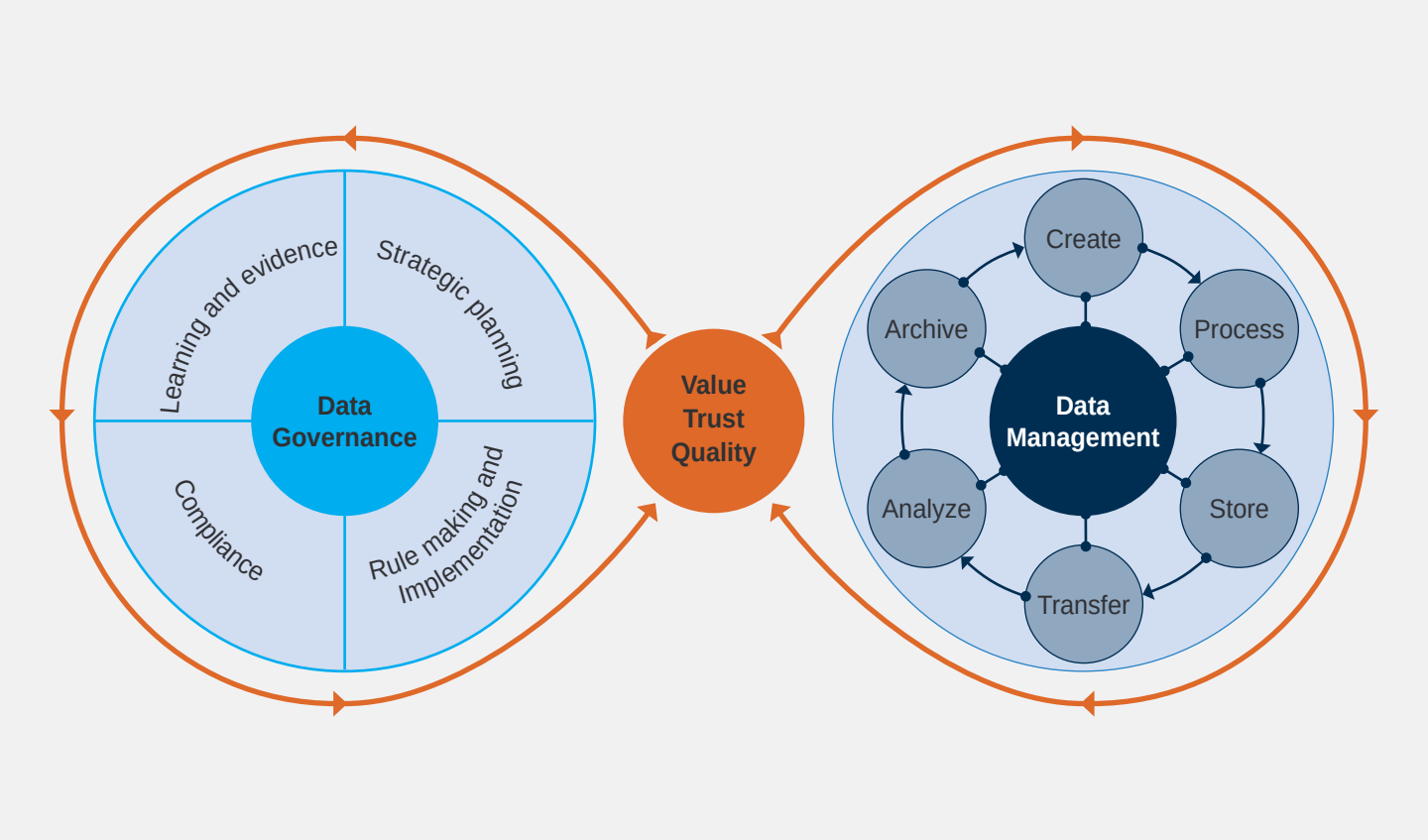
FIGURE 6 - World Bank Data Governance and Data Management Structure



Source: World Bank, 2021b.

One of the main steps a government should take in the promotion of a more digitally advanced ecosystem is to make *good* use of data.[82] Governments rely more and more on a variety of data types in order to level up the digital offer provided to citizens, while innovating the administration from the within. However, not all results and approaches yield timely, significant, and useful results. Often, a combination of policy modelling and data governance components is assembled and enforced to form a bigger digital strategy by governments, disregarding the fragmentation that these elements entail and the loss for public institutions in terms of integration and cohesion. For this reason, a holistic data governance approach, such as undertaken by Thailand (Box 4), is needed to help governments to achieve a truly integrated data-based policy making approach.[83]

The current state-of-the-art in data and metadata modelling by governmental organizations shows that civil servants generally tend to use la case-by-case basis, without a specific and detailed plan laying out guidelines on data sharing.[84] Moreover, data are sometimes handled across departments within a single organization prioritizing internal needs over generally agreed and suggested recommendations. In this respect, many countries are increasingly employing adhoc dashboards and data visualization platforms, adopting the most suitable tools with respect to different departments and activities carried out. This new approach helps governments to develop target dossiers and directly address citizens' needs, upon careful evaluation of the data collected. Because of this misalignment, data leadership is still misunderstood in some countries, wrongly placing data management in the IT departments and not pursuing it as a factor in the achievement of top-level policy goals.[85]

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BOX 4 - Thailand's Government Digital Journey (Group A, GTMI 2020)

In order to provide formal ministerial support and enforce sound governance structures, the Digital Government Development Agency (DGA) has developed an ad hoc document in 2018, emphasizing the importance of data in key policy lines for the country, namely, digital economy and society, while addressing the most relevant challenges this process entails.

The Data Governance Framework[86] defines data governance as "a mechanism for determining the direction, control and verification of the management of data, such that the data are secure, of quality, cost-effective, and economically and socially valuable, and the acquisition and use of government information are accurate, complete, current, safe and private." The document aims to provide standards in supporting government agencies to build the foundations of the digitalization process of data collection, data sharing, data distribution, and data exchange.

Source: OECD, 2022a.

3.3.2 Enhance Trust, Ethics and Data Rights in the Digital Age

Creating a trustworthy and safe digital environment for citizens is important from both a moral and practical point of view. It is the right thing to do and it is a necessary condition for citizens to participate in the GovTech system. Citizens will simply be less keen to engage with public authorities via digital means if they do not have clear digital rights and if they believe that the government is unwilling or unable to safeguard these rights. Citizens' willingness to take up public digital services is strongly related to the overall interpersonal trust level in a country, and especially the general trust toward public institutions and officials.

Research from the Inter-American Development Bank shows that the uptake of digital services is hindered by the low level of interpersonal trust in Latin America and the Caribbean and underlines that strengthening both digital-specific and trust-building institutions would help unleash the potential of digital transformation for growth.[87] Any measures to define and assert citizens digital rights thus need to be accompanied by efforts to build, restore, and/or solidify trustworthy public institutions. The World Bank's World Development Report 2011 (WDR11) underlines the need of a social contract around data, being able to connect three dimensions: value, trust, and equity (Figure 7). This social contract is based on an agreement among all participants that, in the process of creating, reusing, and sharing data that fosters trust, they will not be harmed from exchanging data and that part of the value created by data will accrue equitably. Although recognizing that persuading all the parties on this agreement requires permanent efforts, WDR11 underlines the importance of securing that the benefits from using data are shared in an equitable way. This World Bank flagship report on data also stresses that, considering the cross-border nature of data, these social contracts are needed both at national and international level.[88]

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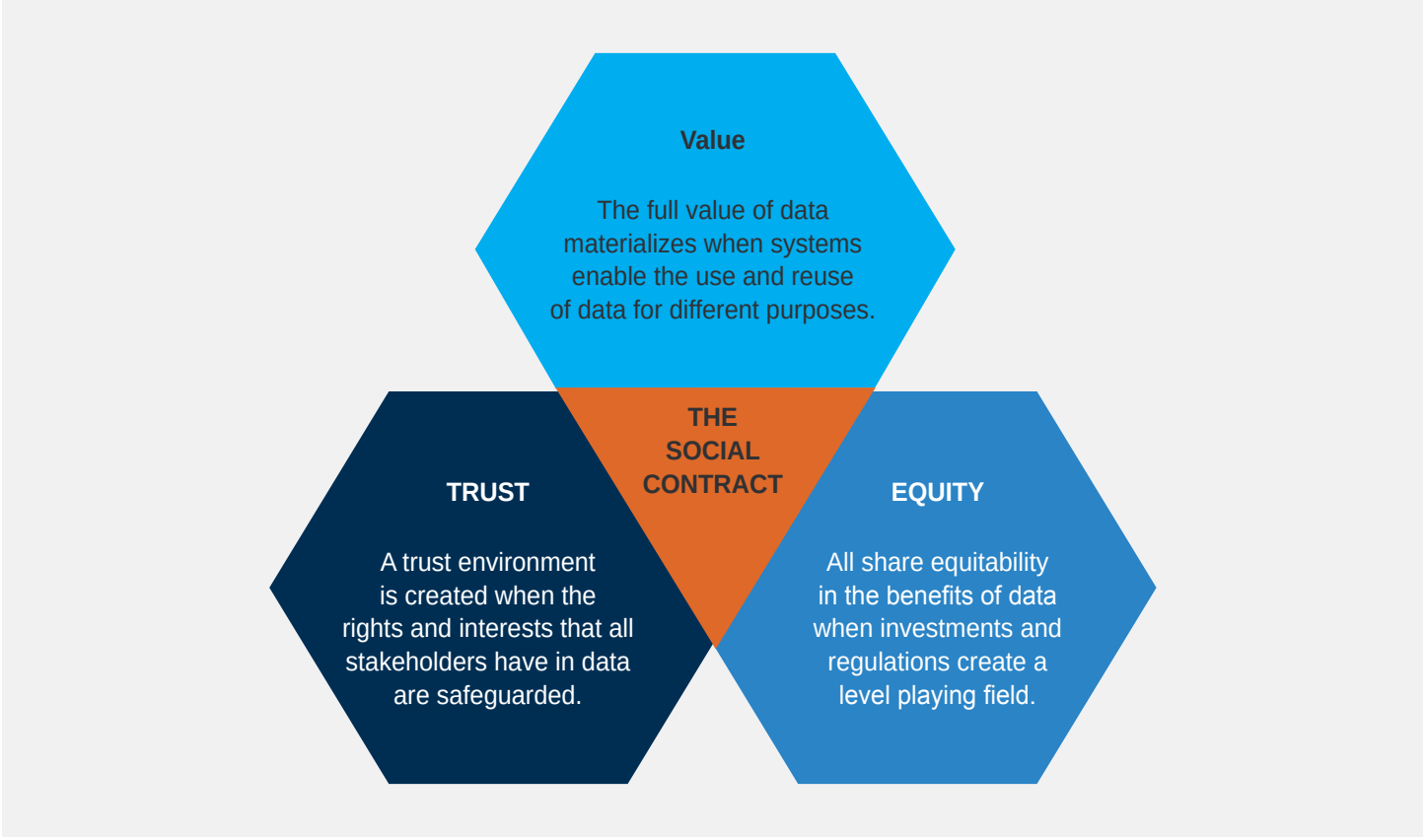
FIGURE 7 - A Social Contract Founded on Value, Trust, and Equity



Source: World Bank, 2021c.

Additionally, the 2017 OECD report, *Trust and Public Policy,* identifies two critical policy levers impacting citizens' trust in public institutions.[89] The first is policy competence, which concerns operational efficiency, capacity, and good judgement to actually deliver on a given mandate. As previously argued, policy competence can receive a significant boost in the data-driven public sector through its ability to advance evidence-based policymaking, forecasting and monitoring, and pro-active service delivery. Embedding the values of good governance into policy making is the second policy lever for public trust. This means that the underlying intentions and principles that guide actions and behaviors of public institutions should be in line with citizens' expectations. Notably, integrity, openness, and fairness are important in this respect. These insights are mirrored in a more recent study of the European Commission's Joint Research Centre on public sector innovation in a data-driven society.[90]

What then are the rights that are important to safeguard for citizens to reap the benefits of a data-driven public sector? While protecting privacy through data protection regulation clearly is a key aspect of data rights, practices in the more advanced data-driven public sector countries show that data rights entail more than that. Asserting data rights is about applying a number of key GovTech principles to public data governance and services involving data exchange with citizens, and backing them up by solid legal foundations and governance mechanisms. For instance, Eurostat, the EU statistical office, has placed trust at the center of its activities, from managing data collection to assessing data quality to delivering robust indicators.[91] The strategic aim is to deliver trusted smart statistics from the widest possible range of data sources and in full compliance with personal data requirements. Data quality assessment services are one of the ways in which Eurostat manages data sharing from national statistical offices.

Trust-enhancing principles include, but are not limited to openness, transparency, responsiveness, and citizen control and are implicitly or explicitly present in international digital government frameworks, such as the European Interoperability Framework, the World Bank GovTech approach and the OECD Digital Government Policy Framework.[92] The idea of principles complementing and potentially influencing new regulation to protect citizens' digital rights is at the core of the new draft Declaration on European digital rights and principles.[93] The draft declaration contains several principles that are directly relevant to data rights.

> > >

BOX 5 - European Digital Rights and Principles

1. Putting **people** and their rights at the **center** of the digital transformation: Digital technologies should protect people's rights, support democracy, and ensure that all digital players act responsibly and safely. The EU promotes these values across the world

2. Supporting **solidarity and inclusion**: Technology should unite, not divide, people. Everyone should have access to the internet, to digital skills, to digital public services, and to fair working conditions.

3. Ensuring **freedom of choice** online: People should benefit from a fair online environment, be safe from illegal and harmful content, and be empowered when they interact with new and evolving technologies like artificial intelligence.

4. Fostering **participation** in the digital public space: Citizens should be able to engage in the democratic process at all levels, and have control over their own data.

5. Increasing **safety, security** and empowerment of individuals: The digital environment should be safe and secure. All users, from childhood to old age, should be empowered and protected.

6. Promoting the **sustainability** of the digital future: Digital devices should support sustainability and the green transition. People need to know about the environmental impact and energy consumption of their devices.

Source: https://digital-strategy.ec.europa.eu/en/policies/digital-principles.

How are such rights and principles put into practice? Key indicators in the GTMI are whether countries have a data protection law and a data protection agency. More than half of economies (109) have both (Figure 8). Regarding a right to information law, as shown in Figure 9, the majority of countries across all GovTech levels have such a law in place. But, this does not mean that there are supporting mechanisms for citizens to know and exercise their rights.

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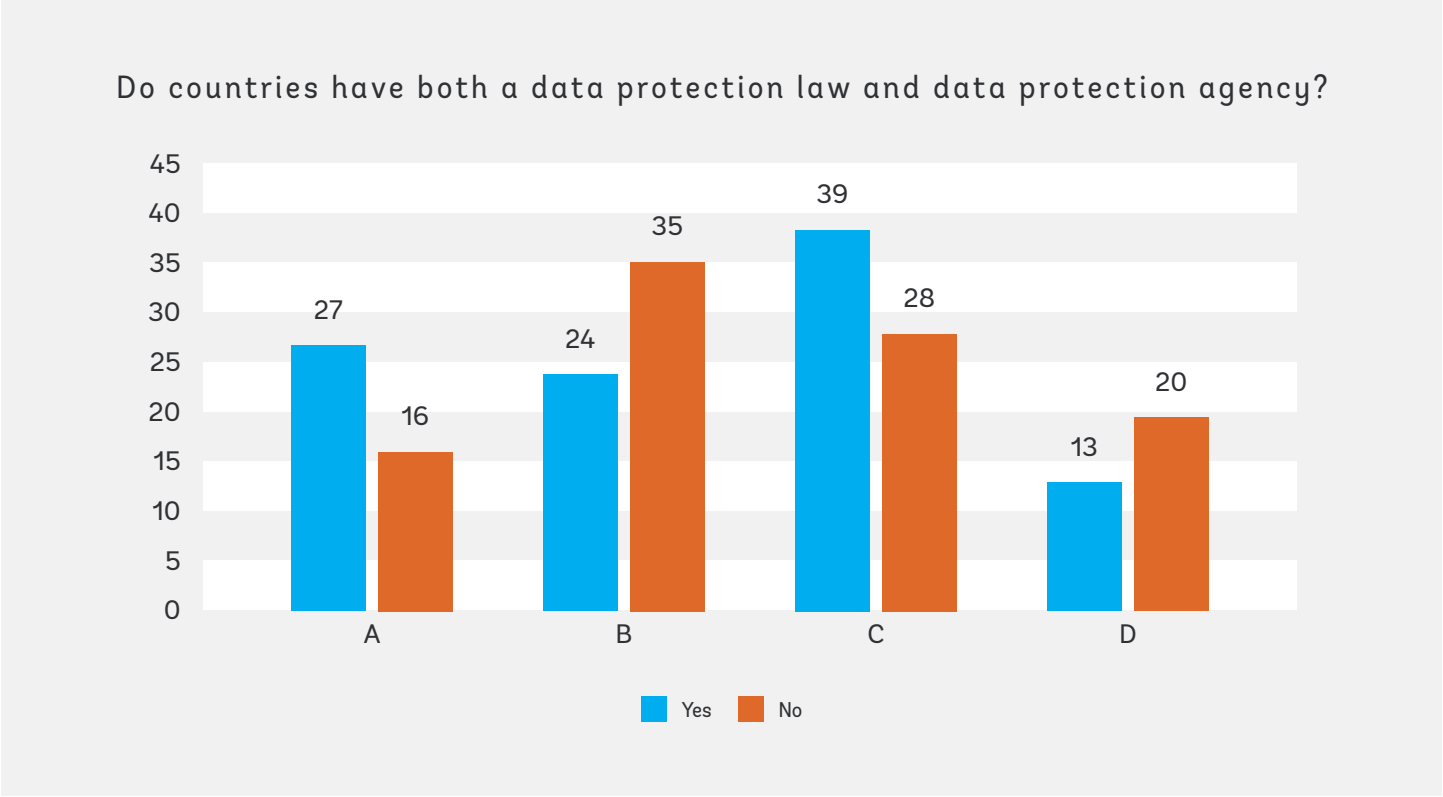
FIGURE 8 - Presence of Both Data Protection Law and Agency by GTMI Group



Source: WBG GovTech Dataset, December 2020.

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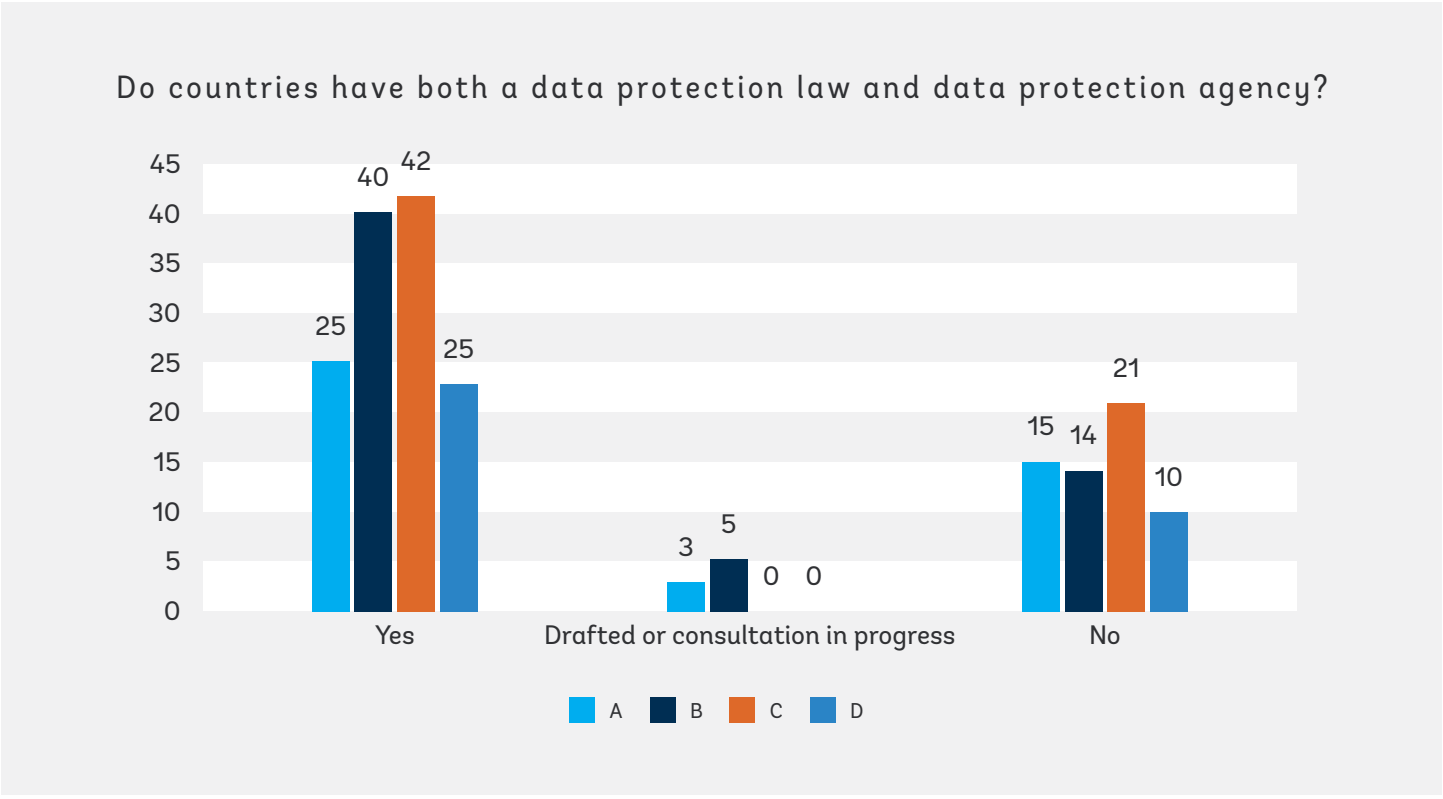
FIGURE 9 - Right to Information Law by GTMI Group



Source: WBG GovTech Dataset, December 2020.

