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Next Generation Reference Architecture For Connected Government

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Abstract

Government Reference Architecture helps the Stakeholders to accommodate their strategies, vision, objectives and principles across the Government Systems. It helps in the evolution of the Government systems based on Reference Architecture Goals, Principles and standards. It helps in reduction in the IT spending in terms of increasing functionality, availability, reusability and scalability etc. It reduces the technology lock-in and promotes the Innovation across the government services. This Article attempts to describe the Reference Architecture for the Government Enterprises. It describes generic reference architecture for Government enterprises and moves on to explain various components of the Whole of the Government and how they can be leveraged to define Government Reference Architecture, which helps for the better service delivery to citizens. Government Reference Architecture enables the reuse and interoperability across Government.

Introduction

Enterprise Architecture is quite relevant to Government as Government is an 'Enterprise of Enterprises'. There exist quite number of Enterprise Architecture definitions, and solutions by various Governments and most of them are not built from scratch. The prime focuses of the government solutions today are to integrate the existing applications and make them interoperable.

Government Reference Architecture (GRA) provides a methodology, set of practices, template, standards based on the set of successful solutions implemented earlier. GRA helps as a reference for the various architectures that the Government can implement to provide the solution for various problems. It can be used as the start or the base point for various departments/Business entities of a Government that contain all the major high level functions routinely performed or required by the majority of them. GRA provides multiple views for multiple stakeholders.

According to the author, the major artifacts of the GRA are Dimensions, Business, Application, Data, Technology, Integration, Security, Transformation Elements, Capabilities, Methodologies, Standards, Metadata, Documents, Patterns and Governance etc. This article provides the overview of all these artifacts and how they connected to each other to define an End-to-End reference Architecture for whole of the Government (WOG).

Purpose of Government Reference Architecture

The Goal of e-Governance is to enable citizens and private/public sectors to access the Government Services in effective & efficient integrated Services delivery to the customers anywhere, anytime in a form convenient to the Service recipients using Internet & other channels like Mobile Computing, WAN etc. Enables citizen to participate in Government's Policies framing and decision making, enhanced transparency, empowerment and less corruption.

Government Reference Architecture helps to achieve the following at the abstract level,

- It is more of a communication channel to the Government
- Helps the Governments to accommodate their Strategies, Vision, Objectives and Principles
- Helps to evaluate the Government IT systems based on Reference Architecture Principles
- Helps to reduce IT spending in terms of increasing the usage of Next Generation Technologies, availability and scalability etc.
- Real time Integration Model, helps to reduce the latency of the data updates
- Used to define single source of Information
- Provides a clear vision on the managing of the information and security
- Cost Optimization across Project and Solution Portfolios, by eliminating unused or duplicate investments and assets
- Shorter Implementation Time and Cost

Once the reference architecture is in place, the set of architectural principles, standards, reference models, and best practices ensure that the aligned investments have the greatest possible likelihood of success in both the near term and the long term (TCO) and better Service Delivery and policy implementation.

Common pitfalls of Government Architectures

During the course of assignments/experiences with various Government engagements, the author made the following observations - some indicate a lack of maturity of the Global Government Initiatives and advanced technologies.

- Most of the Government departments/agencies have developed significant amount of in-house or home-grown applications which are not flexible
- Most of the applications do not have the required scalability, maintainability to sustain growth in volumes or functionality
- Applications face interoperability issues with other applications in the Government landscape. Integrating a new application or process requires a considerable effort on part of other applications
- Application boundaries are not clear and functionality, which is not in the initial scope of that application, get pushed onto it. This results into development of the small & multiple applications without proper boundaries
- Usage of Legacy systems, Poor Integration across various applications and Internal Systems. Most of the Integrations are developed on an ad-hoc basis and Point to Point Integration
- Department to department communication is not established. Geographic distribution of the use of the services is non-existent.

- Redundancy of the Business Functions in different applications. Reusable services are not built
- Fragmented data across the different applications and no integrated view of the Strategic data
- Many Performance Issues due to the use of the Complex Integration across various departmental systems
- Lack of Mobile Centric approach

The collaborative efforts of Governments to overcome some of above problems have resulted in the induction of bodies like National e-Governance, Digital Governance etc. These bodies have come up with frameworks for business processes, data, applications and technology for Government Transformations. These are good starting points for Governments to clean up their enterprise landscape.

Government Enterprise Reference Architecture

Connected government is about enabling governments to connect seamlessly across functions, departments/agencies and jurisdictions to deliver effective and efficient services to citizens and businesses. GRA is an abstraction of multiple solution architectures designed and implemented to solve a specific business or technical problem within a given problem space. It incorporates learnings, standards and best practices gained from multiple successful implementations. Adoption of Reference Architecture provides the benefits such as citizen-centricity, certificate less governance, multi-channel service delivery, service levels and better performance.

GRA reduce challenges in the ability to leverage solutions across Government. For architects, it serves as a key input when creating department/agencies future state enterprise architecture. Additional benefits of GRAs include risk mitigation, simplified decision making, improved deployment speed and cost reduction.

The major components of the GRA are Dimension, Business Architecture, Application Architecture, Integration Architecture, Data Architecture, Technology Architecture, Security Architecture, Architecture Subject Areas, Transformation Elements, Capabilities, Performance Indicators, Standards and Governance. The details of each at the abstract level are examined in the subsequent sections.

The following diagram depicts the Government Reference Architecture of the Whole of Government (WoG).

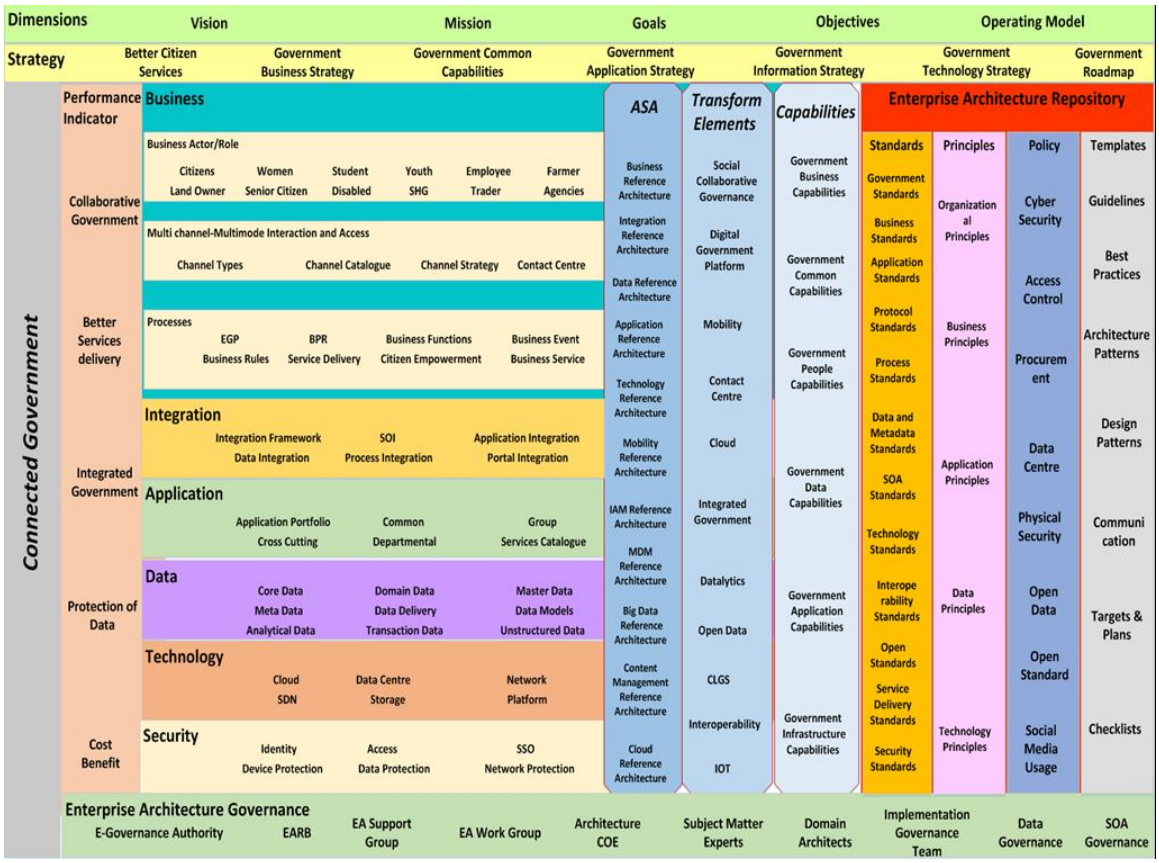

Fig 1: Government Reference Architecture-WOG View

Dimensions of Government

This section describes the Vision and Strategy of Whole of Government (WOG).