An increasing number of countries are aware that ethical data management includes granting data subjects a certain level of insight and control over what is happening with their data. Single access points or portals for digital public services, such as the citizen folder in Spain, the *mygovernment* portal of the Netherlands, and the citizen portal of Denmark usually bring together citizen data from different government sources.[94] These initiatives are not only a manifestation of the "once-only principle," but also increase transparency and citizen control over data that governments collect about their citizens. Colombia's (Group A, GTMI 2020) citizen folder, "carpeta ciudadana," prominently indicates on the homepage the possibility for citizens to consult and protect their data as well as the option to see the status of service transactions with the government.[95] In Portugal (Group A, GTMI 2020), the interoperability platform equally offers the possibility to citizens to monitor their ongoing affairs and see what data the government holds about them.[96] In Moldova (Group B, GTMI 2020), through *MCabinet,* citizens can see what data is collected about them, also who accessed their data in the state registers when, and for what reason (transparency of data use).[97] In the Republic of Korea (Group A, GTMI 2020), the *MyData* service allows accredited organizations to manage personal information scattered across public sectors and to provide tailor-made service recommendation to the client. Through the introduction of *MyData,* more personalized innovative services are being provided to users in various fields such as finance, medical care, and education.[98]

Transparency and control are also about the ability to monitor how authorities process and use citizen-generated data. This is especially relevant for data-driven co-creation with citizens. This is not only relevant from a privacy perspective, but also from a democratic perspective. In order for citizens to keep engaged and see the value of their input and effort they require feedback from the government on how their input is being taken on board.[99]

Finally, it is essential for citizens to be able to trust that personal data processed by public institutions are well secured and do not fall into the wrong hands. A broad body of evidence shows that people's experiences and perceptions of cybersecurity and data protection shape their trust in, and uptake of, digital services.[100] Among other objectives, cybersecurity seeks to prevent theft of user information, which is typically used for financial gain via sale or extortion.[101] The OECD underlines that digital security needs to be a fundamental part of government's digital, data, and technology strategies. It needs to be addressed by government-wide strategies and approached in ways that enable the proactive use of data for designing and delivering better quality government.[102]

3.4 Module 4: Promoting a Data Culture and Cultural Interoperability

Cultural aspects influencing interoperability developments are perhaps the most difficult to capture, as they are usually not documented or explained. Yet, the often implicit organizational and personal values embodied in traditions, habits, and beliefs are highly influential for the success of any interoperability project, especially in consensus-based systems. Key actors, such as decision makers and public servants, need to be convinced that interoperability endeavors, data sharing, and digital government more broadly can be of positive value rather than threatening to their core activities. If they don't see the added value, it is not likely that they will dedicate time and other resources to making it a success, or even worse, they may oppose the initiative out of fear of loss of power. The importance of cultural change is underlined in the 2014 OECD Recommendation of the Council on Digital Government Strategies. Recommendation 3 calls on governments to "Create a data-driven culture in the public sector" and emphasizes openness, transparency, a focus on public engagement, timeliness, ethics, and trustworthiness.[103]

As highlighted as part of Module 1, clear leadership and institutional coordination are key to promoting the required systems thinking approaches for a data-driven public sector. Change is generally uncomfortable and resource-consuming at first, so proper change management leveraging concrete incentives and a shared understanding of expected benefits is needed to get all relevant actors to embark on the journey and participate in shaping it. The leadership needs to be capable of listening to the involved stakeholders and adapting the interoperability journey in light of emerging insights.

How can managers drive cultural change? The COVID-19 crisis has given a clear push to GovTech developments across the globe. In demonstrating an immediate need for user-centered digital public services backed by data seamlessly flowing between public organizations, the crisis worked as an accelerator of cultural change and accompanying political mandate. This is especially the case if other drivers of change present themselves at the same time. For instance, in the United Kingdom (Group A, GTMI 2020), the interoperability project launched in 2019 by the Government Digital Service experienced a rather slow start, but is now taking a leap with the development of a new government data hub. The required political mandate and budget became available as a result of a clearly demonstrated need to implement the once-only

principle through insights from previous policies and the urgency of the health crisis.[104] Demonstrating a real need for data governance and interoperability, coupled with tangible benefits is thus very helpful to foster the necessary cultural change, as is also highlighted in the interoperability checklist in Annex I. But a crisis is not required to turn this into a strategy. The renowned open data policy of France (Group A, GTMI 2020) owes its success in large part to the government's efforts in focusing on where the need for open data lies--with the end users. This vision has translated into an observatory of data reuse cases, engagement activities towards (potential) reusers, and a sophisticated system of measuring impact and reuse through qualitative and quantitative approaches.[105]

Attention to creating the proper culture favorable to using data as a strategic asset for the whole public sector rather than a one-off ingredient to deliver a specific service is equally relevant in highly mature GovTech countries and in more novice environments. A cocreation approach is important in this respect. For instance, in Denmark (Group A, GTMI 2020), the flagship Basic Data Program is not only successful due to its solid legal basis and technical infrastructure, but also because the government united stakeholders around a shared value proposition of efficiency and public sector modernization.[106] This helped to create a common agenda around the ideas of data governance (quality, use and exchange) as central to public sector reforms (employment, taxes, the environment). Also, in a development context "successful digital initiatives are rooted in an understanding of user characteristics, needs and challenges," as espoused by the community of bilateral and multilateral organizations that endorsed the Principles for Digital Development. Consequently, cocreating digital tools with businesses and citizens can help to respond to the needs of a specific country context, region and community, also in terms of local expectations, cultures and behaviors.[107]

It is also fundamental to recognize the role of organizational and individual incentives in reforms that can lead to more interoperable and data-driven public sectors. Clarifying and disseminating the benefits of interoperability in governments is fundamental to overcoming some of the main barriers of the required reforms. As mentioned previously in this note (Box 1), challenges such as trust and security on data exchange, the limited financial resources available, and the existing legacy technology represent substantial obstacles for the development of sound interoperability approaches. Leadership across the public sector and within public sector organizations is required to reveal and signal the organizational and individual benefits in terms of efficiency gains, improved service delivery, reinforced resilience, and sound accountability.

The World Bank report, *Tech Savvy: Advancing GovTech Reforms in Public Administration,* argues that impactful Gov Tech adoption requires an effective personnel ecosystem in organizations, zeroing in on good quality management and an organizational culture conducive to innovation.[108] The report provides six policy recommendations aimed at improving management and encouraging an innovation culture, using a combination of capacity building and incentives (Box 6). These recommendations can help overcome cultural barriers, such as organizational resistance to data sharing or centralizing data storage, which is a prevalent problem across GovTech levels.[109]

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BOX 6 - Fostering a Data Savvy Organizational Culture

Leadership training: Concrete and feasible planning and investment is needed for capacity building and skill development, as done in the performance management training at the Canada School of Public Service.[110]

Incentivizing better management: An effective and responsive HRM system is a key enabler to support attraction, recruitment, development, and retention of staff with digital skills.

Greater citizen-orientation: To motivate and improve public service delivery, public servants' work can be linked to the impacts on the lives of citizens through incorporating citizen feedback into an organization's work practices via digital technologies.

Improving within-organization communication: To make staff feel safe and welcome to share their views on issues by inviting them to tackle organizational challenges together by creating technology-assisted open communication forums - An example is using smartphones in low-income countries to obtain employee feedback.

Training for civil servants: To foster civil servant-led innovation by developing mechanisms and curricula which cover a variety of skills from digital, cognitive, and socioemotional, which help drive cultural transformation within an organization. The Mission *Karmayogi* program for civil servants in India[111] is a good example.

Innovation awards: To incentivize staff to innovate, while serving as a learning forum for all involved, complementing organizational efforts in leadership and culture – for example the United Nations Public Service Awards.[112]

Source: Andrews et al., 2022.

3.5 Module 5: Using Policy Levers for Coherent Implementation

As shown in Module 1, the policy and institutional setting is critical to secure a coordinated and sustainable development of interoperability policies. Nevertheless, different policy tools are required to guarantee effective and efficient implementation across the administration. These policy levers are able to instruct, calibrate, and enforce the different efforts underway in order to achieve a system-wide change creating solid bridges between policy and institutional setting and concrete implementation, thereby achieving organizational interoperability. Different policy levers are used by countries from various geographies to push for the adoption of fundamental key enablers of public sector digital transformation.

3.5.1 Adopt Preevaluation of ICT Investments and Public Procurement

The procedures in place to allocate financial resources for digital government development can have a central role in supporting the coordination of efforts and promoting a whole-of-government approach towards interoperability. The existence of a mechanism for preevaluation of ICT investments applicable to different sectors of the administration can determine improved alignment on achieving or developing platforms that are in accordance with the interoperability standards defined by the national digital government policy. Some countries have procedures in place guaranteeing that investments above a certain threshold need to be preevaluated to be certain that key enablers such as interoperability are properly addressed. In Portugal (Group A, GTMI 2020), the entity responsible for the digital government policy – Agency for Administrative Modernization (AMA) – preevaluates all ICT investments in central government above 10,000 euros in order to make sure that specific requisites such as interoperability standards or digital identity are properly addressed.

Structured and coordinated ICT procurement is also a mechanism frequently used to secure that public investments from different sectors and levels of government are aligned with the standards required by the digital government policy, namely in terms of interoperability. Since the proliferation of different and non-interoperable platforms is one of the challenges governments face, intervening in the achievement or further development phase is an important policy approach to secure coherent GovTech implementation across the administration. Governments need to regulate and adapt ICT procurement approaches applicable to different sectors and levels of the administration to ensure that the acquisition of services and products reinforces internal coherency and avoids the sometimes typically siloed public landscape where digital platforms are not properly connected or even integrated.

In Australia (Group A, GTMI 2020), the recently launched portal, *Buy ICT,* supports public agencies through the Digital Sourcing process by providing detailed guidance, helpful tools, and a collection of policies. The information, guidance, and procedures provided by the portal are aligned with the country's interoperability policy.[113] In the UK (Group A, GTMI 2020), the Digital Marketplace is an online service managed by the Government Digital Service that allows public sector organizations to find people and technology for digital projects. Besides supporting the agility of procurement place, the service provided guarantees that the listed suppliers provide service in line with the service standard in place.[114]

According to the OECD Digital Government Index, governments have different policy approaches towards the use of ICT procurement and commissioning. Although just 12 percent of the countries surveyed have a central strategy covering ICT procurement, a vast majority, 67 percent, uses

formal guidelines on ICT procurement as a mechanism to promote cohesive, sustainable, and supportable approaches for ICT investments.[115] Together with budget thresholds for the preevaluation of ICT investments, this demonstrates how coordinated ICT procurement can act as a determinant policy lever for widespread interoperability standards across the administration. Depending on the institutional culture in place and ensuring the involvement of the digital government ecosystem of stakeholders, governments should strongly consider developing or reinforcing financial management mechanisms to promote and even enforce the adoption of key enablers such as interoperability frameworks and standards.

3.5.2 Implement Standard Business Cases and Agile Project Management

Standard business cases and agile project management approaches are some other important policy levers used by governments to secure improved coherence and sustainability on the implementation of GovTech or digital government policies. The use of business cases when designing ICT investments supports GovTech senior officials in improving the planning, managing, and monitoring of their projects, and also plays an important role in the rationalization of public investments. A standardized model of ICT business cases to be used across different sectors and levels of government can also have an important role promoting improved value proposition of ICT investments and streamlining compliance with the GovTech objectives foreseen in the policy agenda, namely in the areas of interoperability. In Denmark (Group A, GTMI 2020), business case models are mandatory to be used for ICT projects above the threshold or 1.35 million euros. The business case is used to demonstrate the value of the investment to be made based on its financial and non-financial consequences. The interoperability of possible platforms to be achieved is one of the considered criteria.

With a similar rationale of business cases, the existence of standard project management tools for ICT projects can have an important role securing the consistency of initiatives across different sectors and levels of government. The availability of these tools and support for its effective adoption across the administration drives improved accuracy on the definition of objectives, activities, and tasks. Standard project management tools can also reinforce coherence and cohesion on ICT projects, including better defining the responsibilities between the different stakeholders contributing for project development and highlighting the ICT key enablers to be considered such as interoperability. In Brazil (Group A, GTMI 2020), public sector organizations are encouraged to use SISP Project Management Methodology (Metodologia de Gerenciamento de Projetos do SISP, MGPSISP). The methodology provides good practices and steps for the project management of ICT projects in public sector organizations.[116] In Slovenia (Group A, GTMI 2020), the use of a standardized project management model is required for ICT projects above the threshold of 20,000 euros. The Ministry of Public Administration developed a specific methodology for ICT projects with clear benefits in terms of monitoring and evaluation of policy implementation.[117]

Governments around the world prioritizing the digital transformation of their public sectors progressively use policy levers such as standard business cases and project management for improved coherence and cohesion. According to the OECD, 57 percent of the countries that responded to the Digital Government Index survey declared having a standardized model/method to develop and present business cases within the central/federal level. And two-thirds of countries (66.7 percent) declared having a standardized model for ICT project management.[118] In order to further develop a systems thinking approach for public sector digitalization, governments should increasingly consider using business case and project management methodologies to enforce coherence in ICT investments and avoid the typical traps of siloed platforms that don't communicate with each other and become a substantial obstacle in the promotion of user-centricity.

Projects aimed at advancing the data-driven public sector, such as the creation of a data analytics unit, the development of an open data portal, and data literacy training for public servants, should be designed and implemented in line with the overall digital government or digital transformation strategy, thereby ensuring policy coherence and opening up the possibilities of synergies between the different projects. Business case models provide a concrete way to realize this as part of a whole-of-government approach. Thus, it can contribute to organizational interoperability.

Notably, in developing countries, digital transformation projects may appear to have too high a price and resources are prioritized elsewhere. Especially in those cases it is crucial to demonstrate the financial benefits and timeline for a return on investment. To estimate a project's potential value, it is imperative to understand the pathways through which this value is achieved. Financial value for the public sector is important, since this is needed for the proper functioning of government organizations, and it enables investments in new projects aimed at creating value for society. Contrary to the private sector, it is the public sector's core mission to look beyond financial value. Business case models for digital projects can and should support just that. As such, they encourage a different way of thinking about the return on investment.

Business models are also about ensuring that digital projects get a chance to affect citizens' lives in a sustainable way. This enables project leaders to keep an eye on the cohesiveness with other projects and the long-term impact instead of short-term quick wins that may look good, but do not benefit citizens in the long haul. If done right, both the content and process of business cases contribute to such sustainability. Engaging stakeholders in the process of designing business cases is essential to promote joint ownership, distribution of benefits. A better understanding of users' needs and the involvement of stakeholders outside government will become increasingly relevant as more actors demand a say in the value proposition embedded in the business case methodology.[119]

3.5.3 Improve Capacity for Monitoring and Evaluation

The existence of monitoring mechanisms for GovTech policy implementation is crucial to achieve structured digital government development. Building on and properly aligned with the previously mentioned pre-evaluation of ICT investments and ICT procurement, as well as business cases and project management models, a government's capacity to properly monitor the different initiatives and projects in place determines its ability to coherently drive the transformation underway. Interoperability policies capable of reaching the different sectors and levels of government can benefit clearly from the existence of standard monitoring approaches. And although it seems an obvious policy requisite to have monitoring mechanisms able to access and evaluate the digitalization underway in the public sector, the frequently siloed approaches block this kind of integrated policy instrument.

The capacity to monitor policy implementation carries clear advantages in terms of evidence-based policy development, allowing policy makers and practitioners to have decision making processes supported by accurate and reliable data. Dynamic monitoring systems can be implemented to create options for constant project improvement, generating benefits in terms of agility through recurrent experimentation and recalibration of the approaches being developed. Improved transparency and accountability are also strong benefits of having developed policy mechanisms in place, promoting further internal policy engagement by different sectors and levels of government, and also enabling improved reporting of the initiatives underway to the public. For instance, making available online updated information about policy information through open data can become an important policy lever promoting key enablers for the digital transformation such as interoperability.

Different examples can be found on the role of monitoring tools to enhance interoperability policies. In the EU, the National Interoperability Framework Observatory (NIFO) is one of the mechanisms put in place by the European Commission to monitor interoperability implementation across European member states and associated countries. NIFO regularly gathers information on the state of play of digital public administration and interoperability activities, becoming a fundamental online community of practice on interoperability matters within Europe.[120]

The existence of monitoring mechanisms and tools is also fundamental step for coherent GovTech implementation across the different levels of government. In line with the efforts underway, governments should strengthen monitoring capacities to continue using them for coordination and accountability. Raising the awareness of the public, private, and civil society ecosystem of GovTech stakeholders about policy implementation and key enablers such as interoperability standards, is an asset for generating common ownership and joint responsibility on the construction of a digitally-enabled public sector.

Despite its benefits, monitoring is an untapped area that even some of the most digitally-savvy governments are struggling with. According to the DIGIT Study on public sector data, except for one case, monitoring is marginally treated in the data strategies of the cases studied (Barcelona, Denmark, Finland, New Zealand, and The Netherlands) and there are no systematic monitoring strategies presented.[121] Key Performance Indicators should be considered across departments, and they should not only concern outputs, but also the inputs and the process, such as the percentage of datasets in line with the required standards, the access to base registries, and the number of departments taking part in the different activities.[122]

3.6 Module 6: Fostering Digital Skills and Talent

Skills and talent are the backbone of digital transformation in the public sector. The lack and gaps in digital competences is a significant handicap for a coherent and sustainable transformation in administrations, able to respond to the demand for quality digital public services. While governments' efforts increasingly prioritize the development of digital skills of civil servants, the public sector faces a significant challenge to attract, retain, and develop the necessary competences

to navigate the digital age. And the highly specialized data skills to promote interoperability in the public sector are at the core of this challenge. Specific barriers in digital skills and talent identified by countries in the Interoperability Working Group include the shortage of technicians specialized in data governance, inefficient authorizations and bureaucratic processes, misunderstanding of the interoperability concept, and lack of capacity for data management and analysis.[123]

The GTMI highlights that 47 percent of the 198 countries surveyed do not have a strategy to improve digital skills, underlining the importance of further efforts and investments by public sectors worldwide to tackle this skills challenge.[124] Although being transversal to digitally developed and developing countries, the challenge is particularly preoccupant in the later, increasing their dependencies to properly digitalize the public sector. Data from the OECD Digital Government Index also emphasizes the existing big talent gaps in the different countries observed, creating significant obstacles for administrations to drive the digital transformation underway in an effective, efficient, and sustainable way.[125] Different reasons are consensually identified to justify the existing challenge. The lack of existing skills in the market, uncompetitive compensation in the public sector when compared with the conditions offered by the private sector, or the underdeveloped HRM systems in governments are some of the most common explanations to the existing digital skills gap.

> > >

TABLE 2 - Top 10 Jobs in Increasing Demand

1	**Data Analysts and Scientists**
2	AI and Machine Learning Specialists
3	Big Data Specialists
4	Digital Marketing and Strategy Specialists
5	Process Automation Specialists
6	Business Development Professionals
7	Digital Transformation Specialists
8	Information Security Analysts
9	Software and Applications Developers
10	Internet of Things Specialists

Source: World Economic Forum. *The Future of Jobs Report,* October 2020; cited by Andrews, 2022.

Data skills are at the heart of the existing problem. Almost all of the top 10 job roles in increasing demand across industries (public and private sectors), are technology-related, and several are closely related to data management and exchange (Table 2). Therefore, workforce planning for a digitally competent civil service is critical.[126] Prioritizing planning would allow public sectors to identify the existing gaps, considering the GovTech initiative(s) underway.

Different approaches can be followed to overcome the data skills gap. Defining the right option is particularly challenging for policy makers and manager practitioners working in the current digital age context. The World Bank report, *Tech Savvy: Advancing GovTech Reforms in Public Administration,* provides three paths to reduce skills gaps in the public sector that are naturally applicable to interoperability domains--building, buying, or borrowing (Figure 10).

> > >

FIGURE 10 - Core Approaches to Reduce Digital Skills Gaps in the Public Sector

Source: Andrews, 2022, based on Ulrich, 1998.

A building approach is focused on upskilling and reskilling the existing public sector workforce. This investment in internal skills might increase the short- and medium-term costs and also requires time to realize the benefits of the investment to be made. Nevertheless, the gains in terms of sustainability are significant since it allows the administration to respond to the increasing GovTech demand based on internal resources. This reduces external dependencies and can also contribute to the internal satisfaction of the public workforce that benefits from the training and potential career development. The same benefits can also be achieved when adopting a buying approach for the recruitment of staff with the necessary digital skills. Although it requires substantial long-term investment, the typical gap and consequent high demand of ICT professionals enforces public decision makers to prioritize fulfilling this need of their public sectors. Borrowing is also an approach increasingly followed, temporarily contracting staff or external know-how, as well as using mechanisms such as secondments and fellowships. The agility of this third approach is its biggest value, but it creates problems in terms of non-retained talent and external dependency.

Different policy priorities can be embraced in order to develop digital talent in the public sector regarding interoperability. For the sustainability of interoperability investments, digital skills should be a specific component of the projects to be developed. Elevating the importance of skills in the digital investments to be made, tagging them as strategic, and securing budget for the necessary training and capacity building, will determine the sustainability of the projects and initiatives being undertaken. Governments also have to modernize HRM policies and practices in attraction, retention, recruitment, job design, training, promotion, and compensation, to ensure that the necessary interoperability and skills are available across the administration. Organizing the communities of practice at the practitioners' level is also useful to share best practices, standard technical approaches, and guidance to improve capacity in the public sector.[127]

Strengthening quality and sustainable learning, training, and development is also an important tool to improve the retention of qualified ICT staff and simultaneously prepare public sector organizations to better respond to digital transformation. Talent strategies should combine different training models such as on-the-job, online, and face-to-face to foster a culture of continuous improvement in digital skills in the public sector. Governments also need to support continued research and data on the digital labor market and skills for public administration. Better quality data will enable public sector organizations to better understand the profile and dimensions of the workforce, including existing digital talent in the area of interoperability.[128]

4

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Implementing Digital Interoperability

KEY MESSAGES

- Based on the right policy and organizational foundations, governments need to reflect some essential considerations – data readiness, technology trends, data architecture, APIs, open source - for establishing technical and semantic interoperability.
- Data management for ensuring data readiness – how to collect, store, and exchange with each other – is one of essential step for digital interoperability.
- Governments may have different starting points with respect to digital interoperability, which may require them to assess their current state baseline from a people (skills and capability), process, technology and ecosystem perspective.
- A modern data infrastructure is recommended, and various types of reference architecture give examples of designs enterprises are leveraging for their data infrastructure.
- APIs play a key role in ensuring that data is accessible across government systems in an efficient and controlled manner. Security-by-design is a key enabler of APIs.
- Open standards and open source provides can increase potential of interoperability by providing more space for stakeholders and low/medium GovTech level countries can benefit from open standards shared by mature GovTech countries.

As highlighted in the previous section, governments may need to focus on setting the right policy and organizational conditions. Based on these foundations, governments are trying to design and implement digital interoperability platforms. This section discusses interoperability considerations from the perspective of data architecture, infrastructures, and emerging and existing technologies. A modern data architecture is intended to provide enhanced analytical capabilities, as well as support the three primary goals associated with achieving interoperability in any system (computer or otherwise): data exchange, meaning exchange, and process agreement. The key guiding principles to consider when considering digital interoperability include data source abstraction, non-invasive systems interconnection, system portability, software defined data exchange, event-based data exchange, and scalability.

This chapter will discuss and suggest five modules that practitioners in interoperability should consider when they design and implement technical and semantic interoperability. It will start by focusing on data readiness, and follow with key technology trends, a modern data architecture, APIs, and Open Standards and Open Source.

4.1 Module 7: Ensuring Data Readiness

With the advancement of emerging technologies such as AI and big data analysis, the quality of datasets, especially in the public domain, plays an important role in the accuracy and quality of algorithmic decision making. To date, some of the challenges with open data and government datasets used for service delivery include systemic, computational, and human bias;[129] cybersecurity vulnerabilities;[130] environmental conditions such as corrosion, humidity, and biofouling[131] that can confound external sensor data; and data drift,[132] a phenomenon wherein data changes overtime, requiring consuming systems to adapt.

When considering semantic (data) interoperability, the maturity level of data captured and stored in government organizations can vary significantly and is a determining factor regarding the level of interoperability that could take place. It is important to understand what data is needed, what is available, what we want to so with this data, and why and who can and needs to access this data. This should be described in a data strategy that will be the foundation that can highlight opportunities that can be converted into projects and demonstrate value.[133]

The development of this data strategy may require a current state baseline assessment (internal data availability assessment), where data assets are identified across the layers of government data stores, data archival and retention are understood, and key data assets are prioritized, forming the basis for a discussion on where interoperability is needed most.

Data governance is the next important step to ensuring data quality, integrity, availability, harmonization, legal, and regulatory frameworks described in previous sections, and the overall management of --people, processes, and technologies. For example, the UK Information Commissioner's Office (ICO) provides a checklist for three issues government agencies can consider with respect to the data they hold. The principle of data minimization can help guard against over-capture of data that is not considered an asset. This means to:

- Collect only personal data needed for specified purposes.
- Retain sufficient personal data to properly fulfil those purposes.
- Periodically review the data we hold and delete data that is no longer needed.

In addition, governments have the responsibility of maintaining data integrity, including in a scenario where new datasets are introduced to the government ecosystem.

Toolkits and guides: Please refer to the UN Statistics Data Interoperability Guide, a practitioner's guide that explores opportunities and identifies good practices for enhancing data interoperability in sustainable development. Statistics Canada also provides a Data Quality Toolkit to raise awareness about data quality issues.

4.2 Module 8: Anticipating Key Technology Trends

With the arrival of the fourth industrial revolution technologies such as AI, Machine Learning (ML), Internet of Things (IoT), quantum computing, and others, governments need to prepare for a new set of interoperability challenges, many of which revolve around how these new capabilities will be integrated into their existing technology ecosystem. These challenges can best be understood through the following lenses.[134]

1. **Technology:** Emerging technologies will need to be aligned to existing and legacy architecture. New technologies

may introduce new cybersecurity risks and challenges,[135] and customized and homegrown applications may need to be retrofitted to adapt to changing ecosystems and capabilities.

2. **People:** The ability to upskill employees may become a competitive advantage for organizations seeking to implement digital transformation. Culture change may be required, and an assessment of digital skills – for example, to implement DevSecOps, MLOps – may be needed to develop roadmaps for the government workforce. Additionally, data literacy may need to be evaluated to enhance data analysis and use skills.[136]

3. **Process:** Emerging technologies that blur the lines between organizations may require new operating models and governance structures–for example, in the case of federated learning for cross-organizational AI.[137] Existing business models will need to be evaluated for gaps, to develop a transition roadmap.

4. **Ecosystem:** The shift away from a siloed, independent enterprise architecture to one that is closely linked to cloud-enabled capabilities requires an ecosystem approach. Government organizations will need to look at new data value chains in considering interoperability requirements, especially with a mesh architecture.[138] Open source may become a more viable option to reshape strategy and explore and trial new capabilities prior to adoption with technology partners.

To further interoperability efforts, digital government departments may need to focus especially on the "people and skills" dimension. For example, one of the key lessons from combating COVID-19 is the need to make data available in machine-readable format, to facilitate government communications on disease surveillance, and the need to create compelling, accurate, and clear data visualizations.[139] This may require both a skills and culture shift for government teams who have not been required or resourced to make data available in this way, or who may not understand the potential benefit of doing so. For more information on how governments can encourage cultural transformation and collaborative environments, refer to the World Bank report, *"Tech Savvy: Advancing GovTech Reforms in Public Administration."*

Governments need to pay attention to specific emerging technologies, and how they might change the need to rethink interoperability efforts and catalyze the acquisition of new skills in a data-driven and potentially decentralized digital environment. Please refer to Annex II for further information on emerging technologies such as Web 3.0, Cloud and Edge computing, IoT, Blockchain and Distributed Ledger Technology (DLT), AI, Central Bank Digital Currencies, and Metaverse.

The modernization of legacy systems and technologies is a critical issue for government's IT departments; it is a complex task which requires careful consideration and advanced planning. Modernization can be considered at the User interface layer. The most visible part of a system, data layer is changing the way data is accessed and exchanged, and this can be done with different approaches such as data wrapping. At the functional layer, the focus is on modernization of the business logic as well as the legacy data. Other areas of modernization that can take place will be at the integration layer. The first step to consider when reviewing legacy technology is to carry out an assessment of the current technologies – for example, data, function, user interface (UI), use of the system, strengths and weakness – . Based on this assessment, teams determine what needs to be modernized and then select the right approach.

4.3 Module 9: Designing a Modern Data Architecture [140]

Currently, "most business value is derived from the analysis of data and products powered by data, rather than the software itself."[141] Data Architecture is the design blueprint of the overall setup of a system, or a group of systems put together to manage data throughout the data lifecycle. This also involves how data interoperability can be executed and maintained across a digital ecosystem of people, enterprises, and systems[142] to fulfil government and business needs. Data Infrastructure focuses on the physical implementation of the specified design blueprint components. For example, for Amazon Web Services (AWS) – the networking, virtual machines, and the database would describe its infrastructure, how the components communicate together, share data via APIs, etc. This section will discusses the Data Architecture design needed to achieve interoperability in any system with the primary goals of data exchange, meaning exchange, and process agreements. According to Ahmed and Twinomurinzi (2019), "one of the fundamental principles of digital government is to maintain a common interpretation of information across all its entities and its citizens. However, ICT systems are often created in each government entity without consideration of whether this common interpretation will be maintained. When meaning between ICT systems is not maintained, it results in semantic conflicts."[143]

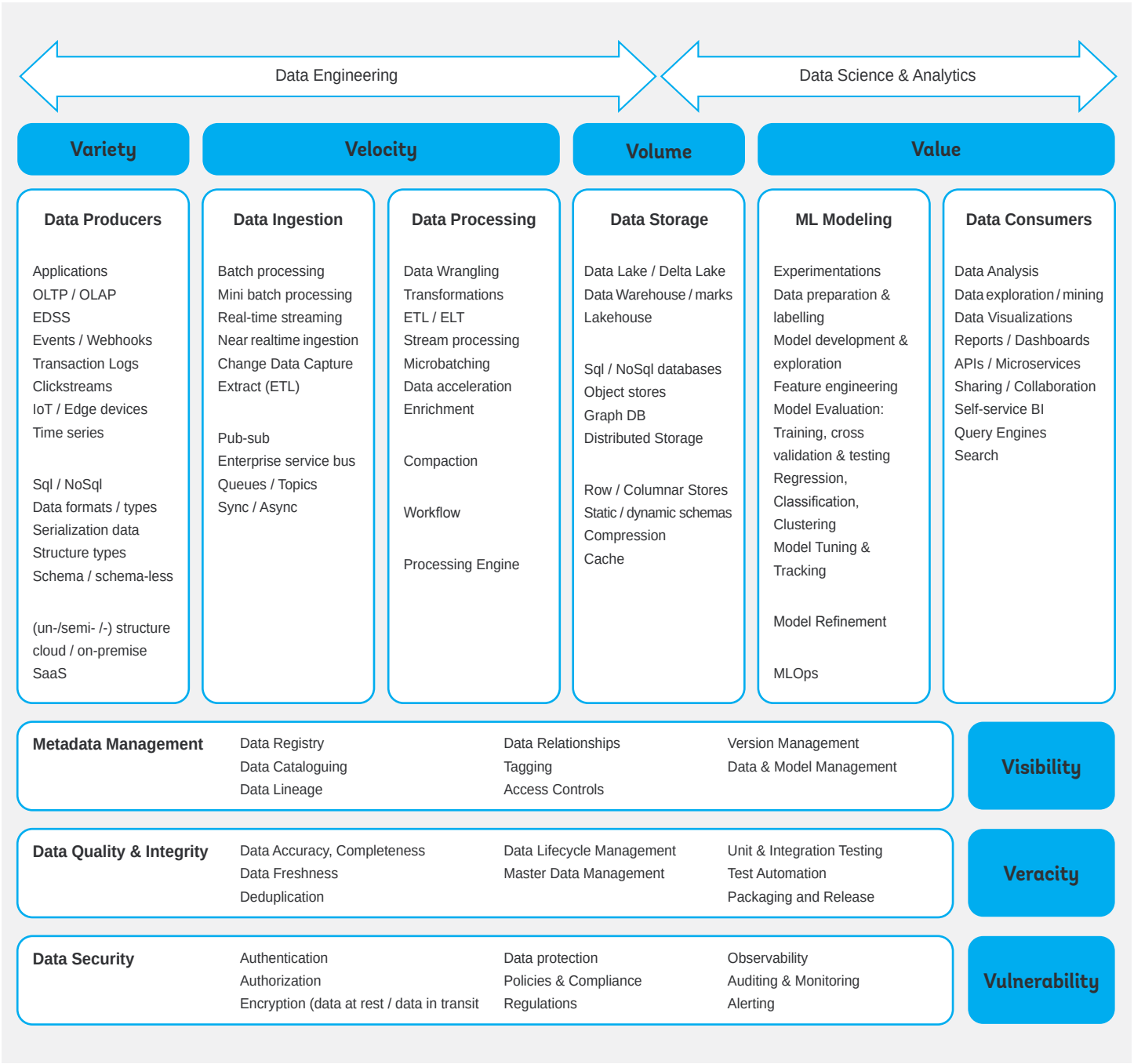
Kumar Illa (2020)[144] describes the key components of a modern unified data architecture that permits enterprises to derive value from data. The architecture includes two core areas of focus:

- Data engineering, which creates the foundation for data to be organized and maintained.
- Data science, which permits enterprises to leverage data to create insights.

This modern unified data architecture provides one potential common view of how different roles within the IT organization can leverage data and technology capabilities for advanced analytics across a cloud or collocated environment, reducing duplicative efforts. Figure 11 below provides a schematic representation of the stages of a data architecture.

> > >

FIGURE 11 - Conceptual Flow of Data through Different Stages for a Data Architecture

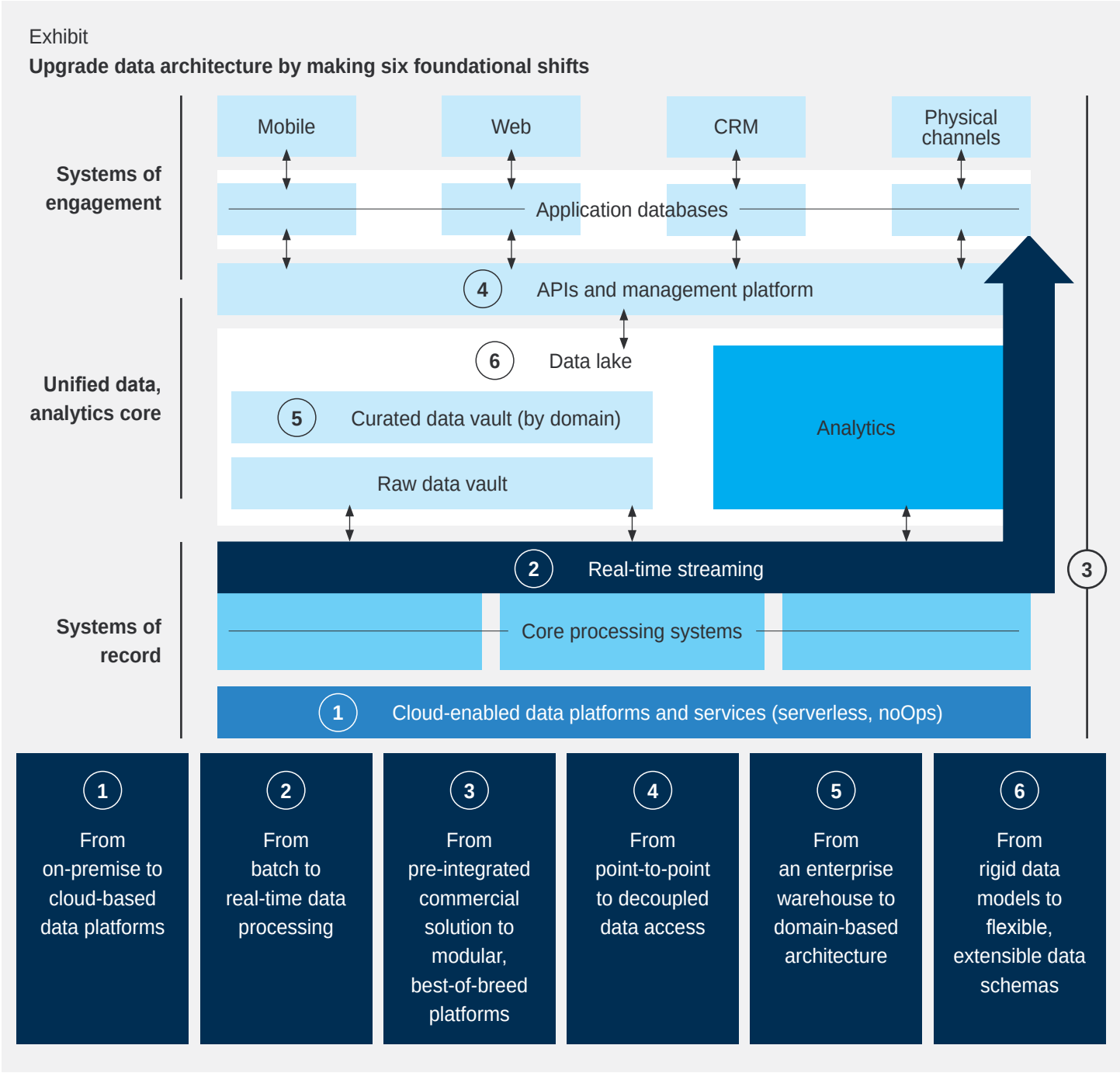


Source: Prasanna Kumar Illa, 2020.

Most governments today have some form of digitalization that has led to either an organically evolved data architecture or a planned data architecture. Whichever the case, this has to be considered when planning a target state. If the data architecture is new, then all components in the Figure 10 will have to be designed or upgraded accordingly. McKinsey Digital's recent report, addressed this issue, stating that "data technologies are evolving quickly, making traditional efforts that define and build toward three-to-five-year target architectural states both risky and inefficient."[145] Some of the key obstacles that organizations face include the increased complexity of managing new data-related capabilities including data lakes, cloud services – for example, predictive analytics – and AI models. To address these challenges, they observe six foundational shifts that enterprises will have to apply to their data architecture to make it more agile, simple, and future-ready (Figure 12).

> > >

FIGURE 12 - Six Foundational Shifts for Data Architectures (McKinsey)



Source: Castro, A., et al., 2020.

To get started, Castro et al. (2020) recommend instituting several crucial practices that enable rapid evaluation and deployment of new technologies to support quicker adoption:

1. An experimentation and testing mindset to architecture development, including the use of open source to trial new capabilities.

2. Establishment of cross-functional teams for development of curated datasets and best practices regarding modeling of data and collaborating across data teams to establish common classification and vocabularies.

3. Creating data (semantic) interoperability between classifications and related governance considerations.

4. Use of DataOps for data architecture development. This data management method emphasizes communication, collaboration, integration, automation, and measurement of cooperation between data engineers, data scientists, and other data professionals.[146]

5. Development of a data culture that connects enterprise-level strategy to the organization's daily work, focusing on improving knowledge capture and sharing (enterprise intelligence).