Vision

To develop Government as an innovation society of global repute, with a focus on enhancing the quality of life of its citizens, through high quality education and healthcare, increased productivity in agriculture and allied activities, creation of requisite employment potential by promoting electronics and IT industries, and above all, by providing good governance.

Strategy

For most of the Governments, e-Government Strategy is designed to provide a link between the architecture and strategic goals, policies and investments.

- Sets the objectives and roadmaps for business improvement and transformation
- Sets goals for data and information quality, governance and sharing
- Sets strategic context for the evolution of the business application portfolio through sharing, reuse and the adoption of common capabilities

Business Architecture

Business Architecture describes the organizational, functional, process, information, and geographic aspects of the business environment of the Government. Business

Architecture in e-Governance describes the relationship between Government and Citizens (G2C and C2G), Government and Businesses (G2B and B2G), Government and its Employees (G2E and E2G) and the internal processes of Government itself (G2G). Business Architecture predominantly addresses the following three categories.

Business Actor/Role (Stakeholders)

Stakeholder, acts like a Business Actor is an individual, team, or organizations that assigned to one or more Business Roles. These roles participate in accessing the Government Services, schemes that help in better Citizen Service delivery. Business Roles will be customized to suit the profile of different categories and classes of citizens, like Women, Students, Youth, Employee, Land Owner, Farmer, Senior Citizen, Disabled, Business People, Self-help Groups, Traders, and Pensioners etc.

Multi-Channel & Multimode Access

Government jurisdictions with multiple channels (municipal offices, physical mail correspondence, contact centers, e-government websites and mobile apps) are struggling to provide their citizens with one coherent view of the Government. A multichannel strategy, in the context of digital government, means more than delivering a seamless experience to stakeholders.

Business Processes

Business Process addresses, Business Process Reengineering (BPR), Elemental Government Processes (EGP), Business Event, Business Service, Citizen Service Delivery Mechanism, Business Functions and Business Rules.

BPR deals with the related departments/agencies, forms and processes simultaneously to normalize the processes across all the agencies. Elimination, Simplification, Optimization, Workflow Automation, Self-Service and Integration shall be the thumb rules for such a process transformation.

Complex Government Processes are broken down to their elemental components called Elemental Government Processes (EGPs). Such EGPs, across all the processes of Government, will be re-engineered and transformed to highly efficient and transparent, so that transforming the more complex processes becomes automatic and trivial.

Business Event triggers or interrupts the Business Process. Events are based on some activity or schedule.

Business Service fulfils the business need of a citizen.

Business Functions fulfill the unique business purposes. It can operate independently, as a separate function and work together to support relevant strategies. Business Functions describe key areas that are required across all Government Organizations and at the 'Strategy' and 'Management' level the vast majority of these functions will be undertaken and provided in a specific manner that is relevant to the individual Government Organization.

The following diagram depicts the interaction between the Business Architecture elements.

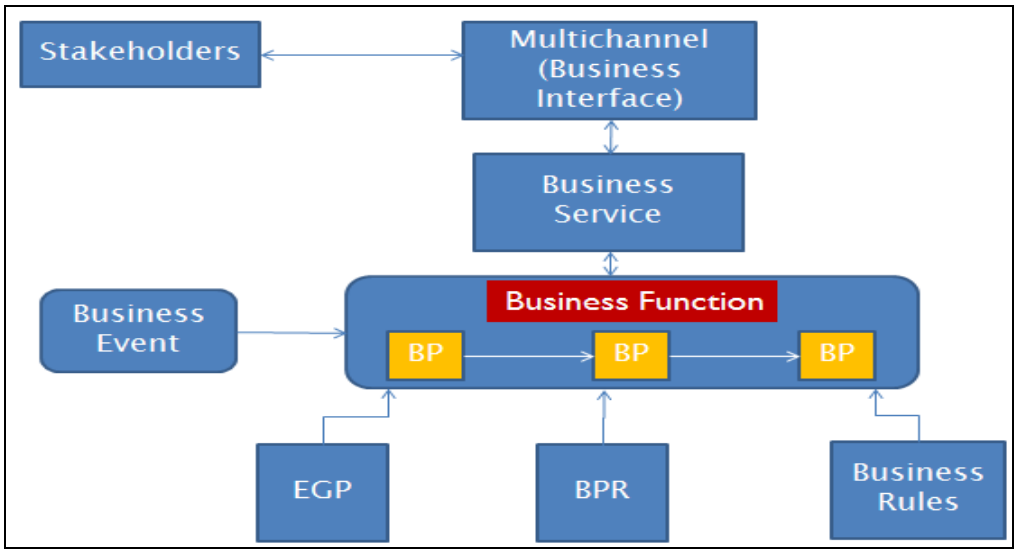

Fig 2: Business Architecture Components

Application Architecture

Application architecture describes the structure and behavior of applications used in the Government, focused on how they interact with each other and with users. This involves defining the interaction between application packages, databases, and middleware systems in terms of functional coverage. Application architecture seeks to manage how multiple applications are positioned to work together.

Generally, the government application portfolio being very huge, the application portfolio categorized into Common, Group, Crosscutting and Department/agencies applications. The following describes the characteristics of these applications:

- Common Applications: Applications that is commonly used across the Government i.e., by multiple departments/agencies. The nature of these applications is generic in nature
- Group Applications: Applications that are common for groups of departments/agencies with comparable or similar functionalities
- Cross-cutting Applications: Applications that have workflows cutting across various departments/agencies while delivering a service or set of services
- Department/agencies Applications: Applications that
- are specific to departments/agencies to deliver a service and do not fall under above categories

Application Architecture should address the following matrices are part of the target architecture,

- Application-Organization Matrix, to show which departments/agencies require/use each of the applications in the portfolio.
- Role-Application Matrix, to show what role each actor plays in each application
- Application-Interaction Matrix, to show, which applications talk to other applications and for what purpose.
- Application-Functionality Matrix, to show the discrete services and functions that each application delivers/ performs.

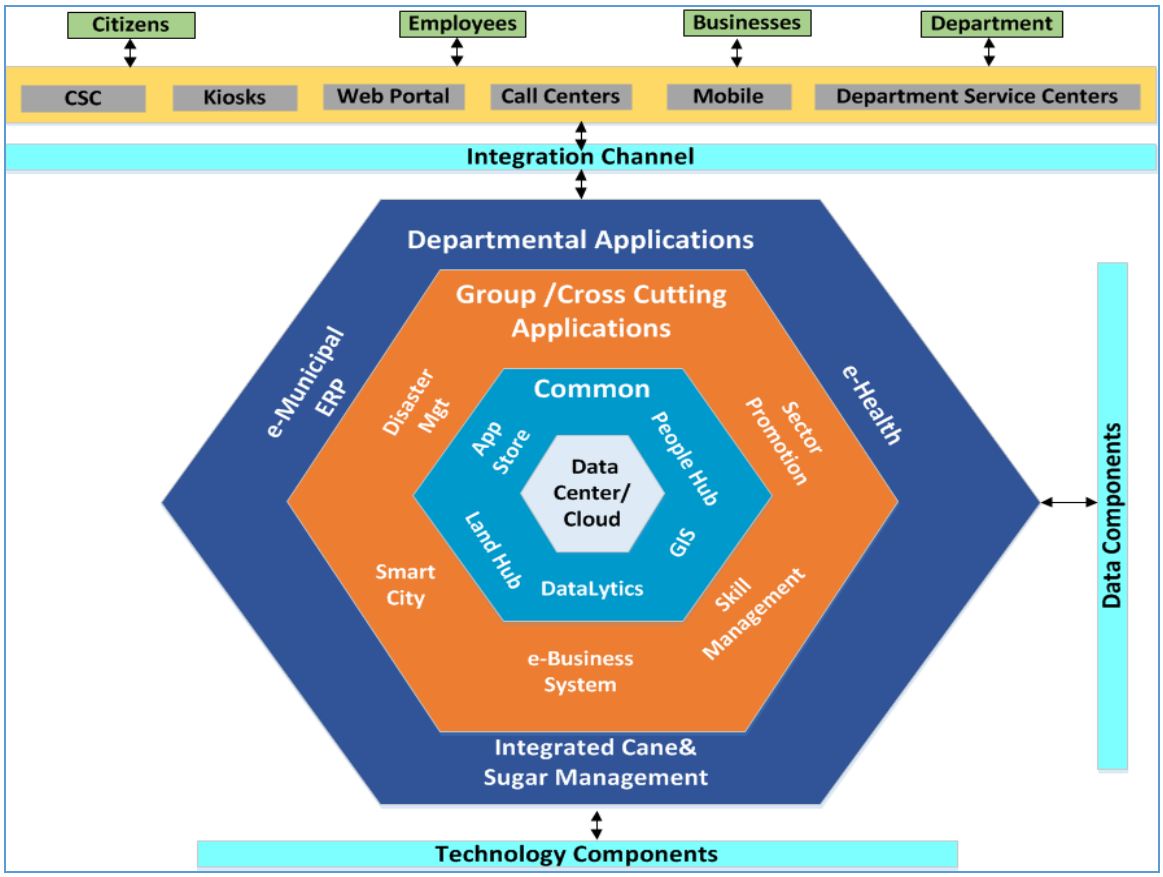

Fig 3: Application Architecture Components

Integration Architecture

Integration Architecture acts as a neural network of the government departments/agencies, to which all systems can connect eliminating tight coupling. An Integration Architecture is the infrastructure component of a SOA software package that enables communication and interoperability between the various government applications. Middleware will replace all direct integration between applications, and serves as a message broker for all communications and service invocations.

The target integration architecture based on SOA reference architecture and consists of multiple layers representing the key considerations and responsibilities involved in designing the SOA based integration solution. Each layer is an abstraction that encapsulates a group of architecture building blocks that define key responsibilities of that layer and support a set of related capabilities. Various Levels of Integration are,

- Service Level Integration
- Data Level Integration
- Process Level Integration