Finally, when considering options for a unified data architecture, governments can review the architecture proposed by Bornstein, Casado and Li of a16z, which distinguishes between analytic systems that support data-driven decisions and operational systems that build data-powered products.[147] Their proposed unified reference data architecture can be customized to design patterns that support different use cases.

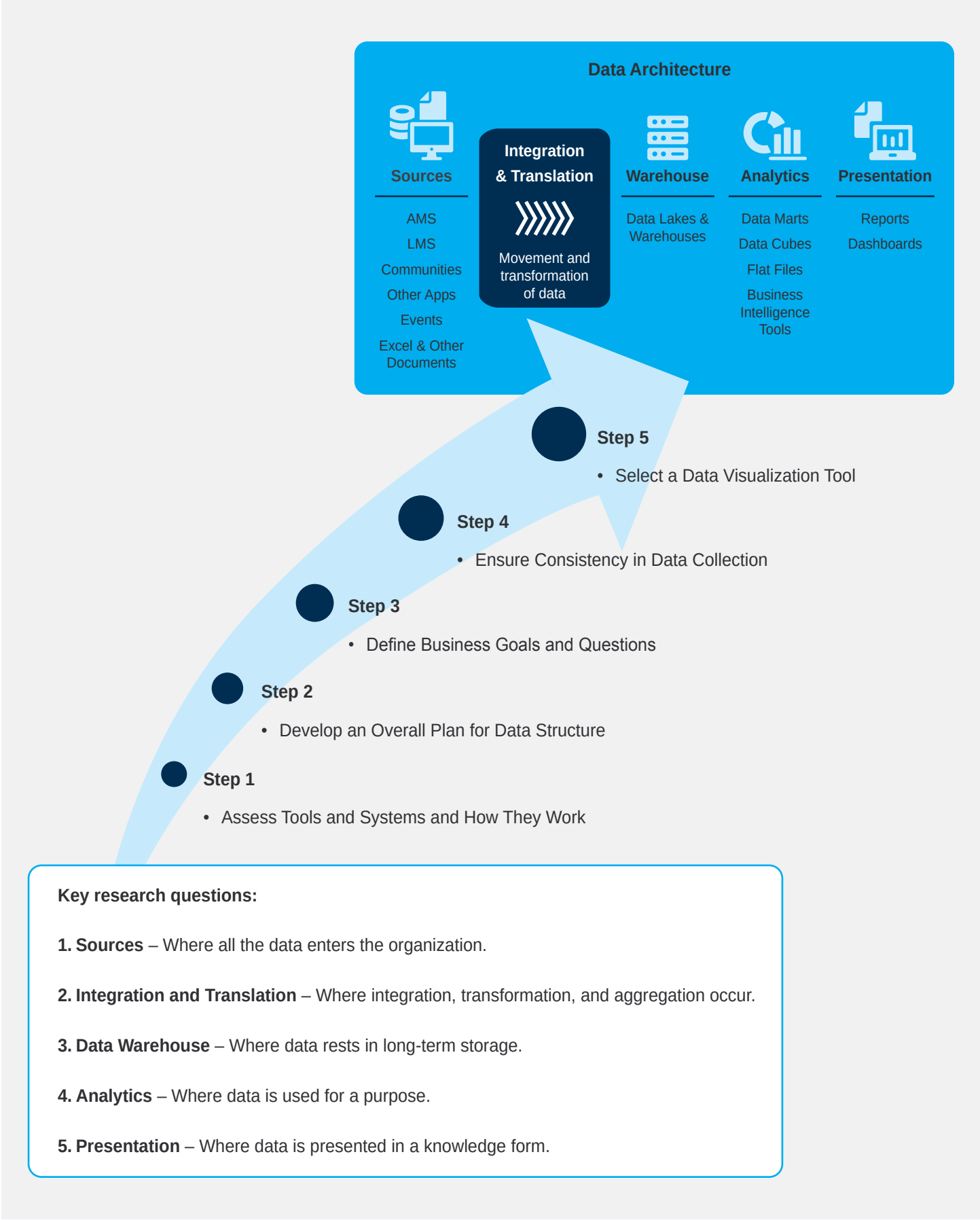
Toolkits and guides:

- Please refer to Annex III to view recommended reference for unified data architecture that can be customized and some examples of three common unified architectures designed for business intelligence: cloud warehouses; multimodal data processing, such as data analytics and operations using data lakes; and operations that leverage AI and ML components. Figure 13 below shows recommended manageable steps for starting the processes of creating or upgrading data architecture.[148]

- UK Government Data Architecture. "Established by the Office for National Statistics in 2017, the government data architecture community share ideas, experiences and methods in an effort to standardize the way we work and ease communication between government departments."

> > >

FIGURE 13 - Steps to Design or Upgrade a Modern Data Architecture



Source: Authors.

Table 3 below details steps to consider when designing or upgrading a data architecture.

> > >

TABLE 3 - Steps to Design or Upgrade a Modern Data Architecture

Steps to consider when designing or Upgrading a Data Architecture[149] (Adapted from Corcoran, 2017)	Detailed Activities
Step 1: Current State Assessment of Tools and Systems	• Conduct a current state assessment all the tools and systems that your organization currently uses and how they relate to each other. • Interview stakeholders associated with each system to identify benefits and pain points. Understand and inventory integration-related pain points.

Step 2: Current State Assessment of Data	• Develop a data dictionary that includes:
	
	  • where your data resides (i.e. data storage tools used in your organization i.e. database, data warehouse).
	
	  • where the data comes from (data sources, format of data), and who is accessing the data (consumers of data, providers of data, etc.).
	
	• Understand what data is being captured in these data storage tools.
	
	• Establish what data sources are included and what data sources are not included, and why.

Step 3: Define Business Objectives and Evaluate Data-Related Policies, Rules & Standards	• Establish what important questions and insights does the organization need to answer. Gain insights into how they can leverage their data to help answer these questions more effectively.
	
	• Establish policies, rules, standards, and models that govern data collection and how data is stored, managed, processed, and used within the organization.
	
	• Establish data architectural principles. Three key best practices principles recommended are:
	
	  • Consider Data a shared resource
	  • Ensure security and access control
	  • Reduce or eliminate data movement and replication.
	
	Determine applicable KPIs for each government unit with respect to business objectives.

Table 3 continued

Steps to consider when designing or Upgrading a Data Architecture[149] (Adapted from Corcoran, 2017)	Detailed Activities
Step 4: Ensure Consistency in Data Collection	• Refer to Section 4.1 on data quality for more in-depth discussion on ensuring quality and consistency. Evaluate and implement data quality practices to ensure trusted analytics. • Evaluate changes, establish change governance for key data, and ensure documentation and communication of changes to key stakeholders. • Implement processes to reduce and manage incomplete and duplicate data to reduce downstream issues that impact the quality of analytics.

Step 5: Select a Data Visualization Tool or Evaluate Current Data Visualization Capabilities	• Review current data visualization tools - are they right for your needs?
	
	  • What would you like to visualize?
	  • Is integration with data stores easy and automated?
	  • Are key business questions being answered using this tool or suite of capabilities?
	
	• Some question to consider before selecting a data visualization tool include:
	
	  • Ease of integration requirements.
	  • Distribution capability.
	  • Degree of interactivity with analysis.
	  • Support for near real-time analysis.
	  • Restrictions on branding and color scheme.
	  • Accessibility.
	  • Access control and security.

Step 6: Reporting and Analysis	• Evaluate and automate business reporting requirements as needed. • Develop capability to add context to business reporting through advanced analytics. Continually re-evaluate reporting and analysis. requirements against stakeholder concerns, to deliver new insights.

Source: Adapted from Corcoran, 2017.

4.4 Module 10: Harnessing Application Programming Interfaces and Enterprise Service Buses

Application Programming Interfaces (APIs) form part of the modern government technology stack, specifically in the area of Middleware. According to Gartner, "Application programming interfaces (APIs) make digital society and digitaliness work. They connect people, businesses, and things. They enable new digital products and business models for services and create new business channels. APIs make digital business work."[151] APIs are a fundamental part of every effort to modernize application architectures and integration.

APIs provide essential access to applications and data services that support:

- Packaged business capabilities that enable a composable enterprise.
- The creation of digital business technology platforms.
- Multipipeline and cloud-native applications.
- Participation in an API economy.
- Pervasive integration.[152]

APIs make data accessible to other systems in an efficient and controlled manner, when accompanied by adequate security controls.[153] An important aspect of leveraging APIs in a government context is to standardize interface designs and make supporting documentation available to all national and subnational agencies.[154] Standardization and reuse of commonly governed APIs can also support government efforts to strengthen security for a digital government ecosystem.[155]

As the case of Estonia shows, cybersecurity and data governance are critical to ensure that APIs are being used for their intended purposes, and not creating opportunities for unintended data loss or unauthorized access.[156] The UK's Integrated Data Programme highlights how emerging technology capabilities such as graph databases can leverage APIs to capture complex relationships within data and support machine-readable data to run AI and ML models.[157]

A concrete way in which countries enable the reusability and sharing of information and solutions when implementing public services is through APIs. For instance, both Canada and the Netherlands have developed one-stop shops for APIs.[158] France made available 90 APIs to administrations and private companies through api.gouv.fr and entreprise.api.gouv.[159] Nevertheless, this internationally renowned open data leader[160] has many challenges ahead when it comes to realizing interoperable systems and implementing the once-only principle. While the country has had an interoperability governance model and repository in place since 2005,[161] its implementation has suffered under the siloed organization and culture of the public administration, which is a key element for whole-of-government interoperability. A legal mandate for a unified interoperability approach is still lacking and highly dependent on the political will of individual ministries.[162]

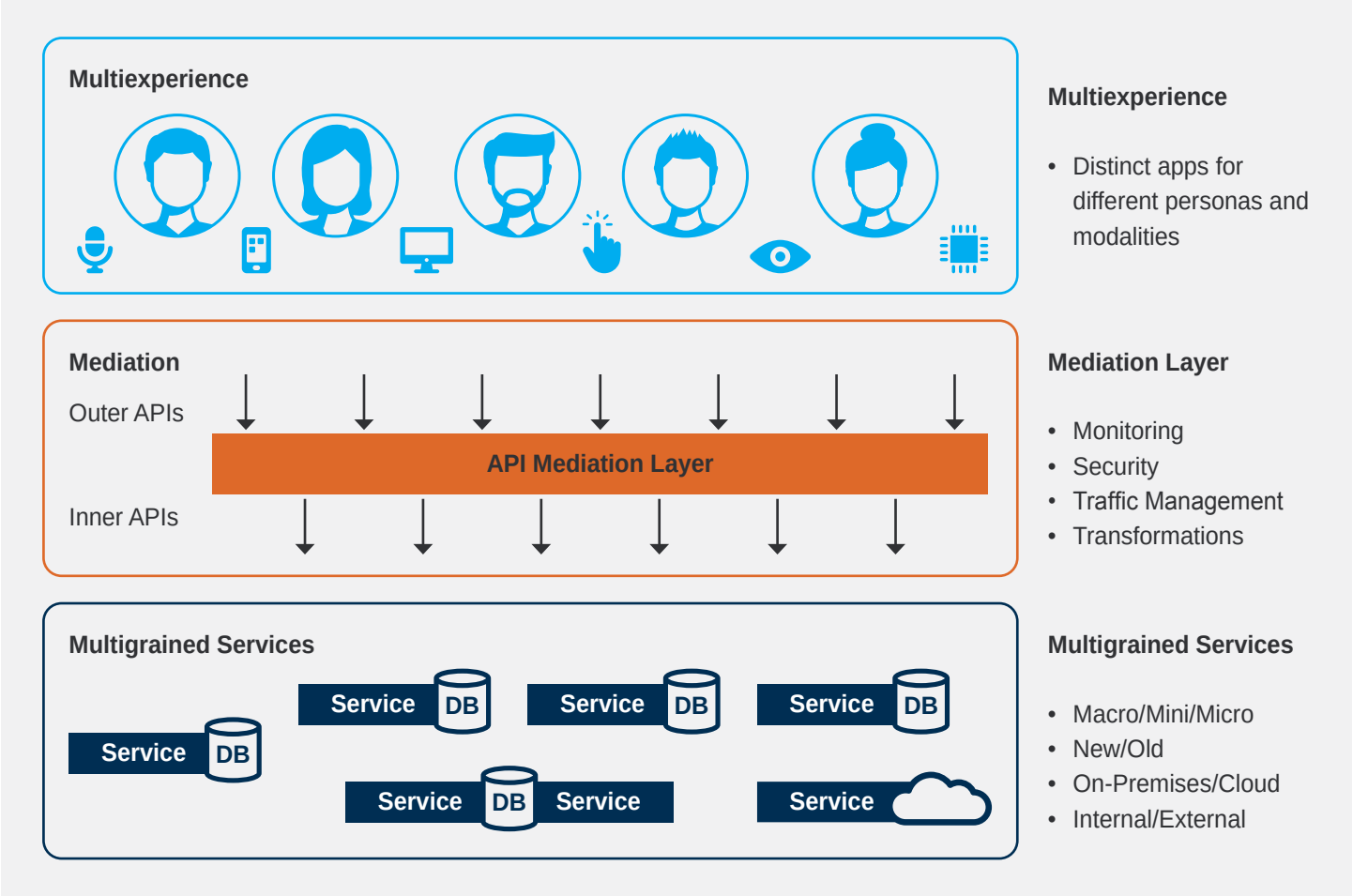
Extensive use of APIs also presents its own challenges. These include cybersecurity challenges, increased network traffic, maintenance requirements and complexity, increased overhead to customize, and challenges using APIs with legacy applications.[163] These challenges can lead to a portfolio of applications and services that are plagued by security issues and lower ecosystem interactions, resulting in a lack of interoperability.

4.4.1 Adopt an API Mediation and Service Mesh

One way to address some of the challenges with increased use of APIs is to adopt a "mediation" approach, in which API consumers and providers are not tightly coupled. Figure 14 below presents a recommended API mediated architecture, which supports multiexperience–the various permutations of modalities such as touch, voice and gesture, devices, and apps that users interact with on their digital journey and cloud-native applications.[164] Within the mediation layer, monitoring, security, and automated traffic management assist with ensuring a more robust and secure implementation. An API mediation layer can also assist with resolving integration with legacy applications, which may have proprietary methods that need to be managed as part of an organization's overall move to a modern architecture and suite of applications. It should be noted that complex orchestration and business logic should generally be avoided in the mediation layer.

> > >

FIGURE 14 - Mesh App and Service Architecture



Source: Gartner, 2018a.

For more advanced organizations, a service mesh approach may be desirable. A service mesh "takes the logic governing service-to-service communication out of individual services and abstracts it to a layer of infrastructure."[165] An example of a more complex ecosystem can be found in Annex III.

4.4.2 Understand Cybersecurity Considerations for Harnessing APIs

Governments will want to consider a range of enabling factors to successfully adopt APIs. A key enabler is to ensure that API developers within the enterprise understand and are able to contribute to secure, productive interactions between applications with minimal effort. These developers will also need to be continuously educated on the types of risks that occur with APIs and that they pose to the enterprise. Similarly, cybersecurity professionals monitoring these APIs should be equipped with visibility into expected behavior and inbuilt controls, especially access controls, to ensure robust implementation. Automated monitoring is especially important given the ease of API deployment in modern architectures. Also, organizations can limit their risk within an API implementation by keeping an updated API inventory.[166] Additional cybersecurity trends, such as security by design and Zero Trust Architecture (ZTA), are described in Annex II.

4.4.3 Enterprise Service Bus and Government Service Blockchains

Enterprise service buses (ESBs) are more mature technologies used for achieving enterprise application integration (EAI) tasks. They offer an abstraction layer and allow for orchestration of various application-to-application transfers, enabling different applications to be able to communicate. They offer somewhat of a precursor to API gateways and focused on exposing services for reuse. Yet as enterprise needs shift and APIs have become increasingly important, API gateways have proven a more useful tool to achieve orchestration of digital services.

ESB technologies are already being used in governments around world. One example is the Ministry of the Interior of the Czech Republic, which leverages ESB technology for a public administration communication infrastructure. The eGovernment service bus is the central service point for the exchange of data between basic base registries and other authoritative government data sources.[167] Nepal's eGovernment portal for public e-service delivery was built on ESBs and it has developed a design guideline to ensure standardization of future services added to the ESB platform.[168]

The idea behind the evolution of the government service bus approach is based on the need to reduce cost and time of inter government agency processes, both from the point of view of implementation and from the operational point of view. Thus, driving the concept of the Government Service Blockchain (GSB) and exploring the use of blockchain technologies to enhance efficiency, security, transparency and engagement, can allow each of their entities to run their own processes with their own technology stacks, regardless of the processes and technologies of any other entity. This can be achieved through the decentralization of the service and the usage of Smart Contracts with blockchains as a kind of "asynchronous communication bus." Transforming current service bus architecture into a distributed, smart, secure service approach involves applying the Smart Contract concept within a private/ permissioned blockchain protocol.

Some current examples of government activity in the space follow. In Japan, the Ministry of Internal Affairs and Communications, which oversees the Japanese administrative system and manages local governments, is testing a blockchain-based system for processing government tenders. In Italy, the Ministry of Economy and Finance, which coordinates the European H2020 research project SUNFISH, is leading a national initiative to provide the Italian public sector with a blockchain-based infrastructure to foster integration among government departments and underpin national digital services. Dubai's ambition to transform the whole of government document management and service process management IT infrastructure to blockchain.[169]

4.4.4 Cyber Security Interoperability

According to Rantos et al. (2020), information has become one of the most valuable assets in governments, and defense of it is a has become a constant concern, as the frequency of cyberattacks continue to rise posing a great threat to organizations and government's digital environments.[170] In this constant battle, governments must retain visibility of emerging and evolving threats and defend themselves against a wide range of adversaries with various levels of motivations, capabilities, and access to resources.

This necessitates the need for governments and organizations to be able to share cyber threat information (CTI) in a timely and reliable manner to enhance their ability to identify any malicious activities or sources with the intention to swiftly mitigate attacks as a preventative measure against damage to the information assets. CTI is defined as "any information that can help an organization identify, assess, monitor, and respond to cyber threats." This type of information includes security appliances log entries and alerts; measurable and observable actions; security bulletins and advisories; identified vulnerabilities; news, reports, and intelligent data. This can be established in two ways:

- Leveraging security technologies such as Unified Threat Management (UTM), Intrusion Detection/Prevention Systems (IDS/IPS) and Security Information and Event Management (SIEM) that can be incorporated as part of the security solutions.

- Participating in Cybersecurity Information Exchange (CIE), CTI communities, or intelligence groups designed to exchange CTI knowledge, enhance their security posture, and protect themselves from cyber threats.

The main motive is to create new knowledge or services about cyber threats, as well as to make cyber-defense systems more effective and efficient. This requires an organization to go beyond the confinement of its environment to use multiple sources instead, thus encouraging Cyber Threat Information Intelligence (CTII) sharing between multiple actors, such as government agencies and organizations, private sector organizations and industry-focused groups.

One of the most challenging issues in this process is achieving consensus regarding how this information should be shared among interested parties and the threat intelligence community. This requires having a common understanding

on what information is shared, how it is shared, and whether its sharing is legal. Some of these communities already exist, such as the Computer Security Incident Response Team (CSIRT), also known as the Computer Emergency Response Team (CERT) network established in the European Union (EU), which counts more than 400 members willing to share incidents and risk-related information. The network includes commercial organizations, EU Institutions, law enforcement agencies, private and public sector organizations, and national and military agencies. Similar initiatives in the US that promote the exchange of information include the US Department of Homeland Security (DHS) Cyber Information Sharing and Collaboration Program (CISCP).

Governments must ensure that CTII sharing is interoperable, safeguarding their personal and classified information within the organization has well established procedures. When CTII is about to be shared with external entities, several interoperability and security issues need to be considered. The CTII suggest a strategic approach that involves a four layered model—legal, policy and procedures, semantic and syntactic, and technical layer.