- Business Process Management
- Portal Integration
- Gateway Integration

Data Architecture

Data has paramount importance in big enterprises like Government. Data comes from different sources, formats, goes through rigorous processing and transformation, stored and accessed in distributed environment. Data should be freely flowing across the system that will help various stakeholders to perform their responsibilities. Data should be accessible with single source of truth with right levels of access controls.

The data architecture addresses the types of databases that exist in the system, how they are integrated, overarching management framework that include data governance, vision, principles and standards, data security, data access, lifecycle and migration models and various data models such as conceptual, logical and physical.

Government data architecture consists of following types of databases:

- **Metadata:** Metadata is 'data about data' and plays an important role in providing context and purpose of data around its definition, relationships with other data entities, creation, polices, transmission, lineage, search, retrieval etc. Metadata forms the basis for the data governance process. Creator, Date, Format etc. are few examples of metadata elements.
- **Master Data:** The data available in master database is relatively invariant and commonly used across many applications owned by departments/agencies. This data is used identify geographic locations, entities, and a large variety of information, which can be represented as a list of standard codes. The number of master datasets can be quite large for an enterprise like the Government, as it relates to / emanates from the functions of various sectors or departments/agencies.
- **Core Data**: The core datasets contain data elements that are the most commonly used in the applications of several departments/agencies of the Government. Core datasets are implemented as data hubs, which represent a single source of truth.
- **Domain Data:** will have following domain databases:
    - Department/agency Databases
    - Operational Data Store (ODS)
- **Analytical Data: will have following analytical databases:**
    - Data Warehouse
    - Data Mart

Data Models were classified as, conceptual Data Models, Logical Data Models and Physical Data Models. Other important aspects of the Data Architecture are,

- Data Access Model
- Data Lifecycle Model
- Data Security Model
- Data Migration Model