4.5 Module 11: Working with Open Standards and Open Source

As previously explained, standards are an essential part of delivering interoperability. Standards allow different hardware, software, and data solutions to work together. Open standards are particularly important, because they are not proprietary, and therefore can be adopted by different solution providers. They ensure that interoperability is open to new software modules and new providers, and avoid lock-in. The Canadian and French guidelines on open standards are a practical example. As reported in the "Open First Whitepaper: Open Standards," published on the Canadian government website,[171] the Quebecoise government's common interoperability framework (CCIGQ) is strongly linked and in line with the French Government's General Guidelines for Interoperability, building on the EIF and the British Cabinet Office's Open Standards Principles. The four documents present common criteria which define open standards that could be followed by developing countries and government agencies which would like to strengthen or implement frameworks from scratch:

- Openness and transparency of the process to define standard's development, which entails no control by a single person or entity.
- Standalone reusable platform, allowing for fast, simple and multiple implementations.
- Limitless and freely supporting material for open standard creation and implementation (with some restrictions).
- Community-enforced and supported, approved through a co-creation and consensus.

Informed by interviews with key stakeholders across four continents, from government decision makers, technical experts, funders and people delivering digital services to citizens, the report, *Open source in government: creating the conditions for success,* demonstrates how open-source software can be a powerful lever for change, giving teams greater flexibility on how they solve problems and develop services based on users' needs.[172] It allows governments to share and reuse solutions across borders, to quickly experiment and pilot services without complex and expensive procurement, and then scale at a lower marginal cost. As such, open source is of high relevance for GovTech. The report recommends that governments advance their open-source capabilities by: (1) building a favorable policy environment, (2) working on in-house skills and capabilities, (3) foster an open-source vendor ecosystem, and (4) paying attention to the sustainability of the open-source activities from the start.

As part of Barcelona's 2017 Open Plan for a more open, transparent and collaborative government, the city has made available its Ethical Digital Standards[173] as an open-source policy toolkit for other cities and interested stakeholders to use.[174] Promoted by the Cities Coalition for Digital Rights, Barcelona has manifested itself as a pioneer the use of open-source software, open standards, data sovereignty, agile development of digital services and guaranteed privacy, ethics ,and security by design. The city council has committed to investing more than 70 percent of the new software development budget into free and open-source software and services based on open standards, open formats, open interfaces, and interoperability.

As highlighted in the interoperability checklist in Annex I, highly mature GovTech countries are encouraged to share their code as open source and publish their standards as open standards, while low- and medium-level countries can especially benefit from already published open-source material and open standards to develop their interoperability initiatives. For example, the GovStack model supports the development of an open platform that focuses on an initial set of use cases where a set of technical building blocks are designed together, to support generic workflows across

multiple sectors.[175] Similarly, the Digital Convergence Initiative highlights a number of different initiatives to develop software that reduces the burden of data exchange and reuse among government systems supporting foundational identity, social registries, civil registries, payment platforms, data analytics platforms, and GIS platforms.[176]

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BOX 7 - E-Government Standard Framework in the Republic of Korea (Group A, GTMI 2020)

The e-Government Standard Framework (eGovFrame) is a platform-specific standardized development framework for public sector IT projects in Korea. It provides increased interoperability as government agencies build applications based on its standards and improves interagency collaboration and connectivity. Through regular monitoring, the Korean government is able to have updated information on the public sector organizations that are adopting the framework, contributing in this sense to a cohesive digital transformation of the Korean administration.

One of main features of eGovFrame is its open innovation approach. 48 open sources were selected and its source code, including outputs, are provided at no cost through its website (https://www.egovframe.go.kr/eng/main.do). Since its launch in 2009, eGovFrame has been downloaded over 900,000times and applied in over 5,000 projects. Also, the eGovFrame Center provides technical support, training, compatibility verification and conduct major upgrades for open ecosystem.

Source: e-Government Standard Framework in Korea, Ministry of the Interior and Safety and National Information Society Agency.

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BOX 8 - Additional Interoperability Reference Examples

Standards & Frameworks

- **Brazil** (Group B, GTMI 2020) has progressed on interoperability through the technical specifications in its architecture for the interoperability standards (EPING), while also defining premises and policies and making its use mandatory for bodies and entities that are part of the Information Technology Resource Management System. As such, the country has ensured technical, legal, and organizational interoperability.

- The **Czech Republic**'s (Group B, GTMI 2020) 2019 National Architectural Framework has been introduced for the community of eGovernment architects and suppliers of public services, and aims to ensure better interoperability across sectors and potentially cross-border.

Platforms & Infrastructure

- **Georgia** (Group B, GTMI 2020) lists many impressive accomplishments, such as a multichannel service delivery approach based on a wide network of physical one-stop shops and a government portal with over 700 fully transactional services. The country has had the Georgian Government Gateway data exchange infrastructure in place since 2010. Use of the system is mandatory for all government institutions and additionally connects several private sector organizations. This approach has facilitated an end-to-end customer journey for key services such as online tax filing and business registration. Interoperability of digital platforms (technical and organizational interoperability) remains an area for improvement.

- In **Moldova** (Group B - GTMI 2020), the Mconnect interoperability platform aims to facilitate and streamline data exchange within the public sector and between the public and private sectors. Its main purposes are to improve the quality of public services provided, support the development of new electronic public services, and ensure

information security. The platform is based on open source and is managed by the Electronic Government Agency, the public entity responsible for leading the national GovTech policy. Currently more than 60 entities are connected to the platform.

- Even though in the 2020 GTMI data collection it reported not having an interoperability platform in place, Cabo Verde (Group B, GTMI 2020) has managed to make significant strides regarding interoperability contributing to the creation of an online one-stop shop (Porton di nos Ilha in Cabo Verde). By 2018, **Cabo Verde** had put in place several central resources for public sector entities to use, allowing the country to advance digital government solutions in a decentralized yet integrated manner. The resources include common standards allowing information and data exchange, a state-owned technology network including email services and management applications, and a platform for the creation and management of electronic government solutions allowing public sector entities to use its services without having to deal with necessary ICT infrastructure.

Plans

- Both **Angola** (Group C, GTMI 2020) and **Mozambique** (Group C, GTMI 2020), according to a 2018 OECD report, have an interoperability plan on the way, which in the case of Mozambique is manifesting itself in concrete progress regarding an interoperability platform. In **Angola**, efforts have been made to improve cross-government communication through a standard system of email addresses, video-conferencing and data and service sharing between government departments. The government's private network (Rede Privativa do Estado) thus provides a common infrastructure for shared digital services across the public sector and is intended to be used in the future as a platform for citizens to access publicly available information via the Internet.

- In **Mozambique**, the Interoperability Project (Projeto de Interoperabilidade) has endeavored since 2013 to connect different IT platforms with the central government. But information and data exchange are still limited, as are the adoption of interoperability standards and the development of a systems thinking culture across the different sectors and levels of government.

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Conclusion: Interoperability for a Connected and Data-Driven Public Sector

No public organization is the same, nor should it be, as the specialized knowledge on policy domains and country context embedded in the fibers of a specific organization is essential to deliver policies and services that correspond to the needs of the citizens in its constituency. However, certain needs, such as providing data only once to the administration and automatically receiving eligible benefits transcend the borders of public organizations, policy sectors and countries. Interoperability is needed to build bridges between different government activities and streamline those activities that do not need to be different. This guidebook has explained what interoperability in the public sector is, why it is needed and how it can be implemented.

WHAT – Interoperability can be understood as the ability to connect ministries, departments, agencies, sectors, government levels, and countries through data, information systems, legal agreements, organizational processes, and shared values and customs. As such, it is considered as a multilayered concept consisting of nondigital and digital elements, namely legal, organizational, cultural, technical, and semantic layers as well as their overall governance.

WHY – Interoperability strengthens governments' ability to design and deliver public services according to the needs of citizens (citizen-centered). It also contributes to a more strategic use of data across the whole public sector to improve policy making, service delivery, and organizational management (data-driven). As such, it opens up benefits for governments and citizens in terms of efficiency gains, data-driven value creation, the implementation of the once-only principle, as well as more automated, proactive, omnichannel, composable, and resilient services focused on life events.

HOW – To reap the benefits of an interoperable public sector, governments should consider interoperability from both a nondigital and digital perspective based on eleven modules that this note explained.

Key considerations to note for practitioners who are involved in designing and implementing interoperability in the public sector are:

- Critical questions for successful interoperability projects are goal-orientation (focus on the desired outcome and value for stakeholders), co-creation (co-designing and -constructing with stakeholders), context sensitivity (adapting to local priorities and limitations), and iteration (considering the different elements of interoperability in a non-linear way).

- Interoperability is one of the key enablers of a whole-of-government approach, but at the same time a whole-of-government approach that covers from setting policy and organizational conditions to implementing digital interoperability is essential for sound interoperability.

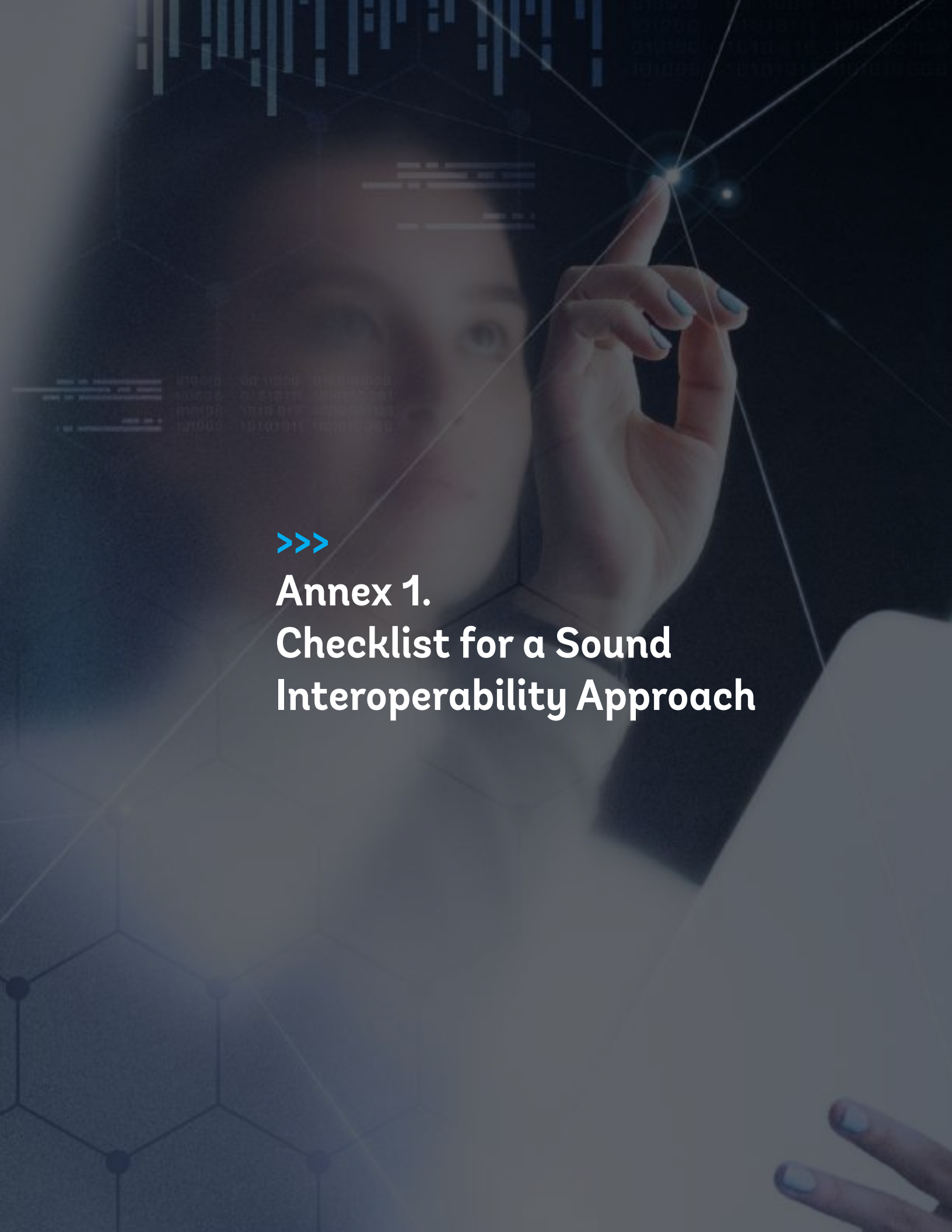
- In order to establish data-driven public sectors, practitioners need to consider: (1) policy and institutional setting, such as strategy, institutional structure with leadership, and coordination mechanisms; (2) updated and agile legal and regulatory frameworks; (3) trustworthy data governance focusing on data-driven value creation and enhancing trust based on ethics and data rights; (4) data interoperability; (5) policy levers that include preevaluation of ICT investment, standard business case, agile project management, and monitoring; and (6) data skills in public sector.

- For technical and semantic interoperability, this note presents five modules: (1) ensuring data readiness, (2) anticipating key technology trends, (3) designing a modern data architecture, (4) harnessing APIs, and (5) working with open standards and open source.

Since every country has a different maturity level, context, and capacity, there is no one-size-fits-all path to interoperability in the public sector. That is why this note provides 11 modules to help task teams and client countries to identify all related issues to establish interoperability and highlight a whole-of-government approach. Many countries may have difficulties to achieve all modules at the same time and have to prioritize some actions, considering their limited resources and time. Annex I provides a checklist for sound interoperability with suggestions of priority actions for each module based on maturity level. Countries in Group C (low) and D (very low) need to focus on establishing a strategy that recognizes interoperability as a foundation for sound public sector digitalization, having updated legal and regulatory frameworks, establishing an up-to-date data protection law, ensuring data quality, and developing national-level semantic interoperability frameworks. Countries in high maturity level (Group A and B) can advance their interoperability level through identifying and investing in areas to prioritize based on the comparison between current status and information presented in the 11 modules.

Several notable reference projects and models described in this note can assist with prioritization of government interoperability requirements. These resources emphasize the challenges of improving data architectures to support the speed and agility required from today's analytical and operational systems, which rely on increased automation, loosely coupled integration architectures, a combination of cloud and on-premise capability, and strong cybersecurity controls.

As the latest technologies are developing fast, the importance of interoperability and the data-driven public sector is also increasing. Governments need to strengthen efforts to connect their systems within the public sector and with the private sector and other countries while addressing interoperability challenges. This how-to note therefore aims to assist them to transition to a better-connected public sector by providing practical guidance on how to design and implement sound interoperability policies and platforms through eleven modules and a checklist.



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Annex 1. Checklist for a Sound Interoperability Approach

Interoperability modules	Priorities according to GovTech maturity level	
	A and B – Very High and High	C and D – Very Low and Low
GOVERNANCE/GENERAL		
Key principles	• Be **goal-oriented**: Define a clear goal and scale in terms of the outcomes of the interoperability project. Ensure that project activities contribute to this goal while keeping an open mind to future developments that may lead to adaptation of the goal. • Follow a **cocreation approach** in the problem definition, project design, prioritization, and implementation to ensure that the needs, knowledge, and support of relevant actors are continuously considered in the interoperability project. • Remain **sensitive to the GovTech maturity level and country context** at every step of the interoperability journey to achieve an ambition and implementation that is fitting to the context. • **Iterate** between the different modules, interoperability layers, and the actors involved.	
SETTING THE RIGHT POLICY AND ORGANIZATIONAL CONDITIONS		
Module 1: Policy and Institutional Setting		
Strategy	• Underline in the GovTech or Digital Government strategy the foundation role of interoperability for the development of an efficient and sustainable data-driven public sector. • Highlight the role of interoperability for data and evidence-based policy making, decision, and evaluation. • Collaborate with the ecosystem of public, private, and civil society GovTech stakeholders in the implementation of the strategy, reinforcing the relevance of the interoperability policy goals • Strengthen the governance and coordination mechanisms between the GovTech or Digital Government strategy and other national public strategies in different policy streams. • Define one or more initial goals and scale of the interoperability project in terms of user	• Highly prioritize having a GovTech or Digital Government strategy at national/federal level that recognizes interoperability as a foundation for sound public sector digitalization. • Highly prioritize recognizing data and its value in the strategy for improved service delivery and processes. • Engage different public sector organizations in the design, development, implementation, and monitoring of the strategy to secure joint ownership and responsibility, in the areas of interoperability. • Align the GovTech or Digital Government strategy and its interoperability goals with other national public strategies, reinforcing policy complementarity.

Interoperability modules	Priorities according to GovTech maturity level	
	A and B – Very High and High	C and D – Very Low and Low
	needs and strategic objectives: "Enable [users and scope concerned, for example, residents of region X; SMEs in country Y] to [service need, for example, be notified proactively about eligible welfare services; provide company data only once for local and national tax services combined] by [interoperability challenge, for example, automatic exchange of xyz data between organizations pqr].	
Leadership	• Assure the required human and financial resources of the public sector organization leading the national GovTech policy dedicated to promoting interoperability across the public sector. • Strengthen the capacity of leading public sector organization(s), using policy levers such as public procurement, preevaluation of ICT expenses, or standard business cases to promote interoperability across the administration.	• Highly prioritize Securing that promoting interoperability across the administration is one of the key policy priorities of the public sector institution leading the national GovTech or digital government policy. • Guarantee high level political support for creating interoperability policy foundations – for example, updated legal and regulatory frameworks, standards, data hubs – in different sectors and levels of government.
Coordination for improved data governance	• Consider having different levels of coordination across the administration for improved data governance: high level/ministerial level and technical level, for instance. • Invest permanently in shared ownership and joint responsibility of the interoperability policy across the administration.	• Prioritize the creation of coordination and governance mechanisms across the different sectors and levels of government for interoperability policy implementation.
Module 2: Ensuring Proper Legal and Regulatory Frameworks		
Legal and Regulatory Frameworks	• Prioritize agility and simplicity, avoiding the trap of an excessively detailed regulatory framework. • Progressively invest in having legal or regulatory frameworks in advanced areas	• Highly prioritize having updated legal and regulatory frameworks in critical digital areas such as privacy and data-protection, base registers, data exchange, and data standards.

Interoperability modules	Priorities according to GovTech maturity level	
	A and B – Very High and High	C and D – Very Low and Low
	such as the once-only principle, data ownership, and consent.	• Build on the experience of other countries of the region or from different geographies in order to leapfrog stages in the development of a sound legal and regulatory framework.
Module 3: Setting Up Trustworthy Data Governance		
Trust, ethics and data rights	Give priority to: • Moving from the right to information to open data laws and initiatives, promoting and fostering data re-use from the start. • Ensuring that citizens can consult and manage personal data handled by public authorities within legal boundaries. • Ensuring digital security, especially regarding sensitive data.	Give priority to: • Highly prioritize ensuring that there is an up-to-date data protection law covering public services, an authority responsible for upholding the law, and appropriate communication and channels to inform citizens about their rights. • Promoting openness and transparency in government. • Considering digital security from the start of a new project involving sensitive data. • Developing new digital projects through cocreation with citizens, ensuring that their concerns and needs are taken on board.
Module 4: Promoting a Data Culture and Cultural Interoperability		
Data culture	• Invest in the permanent involvement of the different stakeholders in order to create support to legal and regulatory frameworks in the area of interoperability. • Cocreate data value propositions for new projects.	• Avoid an excessively legalistic culture through the investment in more consensus-based approaches for enabled interoperability in the public sector. • Find inspiration in data-driven projects undertaken by other countries across different GovTech levels.

Interoperability modules	Priorities according to GovTech maturity level	
	A and B – Very High and High	C and D – Very Low and Low
	• Demonstrate and promote data-driven value creation in existing and past projects. • Provide concrete incentives for an innovative organizational culture. • Improve data literacy in public institutions.	• Unite relevant stakeholders around a shared problem definition, possibly building on Section 2 of this note.
Module 5: Using Policy Levers for Coherent Implementation		
Public procurement and preevaluation of ICT investments	• Continue investing in coordinated procurement for the acquisition of GovTech services and solutions, prioritizing interoperability across the different investments. • Consider implementing preevaluation of ICT investments above a certain threshold across the administration, allowing better alignment between the different sectors and levels of government in the interoperability workstream. • Progressively reinforce the link between public procurement and preevaluation of ICT investments with critical key enablers of public sector transformation such as interoperability standards and interoperability platforms.	• Raise awareness across the public sector on the importance of public procurement coordination mechanisms in order to promote interoperability. • Prioritize an initial number of relevant ICT services and products that need to be interoperable and secure procurement coordination across the public sector. • Emphasize the benefits in terms of savings and efficiency for the public sector, including overcoming the typical siloed culture that exists when managing ICT investments.
Standard business cases and project management	• Adopt standard business cases and project management tools across the administration and consider making their use mandatory. • Prioritize the agility of these instruments, and avoid creating unnecessary layers of bureaucracy for GovTech practitioners. • Consider having business cases and project management central dashboards able to feed the interoperability policy monitoring across the public sector.	• Create the foundations for coordination in business cases and project management in the public sector where interoperability objectives should have a central role. • Invest in training and capacity building of GovTech officials for the use of business cases and project management in their projects. • Obtain the necessary financial resources by linking digital and data project goals to development aid goals.