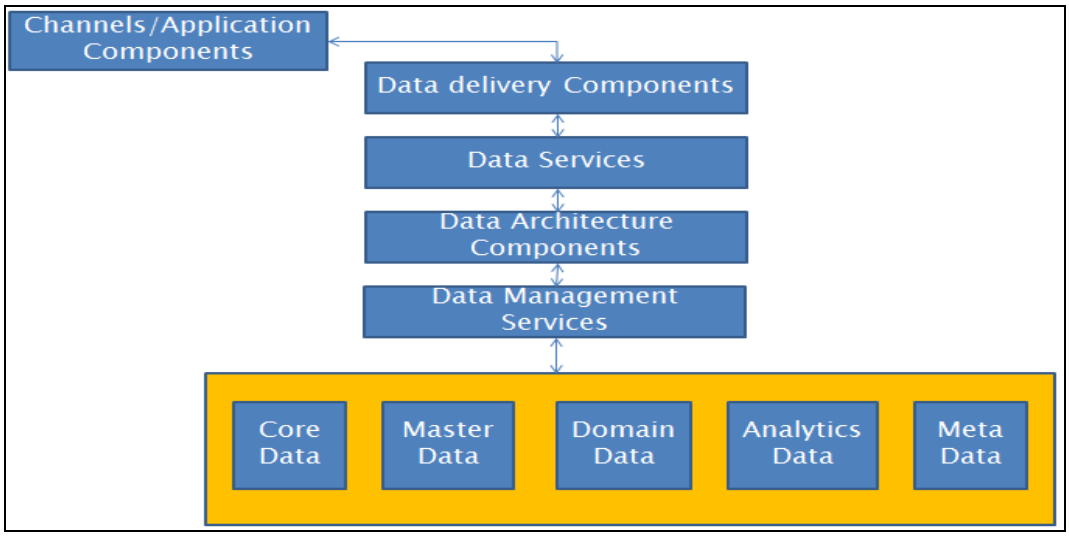

Fig 4: Data Architecture Components

Technology Architecture

Government Technology Architecture is a collection of technology building blocks positioned and/or sourced in such a manner as to enable us to achieve the Government Vision. Technology Architecture is built with technology building blocks that support the systems that are used in Government, both software and hardware. Technology Architecture is designed to fulfil the requirements of Government Enterprise Architecture with the latest technologies and are the most suitable options. The Architecture should be modular in structure and allow easy extension, expansion, enhancement or replacement in parts, with technological advancements. The major components of the Technology architecture are,

- Compute, Storage and Platform Infrastructure
- Middleware
- Networks & Connectivity
- Data backup Architecture
- Data Centre
- Disaster Recovery Architecture
- Network architecture
- Bandwidth Requirements
- Software Defined Networks
- Cloud First
- Platform for Integration with Social Media
- Design, Development and Management of Websites

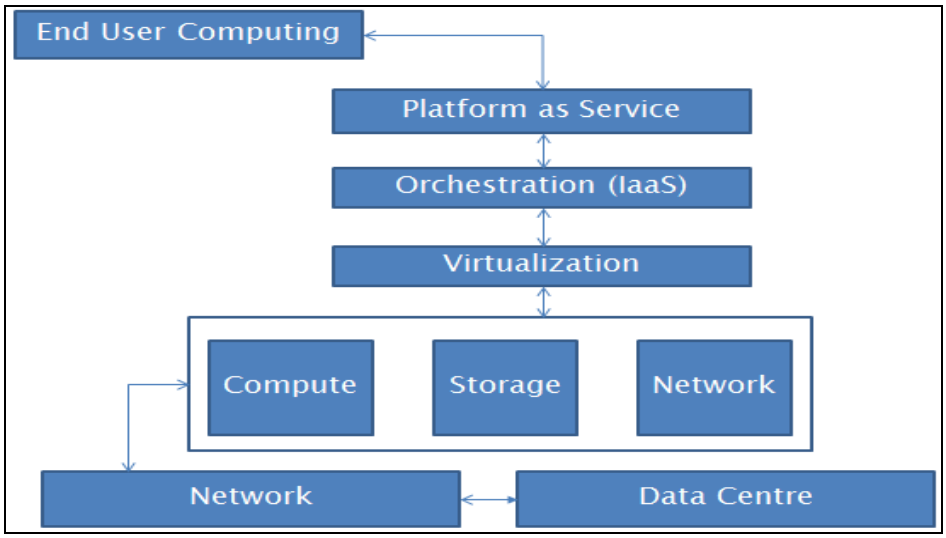

Fig 5: Technology Architecture Components

Security Architecture

Government Security Architecture will apply a comprehensive and rigorous method for describing a current and/or future structure and behavior of a Government security processes, information security systems, personnel and organizational sub-units, so that they align with the organization's core goals and strategic direction. Key components of Government Security Architecture are Access Management, Identity and Credential Management and Single Sign-On.

In addition, Cybersecurity is an integral part of cross-functional services of IT. It can be classified as three major security categories,

- Data protection (encryption, cloud security, access control and authentication, secure data sharing)
- Network protection
- Device protection (server, desktop, laptop, mobile and industrial controls)

Architecture Subject Areas (ASA)

The Architecture Subject Areas (ASA) provides the foundation to improve business capabilities. These are the repeatable solutions across the Whole of Government (WOG), which can be modeled as shared solutions. The implementation of these ASA's helps in reducing the cost, risk and time to delivery. Communication and Collaboration among these Government Systems can also be improved by using these ASA's.

The following diagram depicts the architecture subject areas, which form the part of the Government reference architecture.