Interoperability modules	Priorities according to GovTech maturity level	
	A and B – Very High and High	C and D – Very Low and Low
	• Use the data value cycle for the definition of business cases.	
Monitoring and evaluation	• Prioritize monitoring the outputs, outcomes, and impacts of interoperability across the public sector. • Consider publishing monitoring data of the interoperability policy underway as an accountability mechanism for the ecosystem of GovTech stakeholders. • Co-evaluate the interoperability project process and results, using the KPIs, define follow-up actions and formulate lessons learnt for future projects.	• Highly prioritize ensuring governance across the different sectors and levels of government for sustaining interoperability monitoring. • Allocate human and financial resources for monitoring of interoperability policy and initiatives. • Conduct a joint evaluation of the interoperability project involving all the relevant stakeholders, focused on providing input for follow-up projects.
Module 6: Fostering Digital Skills and Talent		
Digital Skills and Talent	• Modernize human resources management (HRM) policies and practices for the attraction, retention, recruitment, job design, training, promotion, and compensation in order to assure the necessary interoperability skills are available across the administration. • Develop and implement a talent management strategy that combines different models such as on-the-job training, as well as online and face-to-face training in order to foster a continuous improvement digital skills culture in the public sector in the area of interoperability. • Invest on research and data on the digital labor market and skills for public administration, enabling public sector organizations to better understand the workforce, including existing digital talent in the area of interoperability.	• Prioritize reducing digital skills gaps across the public sector in the area of interoperability, considering it an important political priority for navigating the digital transformation underway. • Jointly develop with other public sector organizations and adopt guidelines for building, buying, or borrowing digital skills approaches. • Make digital skills development and reinforcement a specific component of the GovTech projects to be developed in the area of interoperability.

Interoperability modules	Priorities according to GovTech maturity level	
	A and B – Very High and High	C and D – Very Low and Low
IMPLEMENTING DIGITAL INTEROPERABILITY		
	Focus on: • Data quality – identifying data stewards and data gaps to be remediated within priority datasets. • Data governance, including understanding data needs within the organization.	• Highly prioritize ensuring data quality – identifying data stewards and data gaps to be remediated within priority datasets. • Data governance, including understanding data needs within the organization.
Module 7: Ensuring Data Quality		
Semantic	Focus on: • Developing national- and federal-level semantic interoperability frameworks. • Improving common data models and schemas. • Supporting capability for semantic description, mediation, and discovery. • Reusing best practice metadata standards.	Focus on: • Highly prioritize developing national-level semantic interoperability frameworks. • Enabling efficient and effective data sharing between communicating government systems. • Supporting capability for semantic description, mediation, and discovery • Reusing best practice metadata standards.
Module 8: Anticipating Key Technology Trends		
	• Understand challenges through the lenses of technology, people, process, and ecosystem • Encourage cultural transformation and collaborative environments – refer to the World Bank report, *Tech Savvy: Advancing GovTech Reforms in Public Administration.*	• Understand challenges through the lenses of technology, people, process, and ecosystem • Encourage cultural transformation and collaborative environments – refer to the World Bank report, *"Tech Savvy: Advancing GovTech Reforms in Public Administration."*

Interoperability modules	Priorities according to GovTech maturity level	
	A and B – Very High and High	C and D – Very Low and Low
	Module 9: Setting up a Data Architecture	
	Focus on: • Ecosystem approach, moving from closed architectures to more flexible ones that may cross organizational boundaries. • Creating a unified data infrastructure to prepare for data-driven emerging technologies such as AI/ML, and open up to other government architectures – enabling intergovernmental interoperability. • Understanding the 6 foundational shifts for data infrastructure.	Focus on: • Ecosystem approach, moving from closed architectures to more flexible ones that may cross organizational boundaries. • Creating a unified data infrastructure to prepare for data-driven emerging technologies such as AI/ML and open up to other government architectures – enabling intergovernmental interoperability). • Understanding the 6 foundational shifts for data infrastructure.
	Module 10: Harnessing Application Programming Interfaces (APIs) and Enterprise Service Buses (ESB)	
	Focus on: • Mediation layers. • Security-by-design. • API inventories. • Automated monitoring and analytics • Enabling multiexperience engagement with different personas through a mesh application and service architecture (MASA).	Prioritize: • Mediation layers. • Security-by-design. • API inventories. • Automated monitoring and analytics.

Interoperability modules	Priorities according to GovTech maturity level	
	A and B – Very High and High	C and D – Very Low and Low
Module 11: Working in Open Source		
	Make available open source content, trialing new capabilities, whether provided through cloud-service and technology partners or open-source toolsets.	• Use open source code made available by other countries to advance domestic data projects. Trialing new capabilities, for example, through open source toolsets.

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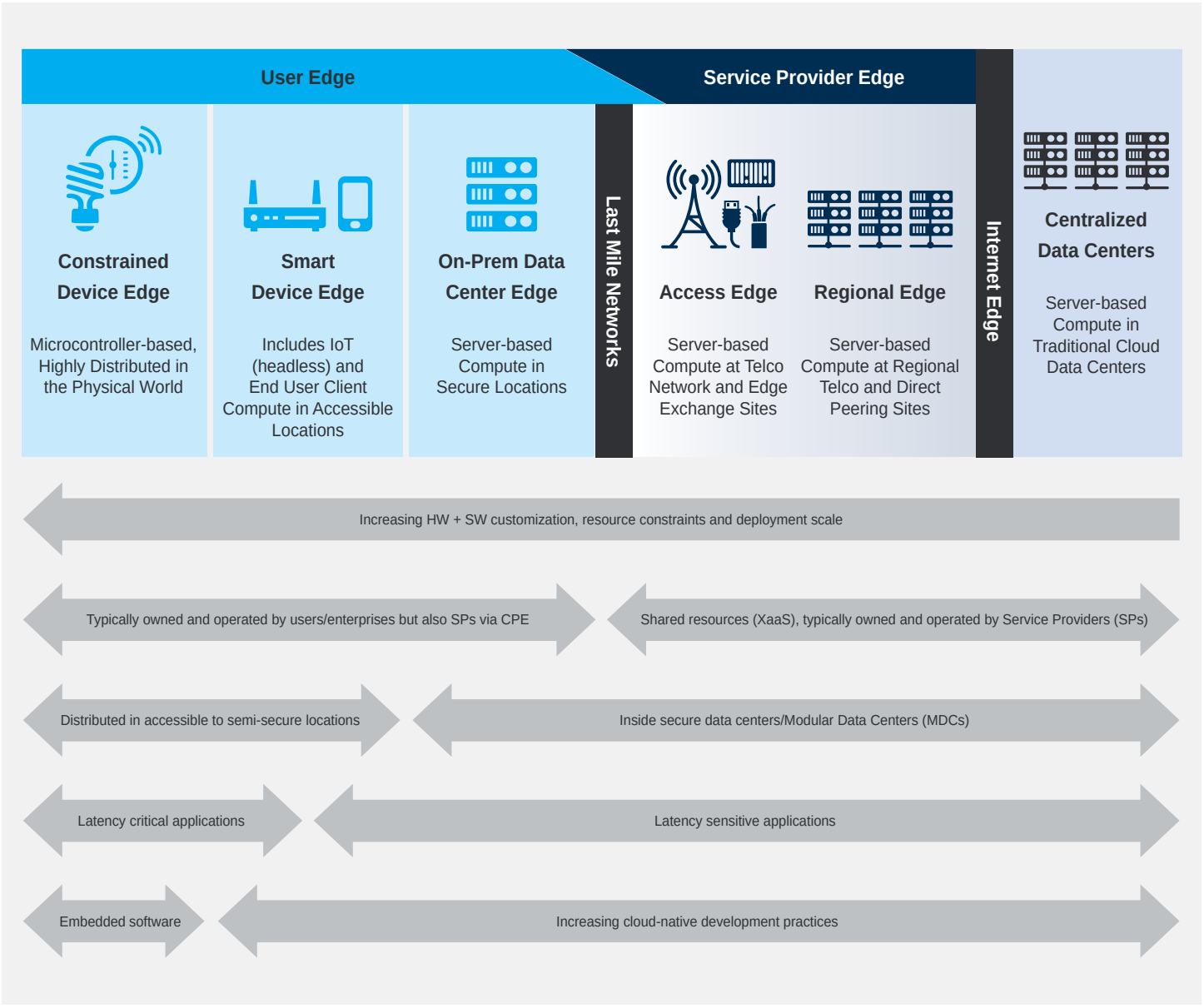
Annex 2. Emerging Technologies Trends

Following is an overview of some emerging technologies, and how they might change the need for governments to rethink interoperability efforts and acquire new skills in a data-driven and potentially decentralized digital environment.

Web 3.0, Cloud and Edge Computing

The architecture of the internet has been evolving since its inception. Recently, the trend of decentralization of computing and increasingly powerful "edge" devices has enabled a technological shift that decentralizes some of the functions of the internet. Edge computing can be defined as a spectrum of "physical infrastructure that comprises the internet, from centralized data centers to devices." This "Edge"[177] comprises a user edge, which may include smart devices, as well as a service provider edge, and forms part of the computing continuum, together with centralized data centers located on-premises or accessible through hyperscalers.

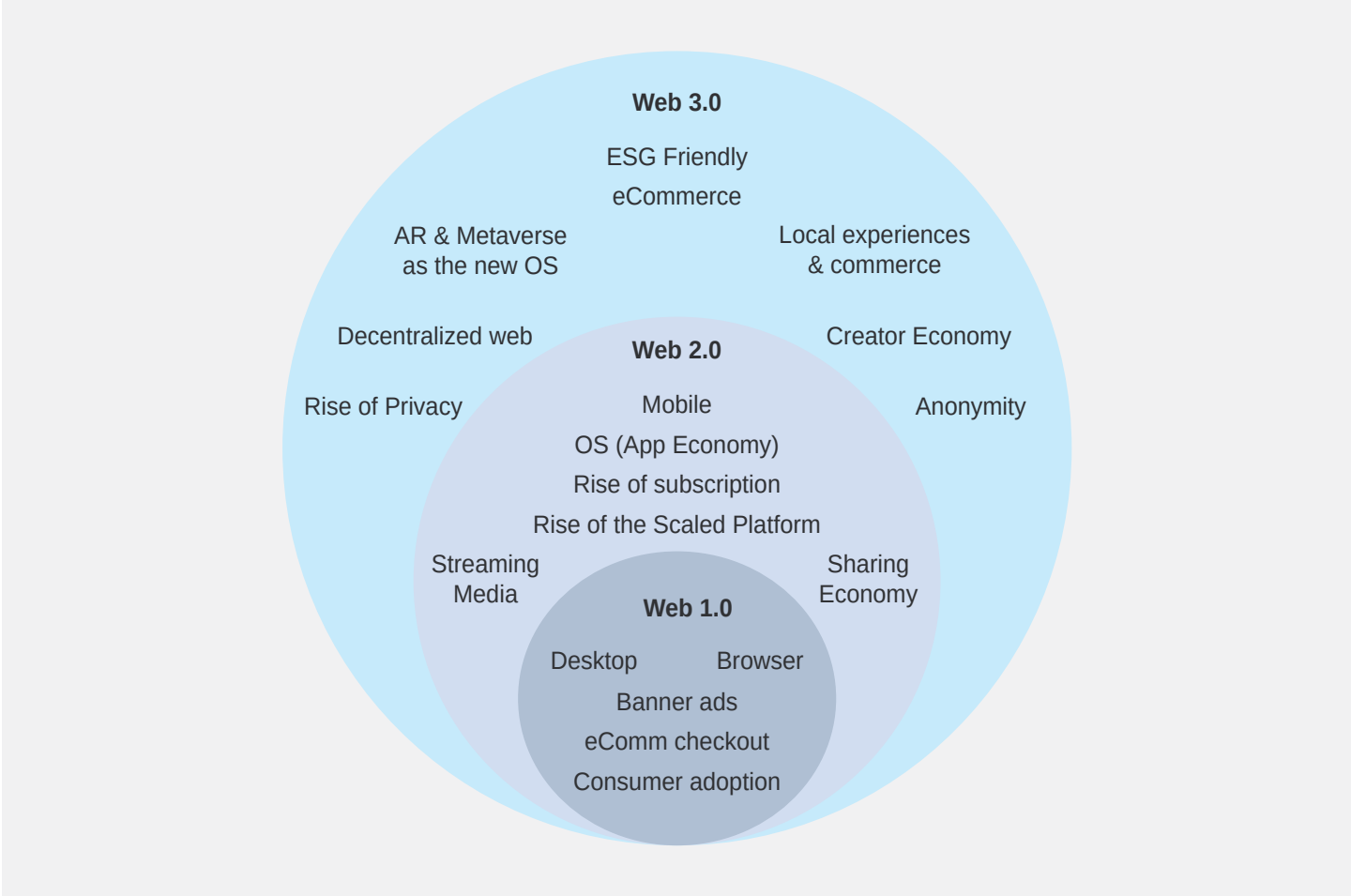
> > >
FIGURE A2.1 - Edge Continuum



Source: Linux Foundation, 2021.

> > >

FIGURE A2.2 - Evolution of the Web



Source: Eric Sheridan et al., Goldman Sachs, 2021.

At the same time, decentralized applications have started to grow in number and adoption, in an ecosystem that is described as "Web 3.0." This phenomenon, which takes advantage of more powerful edge devices, may result in a reversion to a more "localized" experience of the internet, which potentially includes new privacy features. Whereas Web 2.0 was characterized by the rise of the scaled platform, Web 3.0 may be dominated by local experiences and commerce,[178] with applications such as Decentralized Finance (DeFi).[179]

From an interoperability standpoint, this poses new challenges for governments, especially those facing a heterogeneous environment where data may be generated from multiple types of devices, with processing performed at the Edge. The volume of data processed may also exceed traditional analytical capabilities, and require new capabilities – for example, AI and ML – to deliver insights.

Internet of Things

The availability of lower cost sensors, as well as the recognition of the value of automation in urban public service delivery has led to many projects supporting the integration of Internet of Things (IoT) in today's cities. For example, IoT sensors can be used to gather data for a variety of objectives, including monitoring indoor air quality[180] and improving traffic management and flood sensing.[181] IoT devices may play a substantial role in gathering bottom-up data required to understand greenhouse gas emissions sources (GHG), with a challenge being synthesis of this data to provide intelligible insights for policy makers across a variety of sectors, including energy, buildings, mobility and transport.

Currently, the interoperability landscape in IoT is nascent, with a lack of an overarching ontology.[182] Sensor systems may employ "different standards, formats and protocols,"[183] which impedes their integration into analytical models, a barrier for such use cases as smart cities and climate change mitigation and adaptation.

Ensuring that IoT platforms "export information with semantic annotations"[184] can be a way to ensure that the data collected by these sensors can be used to support other applications, including AI and ML) models that are used for prediction in a smart city context. Interoperability may also assist with machine-to-machine communication.

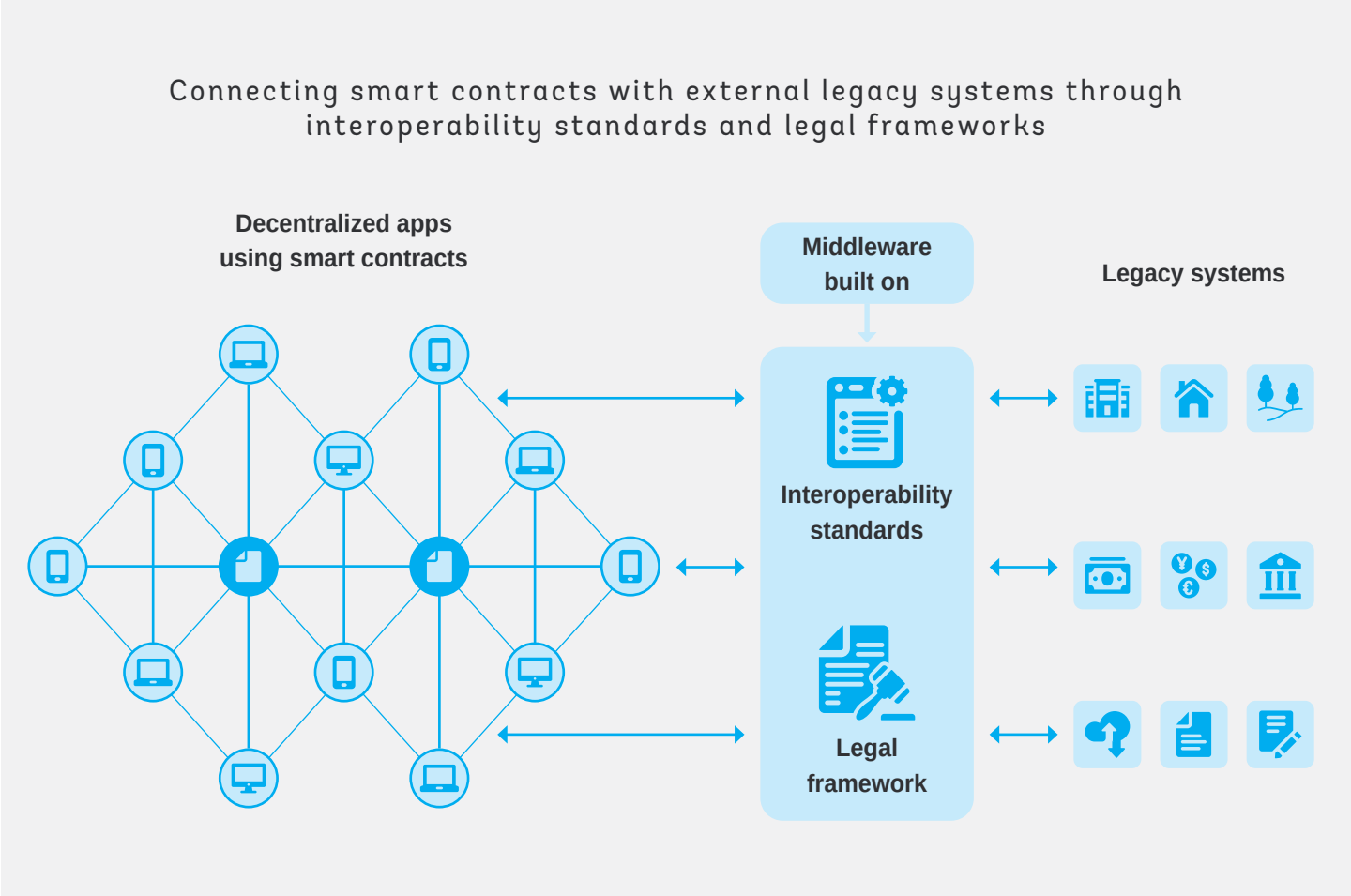
Blockchain and Distributed Ledger Technology

Blockchain is a decentralized technology that facilitates collaboration and exchange of transactional data and information among and across different players, industries, sectors, and countries in a secure and transparent way. Blockchain has entered the mainstream of computer applications, fundamentally changing the way transactions can be implemented by ascertaining trust between unknown parties. In addition, it ensures immutability (once information is entered it is difficult to be modified) and enables disintermediation (as trust is assured, no third party is required to verify transactions). These advantages can produce disruptive changes when properly exploited, inspiring a large number of applications.

Technically, blockchain interoperability seeks to achieve one fundamental goal, namely ensuring the integrity of both information exchanges (data exchange among business systems) and value transfers (digital assets exchange, for example, crypto-assets, tokens).[185] The World Economic Forum report, "Bridging the Governance Gap: Interoperability for Blockchain and Legacy Systems,"[186] highlights the important question on how the DLT innovation will affect the legacy digital systems, operated by enterprises, governments, and institutions. The report provides details about the key pillars and efforts being made for legacy systems – DLT interoperability. Smart contracts have logic embedded in the code and are triggered based on the defined inputs. These again need to interact with non-blockchain systems, thereby facilitating interoperability between smart contracts and legacy systems could unleash strong capabilities. Specific use cases and examples can be found through the UN Innovation Network, the International Association for Trusted Blockchain Applications (INATBA), the World Economic Forum, and the EU Blockchain Observatory & Forum.

> > >

FIGURE A2.3 - Blockchain Interoperability Challenges



Source: World Economic Forum, 2020a.

Artificial Intelligence

The OECD defines Artificial Intelligence (AI) as a "machine-based system that is capable of influencing the environment by producing an output (predictions, recommendations, or decisions) for a given set of objectives."[187] As AI and its related capabilities are considered to be a data-driven technology, interoperability of datasets for AI applications will be of particular concern. In the healthcare field, for example, there is a need to "develop mechanisms to enable the efficient exchange and interoperability of health data, including by setting standards for data exchange and terminology."[188] In the telecom sector where AI will play a fundamental role in harnessing new technologies, such as 5G, interoperability may focus more on the availability of open and shared standards for more efficient deployment in the enterprise.[189]

Central Bank Digital Currencies (CBDC)

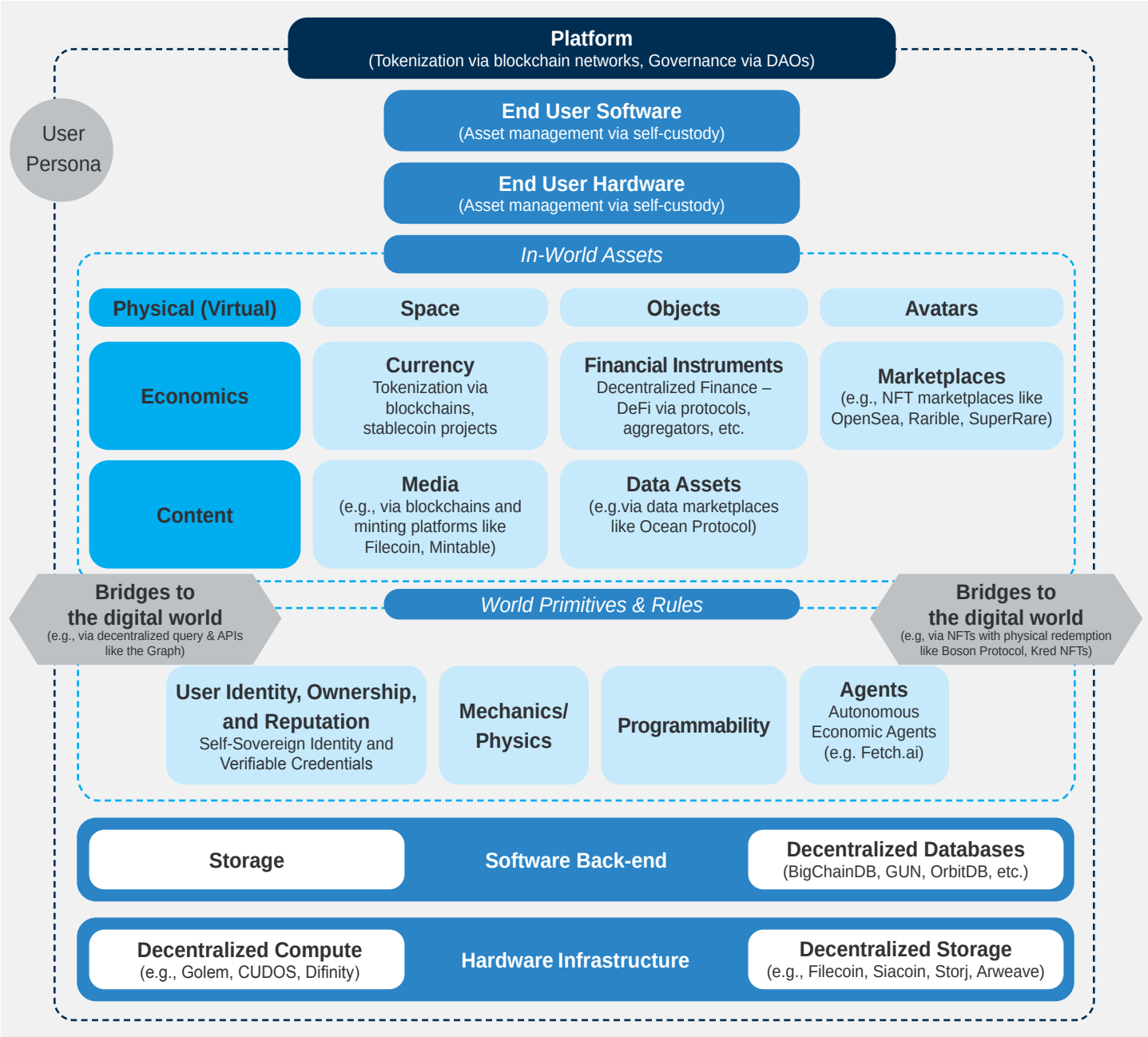
Central Banks have been exploring wholesale digital currency with a number of different motivations, including financial stability, monetary policy implementation, and payments safety and robustness. According to a recent survey by the Bank of International Settlements, one of the key drivers is to improve the efficiency of cross-border payments,[190] which will require governments to carefully think through interoperability issues to ensure the expected benefits are achieved.

Metaverse

A Metaverse is "a collective virtual open space, created by the convergence of virtually enhanced physical and digital reality."[191] Even though the adoption of Metaverse technology is still at an early stage, it is envisioned that various activities taking place in real life such as commerce, education, digital events, smart manufacturing, and telemedicine will eventually take place in a Metaverse environment.[192] A Metaverse – while currently a notional concept with proto-Metaverse development underway in many forms – may be implemented in both centralized and decentralized forms. Key issues for interoperability in a decentralized Metaverse will include identity and aspects of the shared digital economy.[193] Users may want to be able to port digital assets (for example, non-fungible tokens, or NFTs) across Metaverses, which may require open standards to facilitate.

> > >

FIGURE A2.4 - Open Metaverse Concept



Source: Shamash, David, and Robin Andre Nordnes, Outlier Ventures, 2022.

Security by Design and Zero Trust Architecture

With the adoption of emerging technologies and the increasing amount of commercial and public activity occurring in the digital space, cybersecurity concerns are of paramount importance. For example, IoT devices that support public service delivery may introduce cybersecurity vulnerabilities due to lack of firmware updates, insecure development practices, and a "fragmentation of good practices and standards."[194] According to the European Union Agency for Cybersecurity (ENISA), security by design means that "physical/cyber infrastructure should incorporate security requirements upstream during the engineering process to minimize the potential and impact of breaches."[195] This is especially important in API development, where a lack of layered defenses could lead to unintended access to system data or functionality.[196]

Separately, many enterprises are moving towards a Zero Trust Architecture (ZTA), which increases the need for "interoperable visibility and analytics capabilities."[197] The increasing use of cloud services and a hybrid workforce makes ZTA a priority, with application interactions as a key focus area. According to Palo Alto Networks, "A fundamental concept of Zero Trust is that applications cannot be trusted and continuous monitoring at runtime is necessary to validate their behavior."[198]

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Annex 3.
Modern Reference Architecture

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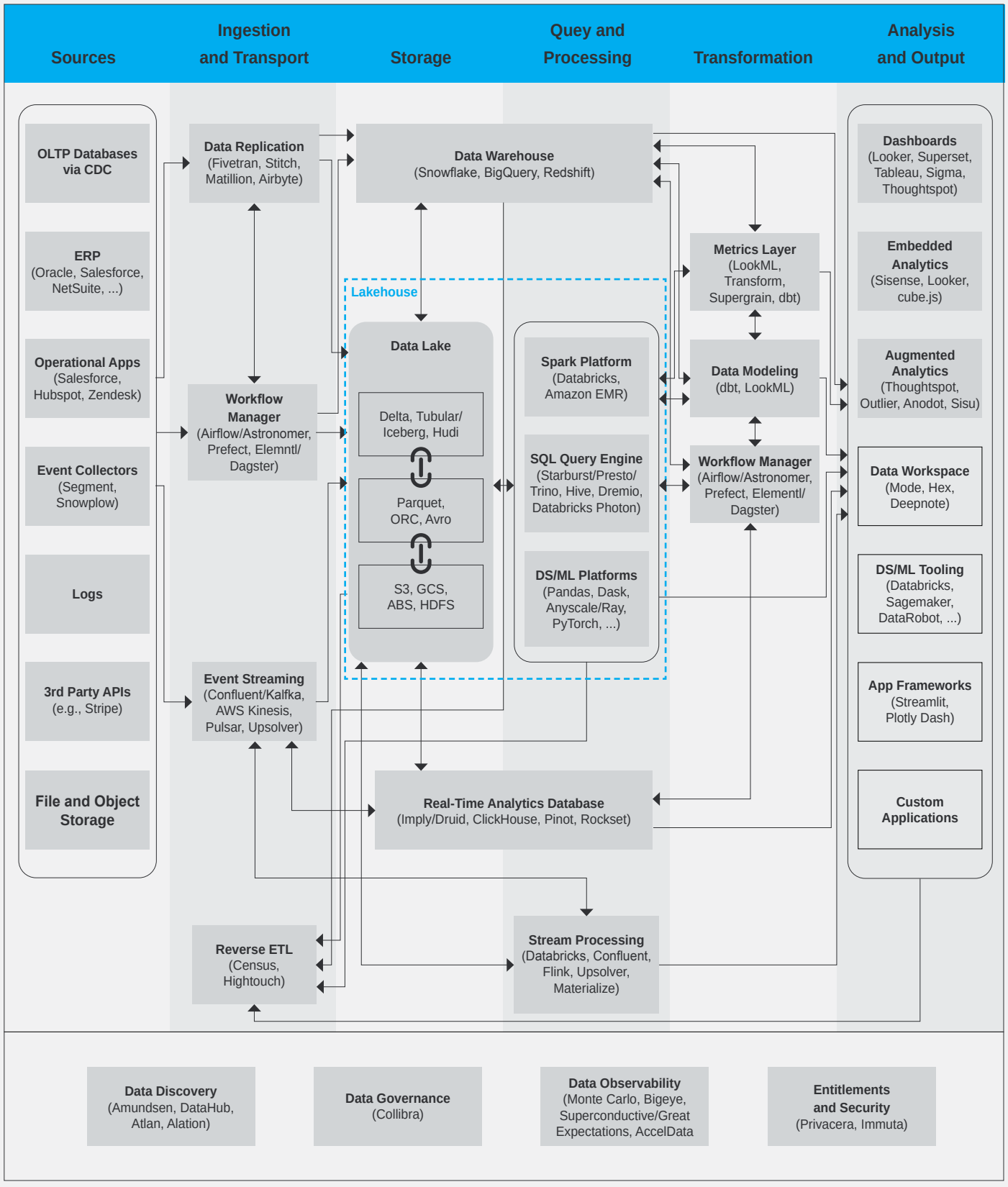
FIGURE A3.1 - Modern Reference Architecture for Unified Data Infrastructure



Source: Bornstein, Matt, Li, Jennifer and Casado, Martin, 2020.

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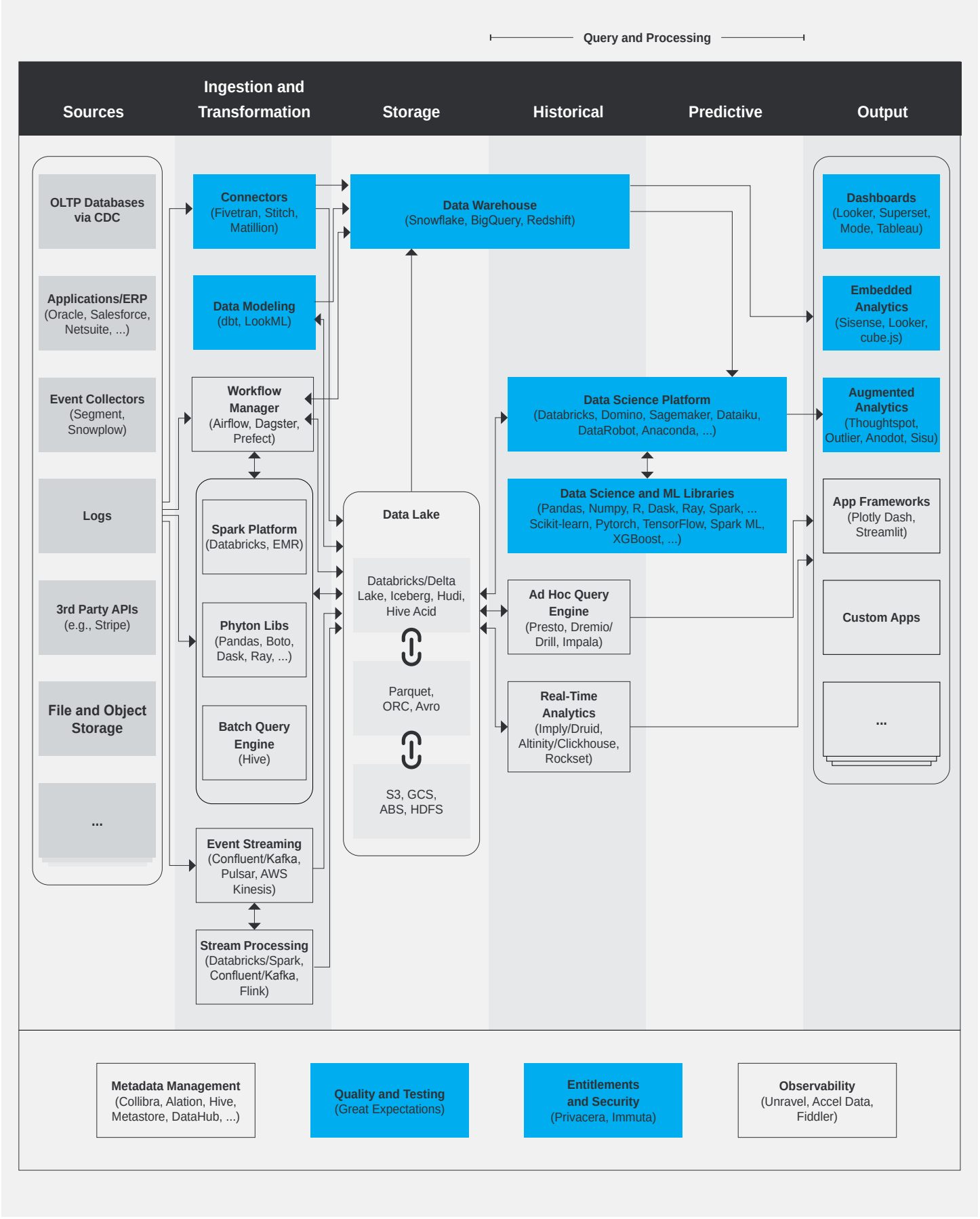
FIGURE A3.2 - Blueprint 1: Modern (Cloud-Native) Business Intelligence



Source: Bornstein, Matt, Li, Jennifer and Casado, Martin, 2020.

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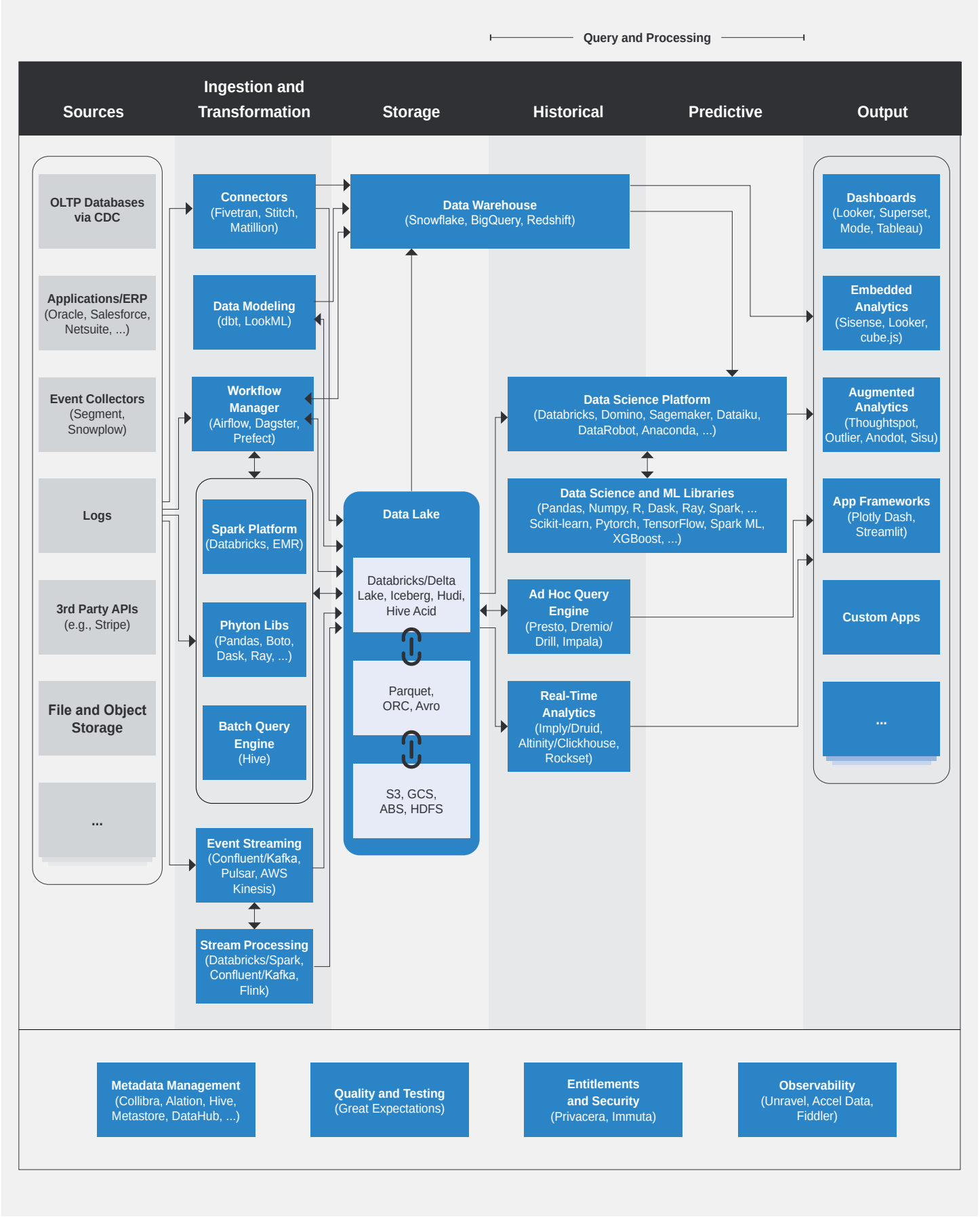
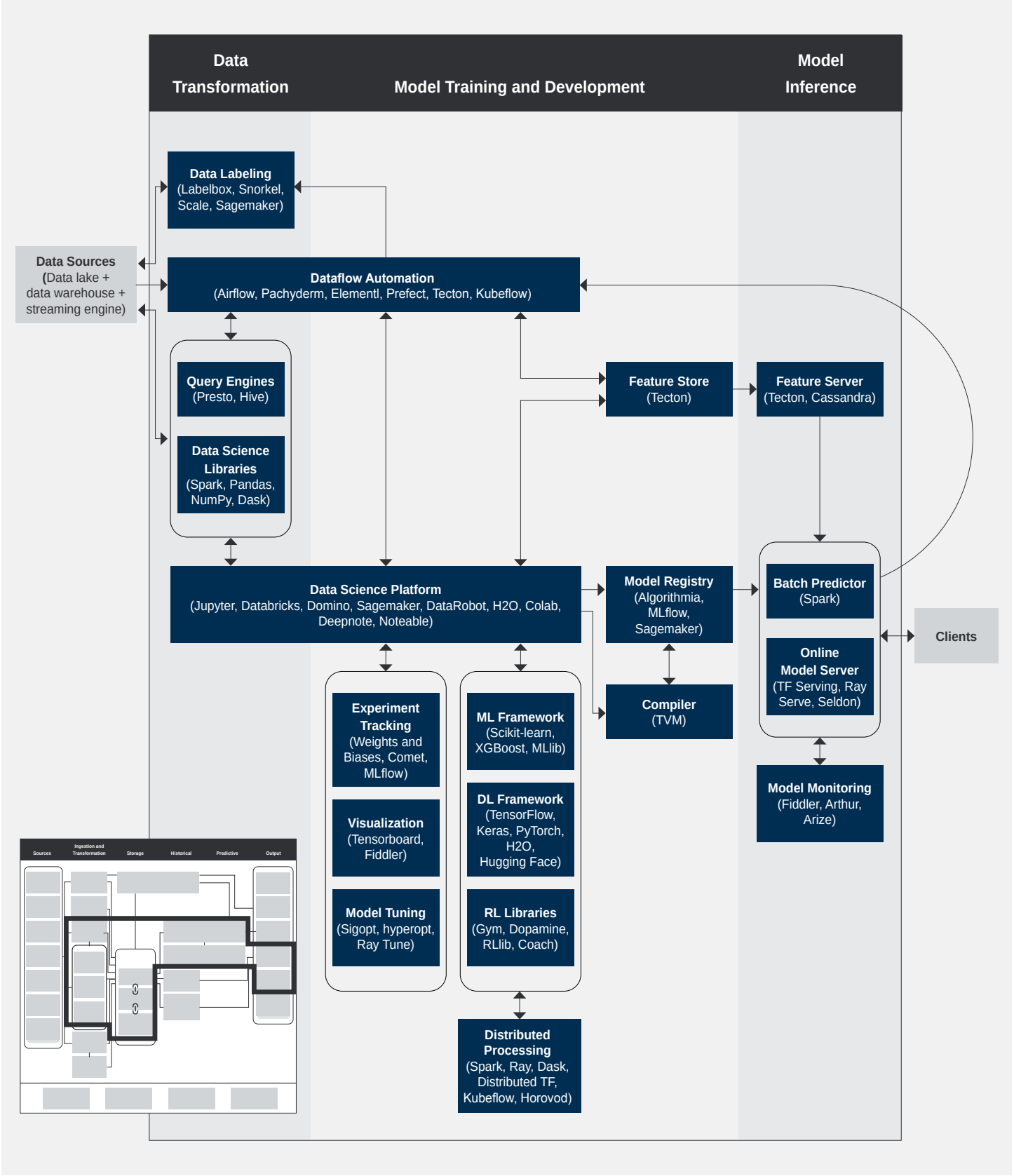
FIGURE A3.3 - Blueprint 2: Multimodal Data Processing



Source: Bornstein, Matt, Li, Jennifer and Casado, Martin, 2020.