- Integration Reference Architecture
- Big Data Reference Architecture
- Cloud Reference Architecture
- Mobility Reference Architecture
- MDM Reference Architecture
- Identity and Access Management Reference Architecture
- Service-Oriented Reference Architecture
- Enterprise Content Management Reference Architecture

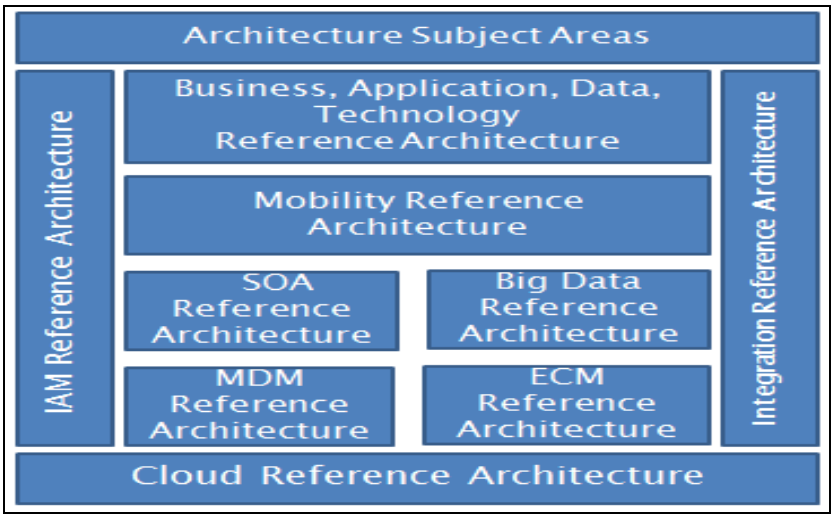

Fig 6: Architecture Subject Areas

Government Service Transformation Elements (GSTE)

Government Service Transformation elements serve to transform the Government and build the Government of a state/country as an innovation society of global repute. In addition, the goal is to enhance the quality of life of Citizens, through technology revolution and process revolution. Implementation of Transformation elements improves the service delivery to the citizens and business and helps to enhance the happiness quotient of the Citizen.

The key GSTE are,

a. Social Collaborative Governance: Collaborative governance is a Platform in which government actors are participants and/or objects of the processes.
b. Digital Government Platforms: A digital government platform incorporates service-oriented architecture design patterns for the provision and use of enterprise services across multiple domains, systems and processes.
c. Digital Inclusion: Digital Inclusion ensures citizens have access to Information Technology so that they can benefit from the Government's growing knowledge and information society.
d. Mobility: Using the mobile web sites and mobile apps all the citizens can access the Government services offline from smart phones, tablets or other devices at anywhere and anytime.
e. Contact Centre: The Contact Centre is not only for receiving or transmitting a large volume of requests by telephone, compared with the traditional citizen self-service, it has more benefits such as migrate agent-based assisted service to interactive voice response (IVR) flows resulting in reduced costs, computer telephony integration (CTI) for helping citizen be more efficient.
f. Cloud: The main objectives of cloud adoption in Government are cost reduction, speed of procurement and deployment, and responsiveness to regulations and needs for cost cutting.
g. Integrated Government: Integration acts as a neural network of the government departments/agencies, to which all systems can connect. It helps to move towards a "Certificate-less society" or, ideally towards "Service-less Services"
h. Datalytics: Datalytics provides tools for performing analysis on the data, and gain insights, make data-based predictions, and identify the best course of action for improving operational efficiency and governance.

i. Open data: Opening up of government data in open formats would enhance transparency and accountability while encouraging public engagement. The government data in open formats has a huge potential for innovation building various types of Apps, mash-ups and services around the published datasets.
j. Certificate less Governance System (CLGS): CLGS system helps to abolish most of the certificates and establishes a Certificate Less Society across Government. It minimizes usage of physical documents (no scan/photocopies, no physical papers) via electronic formats and sharing across agencies.
k. Interoperability: Interoperability is the ability of government organizations to share information, integrate information and business processes by use of common standards, and work flows.
l. Security: Government departments/agencies need to implement more encryption technologies that enable departments/agencies to protect the data and transmit that data securely.
m. Internet of Things (IOT): IOT is the network of physical objects (fixed or mobile) that contains embedded technology to communicate, monitor, sense or interact with multiple environments.
n. Gamification: Gamification can be used by government to motivate interactions with citizens or to achieve more meaningful levels of engagement with employees. It help government to run communications campaigns, engage citizens, train officials and even change behaviour.
o. Smart City: Various instruments are used to build smart cities such as use of clean and green technologies, wide spread use of ICT, PPP model for efficiency and good governance.