> > >

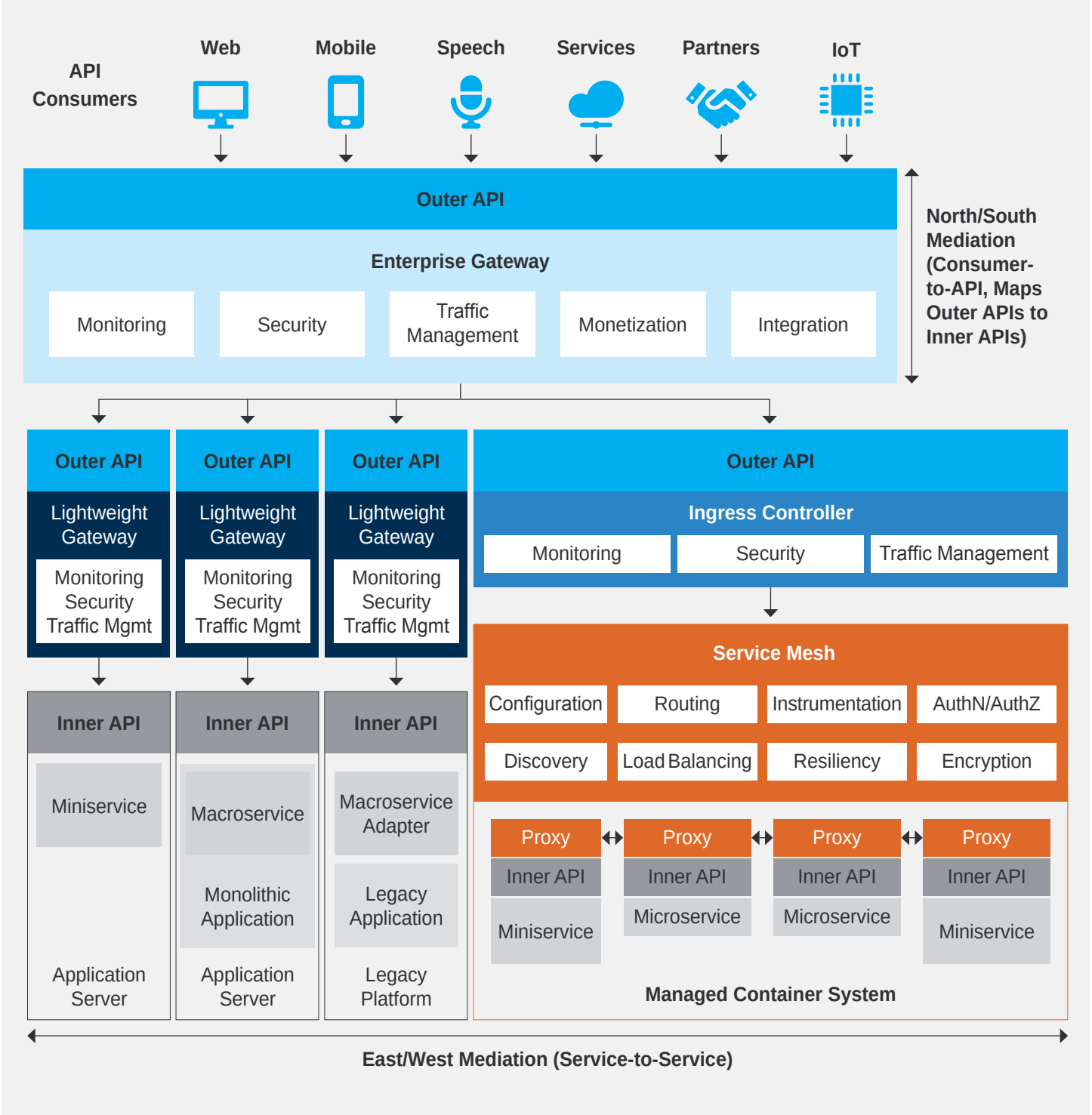
FIGURE A3.4 - Blueprint 3: Artificial Intelligence and Machine Learning



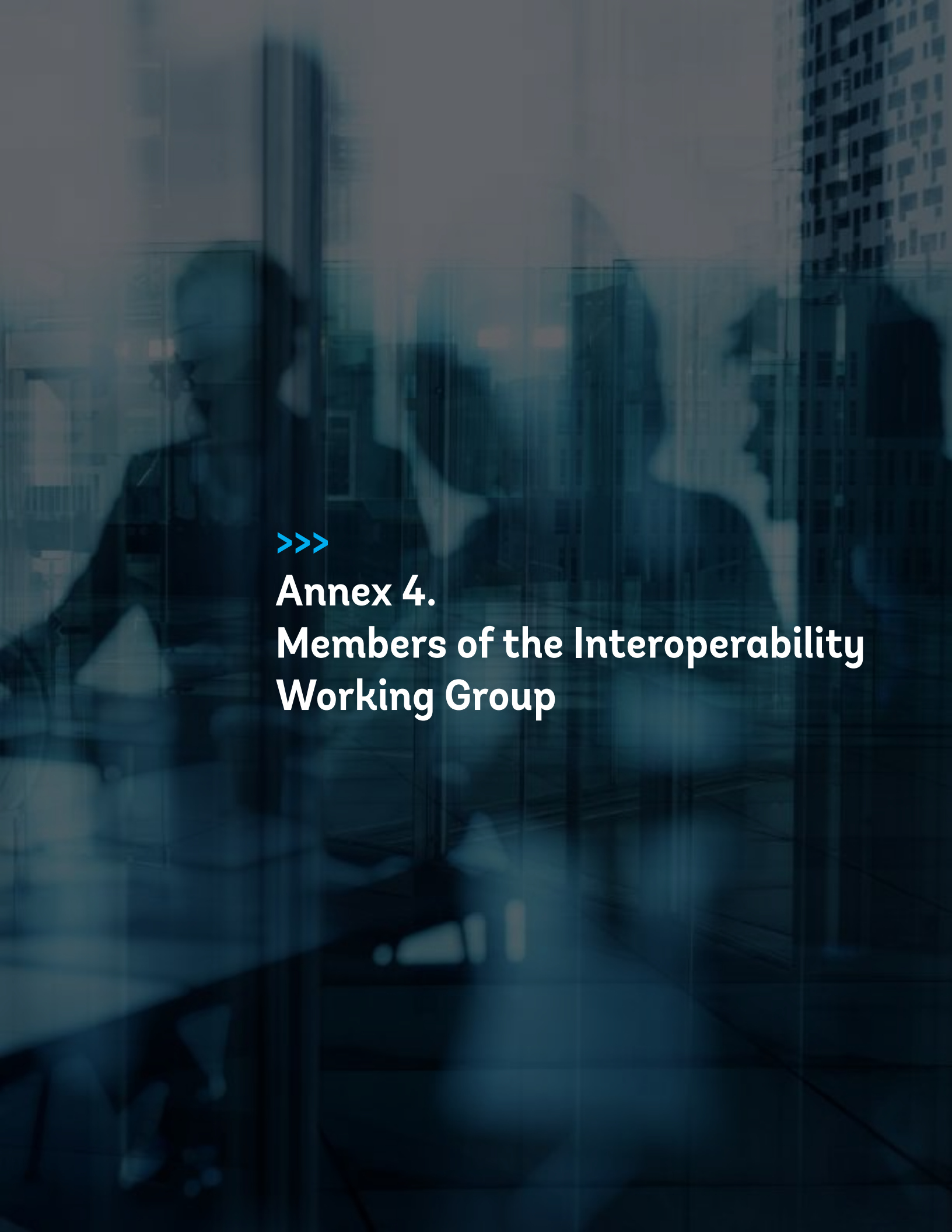
Source: Bornstein, Matt, Li, Jennifer and Casado, Martin, 2020.

> > >

FIGURE A3.5 - API: Multiple Complementary Mediators



Source: Gartner, 2018b.
Note: API = application programming interface; IoT = Internet of Things; Mgmt = management.



Annex 4. Members of the Interoperability Working Group

Country	Name	Position	Institution
Indonesia (Co-Chair)	Bobby Nazief	Senior ICT/Advisor to the Minister of Finance (MOF)	Ministry of Finance
	Gerry Firmansyah	Executive Director	WANTIKANS (National ICT Council)
	Prasetya Dwicahya	Head of Tribe	GovTech Edu
	Erwin Ariadharma	Senior Public Sector Specialist	World Bank
Portugal (Co-Chair)	Carla Marques Pereira	Digital Transformation Director	Agency for Administrative Modernization (AMA)
	Paulo Vale	Project Manager	Agency for Administrative Modernization (AMA)
	Cláudia Gonçalves Barroso	Head of Unit, International Relations	Agency for Administrative Modernization (AMA)
	Catarina Almeida	International Relations Officer	Agency for Administrative Modernization (AMA)
Argentina	Silvana Rica	National Director of Digital State Integration and Processing	Secretariat of Public Innovation team
Cabo Verde	João Cruz	Nacional Director of State Modernization	Ministry of State and Administration
	Mário Cardoso	Special Advisor	Ministry of State and Administration
	Edemilson Alves	Director of Budget, Planning and International Affairs	NOSI - Operational Unit for the Information Society (under Ministry of Finance)
Canada	Michael Mohammed	Manager, Policy and Legislation	Office of the Chief Information Officer, Treasury Board of Canada Secretariat
Citibeats	Marcos Cuevas	Chief Product Officer	Citibeats
Denmark	Carsten Ingerslev	Head of Division - Office of Digital Innovation	Danish Business Authority

Country	Name	Position	Institution
	Magnus Antonio Salcedo Jakobsen	Area 1 - Social economy, jobs of the future and green transformation	Ministry of Industry, Business and Financial Affairs
EU-DIGIT	Miguel Alvarez	Head of Interoperability Team	DIGIT
	Peter Burian		DIGIT
	Georges Lobo		DIGIT
Republic of Korea	Sungjoo Son	Director	Ministry of the Interior and Safety
Lisbon Council	Nathan Da Silva Carvalho	Project Manager and Research Associate	Lisbon Council
	David Osimo	Director of Research	Lisbon Council
	Charlotte van Ooijen	Associate Director, Digital Government and Data	Lisbon Council
Mozambique	Erminio Jasse	Director	INAGE (National Institute of Electronic Government)
	Carlos Manique		INAGE (National Institute of Electronic Government)
	Laisse Mucavele		INTIC (National Institute of Information and Communication Technology)
	Bicael Francisco		INTIC (National Institute of Information and Communication Technology)
New Zealand	Andy Warden	Principal Advisor	Department of Internal Affairs
Open Group	Pallab Saha		Open Group
Public Digital	Joanne Esmyot	Director	Public Digital
	James Steward	Partner	Public Digital
Saudi Arabia	Khalid AlGhamdi	Director	Digital Government Authority

Country	Name	Position	Institution
	Noura Al-Sanie	Director of Digital platforms' studies and business analysis	Digital Government Authority
	Majed A. Alhaidar	Director of Operations, Digital Transformation	Digital Government Authority
	Mohammed Alessa	Digital Integration Director	Digital Government Authority
Timor-Leste	Andre Marquez	Director of Infrastructure Division	Council of Ministers, Information and Communication Technology Agency, lP - TIC TIMOR
	Elizabeth Baptista	National ICT Policy & e-Governance Adviser	Council of Ministers, Information and Communication Technology Agency, lP - TIC TIMOR
United Kingdom	Liz Lutgendorff	International Lead Insight and Analysis Advisor	Government Digital Service
UNU-EGOV	Delfina Soares	Head	UNU-EGOV
	Zoran Jordanoski	Senior Academic Fellow	UNU-EGOV
	António Tavares	Adjunct Associate Professor	UNU-EGOV

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Notes

1. Andrews et al., 2022: p.23.

2. The World Bank GovTech Maturity Index (GTMI) provides insight about the extent to which countries have adopted a whole-of-government approach to the digital transformation of the public sector. This note will demonstrate that a country's GovTech maturity level is a crucial starting point for any interoperability project. For further reading on the GTMI, see Dener et al., 2021.

3. According to the GovTech Glossary (World Bank 2022a), a Government Service Bus (GSB) is a standards-based integration platform for automating secure data exchange among different government databases and applications to support government operations and the delivery of services. It entails cross-boundary platforms for connectivity and interoperability of systems across ministries and agencies.

4. Naser, 2021.

5. Gazis and Katsiri (2022) define middleware from the perspective of computer science and reflect on its necessity, and address controversies about when and where it applies.

6. Obviously, the nondigital interoperability layers that consider governance, legal, organizational, and cultural aspects can be supported by the use of digital technologies, but do not have digital characteristics as a main focus.

7. This layer has only been defined within the context of the EIF4SCC. It is not part of the EIF at the member state level.

8. Mitta et al., 2021.

9. Dener et al., 2021: p7.

10. World Bank, 2022b.

11. Banco Interamericano de Desarrollo, 2019.

12. Van Ooijen et al., 2019.

13. These and other critical issues should be addressed as part of a whole-of-government data strategy, falling beyond the scope of this note. For an analysis of the potential benefits and dangers of the use of data in development countries, see World Bank, 2021c.

14. OECD, 2019.

15. All country cases are shown with their GovTech Maturity Level in 2022 to provide readers how each maturity group design and implement interoperability clearly. Each group's level means; Group A – GovTech leaders, Group B – Significant focus on GovTech, Group c – Some focus on GovTech, Group D – Minimal focus on GovTech.

16. Skat.dk, 2022.

17. Țurcanu, 2019.

18. Buyle, 2017.

19. Wimmer, 2021.

20. Wimmer, 2021.

21. Danish Digitization Agency, n.d.

22. Duncan et al., 2021.

23. Duncan et al., 2021.

24. Tuulas, n.d.

25. OECD, 2019.

26. Roseth et al., 2019.

27. Ubaldi, 2020.

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31. Cocciolo, Serena. 2022.

32. https://www.pagopa.gov.it/it/dashboard/.

33. Denmark is transitioning from the former national eID system NemID to the new MitID, which intends to further strengthen the position of businesses, both as service users and providers. For more details, see https://www.mitid.dk/en-gb/about-mitid.

34. Dener et al, 2021.

35. Brooks, 2022.

36. E-Estonia, n.d.; 2017.

37. See https://luxembourg.public.lu/en/invest/innovation/e-embassies-in-luxembourg.html.

38. Van Ooijen et al., 2021a.

39. See for instance the DECIDO project at https://www.decido-project.eu/what-is-decido.

40. United Nations Environment Programme (UNEP), 2021.

41. Berends et al., 2020; Carrara et al., 2015.

42. Huyer et al., 2020.

43. WBG GovTech Dataset, 2020.

44. Ubaldi, 2013; Van Ooijen et al., 2022.

45. Translated by the authors from Naser, 2021: p 10: “cualquier Estado que quiera abordar la interoperabilidad desde una perspectiva holística debe tomar como punto de partida la gobernanza digital, ya que esta generará la política, la estrategia, los recursos y el apoyo institucional.”

46. WBG, 2022.

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53. Andrews et al., 2022.

54. Dener et al.

55. OECD, 2020a.

56. Digital Agency, 2022.

57. Input provided by the Interoperability Working Group.

58. Dener et al., 2021.

59. OECD, 2020a.

60. Andrews et al., 2022.

61. Andrews et al., 2022.

62. Input was provided by the Interoperability Working Group.

63. Dener et al., Ibid.

64. OECD, 2020a.

65. RIS, 2022.

66. Andrews et al., 2022.

67. ISB, 2019.

68. PCM, 2015.

69. European Commission, n.d.

70. https://www.hacienda.gob.es/en-GB/Areas%20Tematicas/Administracion%20Electronica/Paginas/default.aspx.

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74. World Bank, 2021c.

75. The Royal Society, 2020.

76. Ruhaak, Anouk, 2021.

77. Ada Lovelace Institute, 2019.

78. Open Data Institute, 2022.

79. van Ooijen, et al., 2019.

80. World Bank, 2021b.

81. Input provided by the Interoperability Working Group.

82. Van Ooijen et al, 2019.

83. OECD, 2019.

84. United Nations Environment Programme (UNEP), 2021.

85. OECD, 2019.

86. DGA, 2018.

87. Porrúa and Roseth, 2022.

88. World Bank. 2021. World Development Report 2021: Data for Better Lives. Washington, DC: World Bank. doi:10.1596/978-1-4648-1600-0.

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90. European Commission et al., 2020.

91. Battisti et al., 2019.

92. OECD, 2020b.

93. https://digital-strategy.ec.europa.eu/en/policies/digital-principles.

94. OECD, 2018b.

95. https://carpetaciudadana.and.gov.co.

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97. https://mcabinet.gov.md.

98. https://oldwww.mydata.org/korea/.

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101. Keefer and Scartascini, 2022.

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103. OECD, 2014.

104. World Bank interview with representatives of the UK's Government Digital Service, May 17, 2022.

105. Van Ooijen et al, 2022.

106. OECD, 2016.

107. OECD, 2018a.

108. Andrews et al, 2022.

109. OECD, 2018a; Battisti et al., 2019.

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114. GDS, 2022.

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126. Andrews, 2010.

127. Input was provided by the Interoperability Working Group.

128. Andrews et al, 2022.

129. NIST, 2022.

130. Davies, Tim, 2019.

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132. IBM, 2021.

133. Duhe, Max and Gracie, Matt. 2019.

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135. World Economic Forum, 2020b.

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138. Abdulla, Ahmed, Janiszewska-Kiewra, Ewa, and Podlesny, Jannik. 2021.

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140. Castro, A., et al., 2020.

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142. Olavsrud, Thor, 2022.

143. Ahmed, Safa M. Yousif and Hossana Twinomurinzi 2019, page 3182.

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145. Castro, A., et al., 2020.

146. Palmer, Andy. 2022.

147. Bornstein, Matt, Li, Jennifer and Casado, Martin. 2020.

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151. Gartner, 2017.

152. Gartner, 2018b.

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154. Australian Government.

155. Singapore Government Developer Portal, 2022.

156. Bridgewater, Adrian, 2021.

157. DataConnect 21, 2021.

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160. Both in the OECD OURdata Index and the European Open Data Maturity Assessment France has demonstrated a consistent excellent performance since many years.

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162. Cao, 2022.

163. Gartner, 2018b.

164. Gartner, 2018a.

165. RedHat, 2018.

166. RSA Conference, 2020.

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168. https://www.academia.edu/35128002/Nepal_Government_Enterprise_Architecture_Deliverable_Checklist.

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193. Shamash, David and Nordnes, Robin Andre, 2022.

194. Naydenov, Rossen, 2020.

195. ENISA, 2022.

196. GovTech Singapore, 2019.

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198. Palo Alto Networks.

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Supported by the GovTech Global Partnership - www.worldbank.org/govtech