Government Capabilities

The capability view is one of the most important artifacts of the Government Enterprise Architecture, as it is the immediate focus for:

- Identifying common capabilities across departments/agencies, applications, services
- Gap analysis in future state transitions

Capabilities shall address the following,

- Government Business Capabilities
- Government Citizen Capabilities
- Government Data and Information Capabilities
- Government Application and Service Capabilities
- Government Infrastructure Capabilities

Government Performance Indicators (GPI)

Government Performance Indicators (GPI) provide targets and performance measures that quantify the intended action plan and performance benefits. They provide measurements and controls for business services, processes, capabilities and business change, data, information quality, data governance and data sharing, application cost benefits, application sharing, reuse and effectiveness infrastructure cost benefits, sharing, reuse and effectiveness, security and privacy

Examples for a few Objectives of GPI's are,

- Increased Citizen Participation and Engagement
- Better Performing, Collaborative, Integrated, and Efficient Government
- Better Service Delivery to Citizens through multi Channels
- Protection of information and citizen rights

Standards, Principles & Policies

Standards

Broadly, the standards classified as e.g.e. Business, Data, Application and Infrastructure for Government dimension.

Business Standards:

- Standard shared domain functions
- Standard role and actor definitions
- Security and governance standards for business activity

Data Standards:

- Standard coding and values for data
- Standard structures and formats for data
- Standards for origin and ownership of data
- Restrictions on replication and access

Applications Standards:

- Standard/shared applications supporting specific business functions
- Standards for application communication and interoperation
- Standards for access, presentation, and style

Infrastructure Standards:

- Standards for hardware products
- Standards for software products
- Standards for network products
- Standards for software development

Principles

The Principles are broadly classified as, Organization Principles, Business Principles, Data Principles, Application Principles and Technology Principles. A good set of Architecture Principles has the following 5 qualities:

- Understandable
- Robust
- Complete
- Consistent
- Stable

Policies

The major policies that drive the Connected Government are,

- Cyber Security Policy
- Access control policies
- Data Centre Physical Security Policies
- Procurement Policy
- Open Data Policy
- Open Standard Policy
- Policy on use of Social Media by Government departments/agencies

Government Architecture Governance

Government Architecture Governance (GAG) is less about control and strict adherence to rules, and more about guidance and effective use of resources to ensure sustainability of Government strategic objectives. The objective of GAG is to manage and maintain architecture requirement of Government EA. It comprises enterprise structure, processes and standards to ensure that architecture is consistent with Government objectives/vision and meeting business, department/agencies and citizen requirements. Effective and efficient GAG ensures that priorities are based on broad consensus across the enterprise. GAG is a continuous activity and governance is an integral part for its successful implementation and maintenance.

Lack of GAG may result in non-standardized technology / product selection / purchasing / development, inconsistent architecture that may lead to monolithic implementations ("built in silos"). These will have a long-term financial and operational impact and will create issues related to integration, collaboration and standardization that will be further difficult to manage and maintain at organization level.

Significant cost savings will be achieved with the right governance model in government enterprise, in addition to the following benefits:

- Brings clarity in roles and responsibilities through management oversight.
- Facilitates clear and quick decision making on contentious issues by bringing in transparency and accountability.
- Preserves architectural coherence by weaving in a compliance culture.
- Keeps architecture relevant and useful in a pragmatic manner.
- Elevates the role of and accentuates visibility accorded to architecture within the government.
- Expedites adoption of architecture thinking in the government
- Ensures that architecture efforts are expended on the right activities.
- Sets focus on performance improvement leading to attainment of best practices

Conclusions

GRA is an abstraction of multiple solution architectures designed and implemented to solve a specific business or technical problem in a given problem space. GRA serves as the foundation for disparate architectures throughout the Government, even if they are developed using different tools and technologies. Reference Architectures model the abstract architectural elements for the Government independent of technologies, protocols and products that are used to implement Service Oriented Architecture. Adoption of Reference Architecture provides benefits like citizen-centricity, certificate less governance, multi-channel service delivery, service levels and better performance. GRA reduce challenges in the ability to leverage solutions across Government. For architects, it serves as a key input when creating department/agencies future state enterprise architecture. The effort to create and harvest reference architectures and other reusable assets is not a one-time event but it is an ongoing process of continuous improvement. In addition, for those governments which do not have a reference architecture framework in place, or have an incomplete on, this Article helps to establish/setup reference architecture to be used across the government.

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